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Estimated Business Interruptions Losses of the Deepwater Horizon Oil Spill

Vanessa Vargas

Vanessa Vargas
Candidate

Economics
Department

This thesis is approved, and it is acceptable in quality and form for publication:

Approved by the Thesis Committee:

______________________________ ,Chairperson

Kristine Grimsrud

Ru Santos

ESITMATED BUSINESS INTERRUPTION LOSSES
OF THE DEEPWATER HORIZON
OILSPILL

BY

VANESSA N.VARGAS

BACHELOR OF ARTS
ECONOMICS

THESIS

Submitted in Partial Fulfillment of the
Requirements for the Degree of

Master of Arts
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The University of New Mexico
Albuquerque, New Mexico

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DEDICATION

In memory of my grandfathers Tanilo Estanislado Vargas and Ernesto Holguin Palacios; and my father, who departed in his prime, Estanislado Vargas.

Their sacrifices and desire for higher education achievement for their children and grandchildren were the inspiration for the pursuit of both my undergraduate and graduate education.

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ABSTRACT OF THESIS

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B.A., Economics, University of New Mexico, 1999
M.A., Economics, University of New Mexico, 2011

ABSTRACT

A generalized framework of Economic Analysis of natural and man-made disasters is applied to the estimation of business interruption losses associated with an oil spill. Specifically, this framework is applied to the Deepwater Horizon incident which occurred on April 20, 2010 and resulted in the extensive fouling of the Gulf of Mexico waters and the associated coastline.

The region of analysis is the coastline extending east from Louisiana to the Pan-handle of Florida. Economic impacts were measured as business interruption losses reported as lost Gross Domestic product at the county, state, and national level. Short-run economic impacts were evaluated using the Regional Economic Accounting Tool, based on Input-Output methodology, for business interruptions of less than one year. Medium- and Long-run economic impacts were estimated using the Regional Economic Models, Inc. REMI. The REMI Model is a dynamic hybrid model that combines econometric, input-output, and computable general equilibrium equations to estimated economic impacts. Regional economic impacts, as measured by loss GDP, were found to be of more concern than national impacts.

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Chapter 1

Introduction

On April 20th, 2010, in the Gulf of Mexico, an exploratory oil well unit, the Deep Horizon had an explosion. As a result of this event oil was scattered throughout the Gulf of Mexico, at the time of the event the amount of oil that was flowing from the undersea leak was unknown. It was assumed that any oil leaking from the blow out would wash up on the coastline of the Gulf of Mexico. To date the Deep Horizon oil leak event is the largest and possibly the most expensive oil spill/man-made disaster in history. Estimates of the amount of oil spilled range from 20,000 and 40,000 barrels (840,000 and 1.7 million gallons/3.2 million and 6.4 million liters)[1] The oil that rose to the surface of the sea is predicted to be carried by Gulf currents to coastal waters, beaches, and inland water-ways.

Chronology of Event

Millions of gallons of oil have poured into the Gulf of Mexico beginning with an explosion on Transocean's Deepwater Horizon oil rig – licensed to BP Oil – on April 20, 2010 with 11 workers reported killed in the explosion[2]. The rig was drilling at the site of BP's Macondo project 42 miles southeast of Venice, Louisiana, beneath about 5,000 feet of water and 13,000 feet under the seabed[3]. On April 22, 2010 the rig sinks, flyovers reports observing a 5 mile oil slick. April 25, 2010 the Coast Guard reports that remote

[1] http://response.restoration.noaa.gov/dwh.php?entry_id=809; http://online.wsj.com/article/SB10001424052748704302304575213883555525958.html; http://www.offshore-technology.com/features/feature84446/; http://www.doi.gov/deepwaterhorizon/Interior-Fact-Sheet-BP-Deepwater-Horizon-Response.cfm

[2] http://abcnews.go.com/WN/bp-oil-spill-transocean-holds-memorial-11-lost/story?id=10739080

[3] http://www.telegraph.co.uk/finance/newsbysector/energy/7677198/Gulf-of-Mexico-oil-spill-timeline.html

underwater cameras detect that the well is leaking approximately 1,000 barrels of crude oil per day.[4] April 28, 2010 The Coast Guard approves a plan to have remote underwater vehicles activate a blowout preventer and the stop leak. Efforts to activate the blowout preventer fail. April 28, 2010, the Coast Guard reports the flow of oil is approximately 5,000 barrels per day (bpd) (210,000 gallons/795,000 liters)—five times greater than first estimated.

A controlled burn is held on the giant oil slick. April 30, 2010 President Obama declares that no drilling will be allowed in new areas (exploratory drilling), until the cause of the Deepwater Horizon accident is known. May 2, 2010 U.S. officials close areas affected by the spill to fishing for an initial period of 10 days. May 7, 2010 the fishing ban for federal waters off the Gulf is modified, expanded and extended through the month of May. The leak remains uncontained. May 18, 2010 the U.S. nearly doubles a no-fishing zone in waters affected by the oil, extending it to 19 percent of U.S. waters in the Gulf of Mexico.

The first heavy oil from the spill washes ashore in Louisiana marshlands and part of the slick enters a Gulf current that could carry it to Florida and beyond. May 29, 2010 BP says the complex "top kill" maneuver to plug the well has failed, crushing hopes for a quick end to the largest oil spill in U.S. history. June, 4 2010 BP's containment cap is reported to be collecting about 1,000 barrels per day. The government estimates 19,000 barrels a day could be gushing into Gulf waters. There are reports of tar balls washing ashore on Florida’s panhandle. June 10 2010 U.S. scientists double their estimates of the

[4] http://www.telegraph.co.uk/finance/newsbysector/energy/7677198/Gulf-of-Mexico-oil-spill-timeline.html

amount of oil gushing from the well, stating that between 20,000 and 40,000 barrels (840,000 and 1.7 million gallons/3.2 million and 6.4 million liters) flowed out of the well before June 3.

As of early June it is unclear how long it will take BP to seal the leaking undersea well. There is a large amount of uncertainty on the effectiveness of the oil clean-up effort and attempts to seal the leaking well. It is assumed that further efforts to seal the well will prove unsuccessful for some time, further endangering the coastline of Gulf Coast states. Fishing waters throughout the Gulf Coast remain closed to commercial and recreational fishing. With reports of oil and tar balls washing ashore throughout the Gulf Coast the tourism, recreation, and mining (oil and gas extraction) industries remain anxious about their fate.

Objective

The objective of this study is to apply a generalized framework of Economic Disaster Analysis to the Deep Horizon oil spill in the Gulf of Mexico (GOM) over the short, medium, and long-term. This study is concerned with the: the industry sectors that are likely to be negatively or positively affected due to the oil spill; with losses reported in a standard and accepted metric at the county, state, and regional level; discussion of industry sectors that will be able to recover and those that may be permanently lost. The analysis will be conducted under the assumption that the oil could/will foul the beaches and ports from Louisiana east to the Panhandle of Florida. The study will focus on all states with counties that border the Gulf of Mexico, excluding Texas.

Chapter 2

Economics of Natural and Man-Made Disasters

Assessing the economic impacts of disasters is a very recent methodical field of study. Disasters have been, and continue to be, of great concern. Disaster generally falls into two categories natural and man-made. Natural disasters are events that are outside the domain of human control typically: floods, earthquakes, hurricanes, tsunamis, etc. Man-made events can either have malicious intent or be thought of as "accidental". Regardless of how or why the disaster occurred these events all have similar outcomes: loss of life, property damage, business disruption, and employment losses.

The list of natural disasters is known quite well. We know of the devastation of Johnstown, Pennsylvania flood in 1889 that killed 2,000 died in the; the eruption of Krakatoa in 1883 – described as the first catastrophe of the communications age (USGS, 2005) - and the resulting tsunami that killed more than 30,000 people; and the Galveston hurricane of 1900 killed more than 6,000 of the island's residents. Recent natural disasters have grabbed headlines and brought awareness to the fact that humankind is still vulnerable to such events: the 1918-1919 flu pandemic that claimed an estimated 30 million lives (Becker, 2005; World Book 2005); Northeastern China earthquake that killed 240,000; Northwestern Iranian earthquake killed 40,000 in 1990; and 2004 Indonesian tsunami with a death toll exceeding 300,000.

Man-made disasters differ from natural disasters in that they can range from mechanical failures, human error, or malicious intent. The most distinct difference between a natural disaster and a man-made disaster is the minimal loss of life associated with man-made disasters. When thinking of man-mad disasters it is common to immediately think of terrorist events. Although, a terrorist event may result in loss of life it and other man-made disasters do not often cover such a large area as to impact a large amount human life negatively. The most immediate effects of man-made disasters are often property damage and business losses. In approximately the last 30 years examples of man-made disasters are: the Ixtoc I oil spill in 1979, in 1979 the Three Mile Island partial nuclear meltdown, the Exxon Valdez oil spill in 1989, the September 11th terrorist attack resulting in approximately 3,000 deaths, and the Northeast Blackout in 2003. The Hurricane Katrina disaster can be thought of as a disaster that straddles both categories; the effects of Hurricane Katrina of which were exaggerated due to poor planning, engineering, and outlandish mistakes resulting in approximately 2,000 deaths.

Until around the 1960s the common attitude was that the costs of disasters would be borne by individuals; there was little demand for comprehensive economic assessments of disasters. One of the few early assessments of the economic impacts of a disaster was published in 1920 estimating the impacts of the Halifax ship explosion of December 1917 (Scanlon, 1988). One can find very little in the academic literature for more than 40 years, but during those years, public policy and public attitudes about disaster relief changed. With these changes came demand for information about the size (impact) of disasters from an economic perspective. If there were to be programs to provide aid to victims of disasters, then the impacts must be quantified.

Property Damage and Value of Statistical Life

Availability of data and death tolls are often driving factors in economic analysis; two readily available metrics for assessing economic impact to disaster events include property values and the value of statistical life (VSL). For some classes of disaster events a simple calculation involving the number of anticipated causalities and property damage may be enough to provide the rough magnitude of the economic consequences of a disaster event. However, property damage and VSL are incomplete for understanding the implications of the total impacts on an economic system.

Property Damage

Property damage is often estimated as the cost of replacing or repairing the property. However, according to economic theory, the value of an asset such as a building or property is the discounted flow of the net future returns from its utilization. Property damage is therefore a decline in the original value of an asset that reflects a decrease in the future production of goods or services dependent on the asset. In other words, the value of an asset should reflect its contribution to output over its economic life, so property values and the value of output should be equal. In practice, estimating property damages is complicated. First, measurement problems often occur when determining asset values. Three available measures of the value of real property are: income generated, replacement cost, and the prices of comparable assets. Second, there are difficulties in allocating real property loss to both the constructed facilities and the land, which may not be destroyed in the event. Third, market valuation of an asset is not necessarily equal to its purchase price or the replacement costs. For real property not completely destroyed repair costs are unlikely to equal the value of lost production attributable to the damage. If property is not destroyed in the event, this is a lacking metric of man-made and natural disasters.

Value of Statistical Life

While controversial and multifaceted, placing a dollar value on human life is often necessary for a community to evaluate the appropriate allocation of resources to reduce life-threatening risks. The conceptual premise underlying the valuation of a human life is that one can determine some maximum payment that an individual would be willing to make to improve her change of survival. Of course the statistical value of life cannot be directly observed, and must be estimated implicitly. The VSL is not an appropriate measure if the disrupting event does not lead to significant losses of life.

Disaster Economics Historical Context

The study of disaster economics gained prominence following the devastating Alaska Earthquake in 1964 and the establishment of the National Flood Insurance Act of the United States in 1968. In 1969, Douglas C. Dacy and Howard Kunreuther published the foundational book of disaster economics titled, "the Economics of Natural Disasters." The authors stated that the purpose of their work was to "formulate a clear-cut case for the development of a comprehensive system of disaster insurance as an alternative to the current paternalistic Federal policy". Dacy and Kunreuther's work can be viewed as a book with four major sections: the framework of analysis was established using traditional economic theories based on the frequency and pattern of natural disasters and their related damage in the US; the analysis of empirical data for the short-run (recuperation[5]); and the long-run (recovery[6]); discussion of the role of the federal

[5] Dacy and Kunreuther's term, not often used in current literature.
[6] Dacy and Kunreuther's term, long-run is still thought of as recovery time.

government in natural disasters[7]; the authors recommend and analyze disaster insurance programs.

The fundamental contribution of Dacy and Kunreuther's book is the establishment of a framework for the analysis of the economic impact of disasters. Dacy and Kunreuther's generalized theoretical framework of disaster analysis has two parts: a microeconomic analysis that is centered on the short-run behavior of businesses in the immediate aftermath of the disaster event; and a macroeconomic analysis that is focused on the long-run impacts. Their work is focused on natural disasters but given the similarities of the consequences of natural and man-made disasters their framework should be easily applicable to man-mad disasters.

Short-run Microeconomic Behavior

Traditionally economists are rarely called on to estimate the direct physical damage caused by disasters. This is a job often relegated to engineers, architects, construction specialists, and others. Physical damages include property damage to buildings and infrastructure, debris removal, and the cost of emergency protective services (McEntire and Cope, 2004). It is the losses associated with employment income and indirect losses that occupy the efforts of economists in the field of disaster research. Though there is some disagreement among economists as to exactly what counts as direct and indirect costs they include: the loss of business activity due to reduced activities at damaged businesses; loss of income in secondary and tertiary employment; and business disruptions not directly attributable to damage. According to Dacy and Kunreuther this primarily the domain of microeconomics since it is dependent on the decisions and

[7] Dacy and Kunreuther were primarily focused on the role the Federal government played in providing or establishing comprehensive disaster insurance.

allocation of resources of the firm. Post landfall of Hurricane Katrina in New Orleans many businesses determined that damage and the lack of electricity would keep them from continuing operations. However, it has been documented that some banks and other businesses – despite extreme damage – trucked in their own gasoline for generators, set up tents, and worked on an IOU, honor system, and credit cards to get cash funds and goods into the hands of their local clientele.

Immediately following a disaster event it is difficult to obtain information on the extent and level of damages. The uncertainty surrounding damages is central to decisions regarding business operations and allocation of resources. These decisions based on "direct damage" will determine the magnitude and extent of indirect (and induced often included within indirect) effects.

Given these impacts to firms that are directly affected by the disaster event, other parts of the economy are affected, sometimes to a degree that is much greater than that for those directly affected. Consider a regional industry that does not produce output for an extended period of time; the indirect effects of this direct impact include the (potential loss of sales to the firms that provide input materials to this industry and the (potential) loss of income to the households that work in the disrupted industry.

For example, if damage to a manufacturing firm disrupts production, the firm operators must decide if they are capable of continuing operations if not, then they will not require trucking services to deliver raw materials or pick up final goods, which in turn may impact the employment of drivers. Rose (2004) illustrates indirect effects with the example of a utility plant being damaged resulting in utility customers (i.e. businesses) not being able to operate. Cochrane (2004) uses the comparatively simple definitions that direct damage is property damage plus lost income, and indirect damage is anything else. Rose and other researchers, cited in his study, find that direct and indirect business interruption losses can be as large as physical losses.

This relationship between “directly” affected firm and “indirectly” affected firms, whether the relationship is downstream or upstream, is one of primarily demand and supply. One firm can no longer “manufacture” goods, upstream firms no longer have demand for their inputs to the manufacturing firms, and downstream firms still have demand the goods from the manufacturing firm. The outcome of all these relationships can be traced back to the initial decisions of the “directly” affected firm on whether to cease operations or find a “work-around.” These firm decisions or microeconomic decisions in the short-run will eventually aggregate through the system to the macroeconomic level.

If price changes are sufficiently large, they may affect the short-run behavior of firms. For example, a firm facing higher prices on inputs may reduce production or even halt production; however, a firm that produces a good that increases in price may increase production, provided it has sufficient excess capacity. Although the price changes will benefit some but cost others more, they help reduce overall consequences by encouraging more efficient allocations. Typically these price adjustments cannot be captured in static short-run models or calculations.

Long-run Macroeconomic Adjustments

Macroeconomic analysis considers economic events and activities at a national level. Dacy and Kunreuther (1969) held that the total national cost of a disaster is the replacement value of the property damaged, regardless of government intervention through the presence of a relief program. Even when the scale of the analysis is quite large and an extensive array of costs is included, it is a matter of simple mathematics to see that disaster impacts rarely have an impact on the national economy. As noted by Mileti (1999), capital markets are simply too large to be disturbed beyond a short period of time by natural disasters.[8] In fact there may be some evidence to support the observation that the more often disasters occur, the shorter the time-frame the disturbance of capital markets.[9] The notable exception may be sustained HIV infections in developing countries. Gary Becker (2005) has noted that the pandemic influenza of 1918-1919 had no major effect on the world economy. Although, other economists have argued the effect of the pandemic cannot be successfully separated from the effects of WWI. To support this position, Horwich (2000) presents an example based on the 1995 Kobe Earthquake.

Hurricane Katrina destroyed large swaths of the economic capacity of Louisiana and Mississippi; the combined GDP of these two states represents less than 2 percent of US GDP. Recent data from the US Department of Labor and the RAND Corporation estimates that 230,000 migrated out of the New Orleans area after Hurricane Katrina in the affected region; total national employment for the month of September 2005 declined by only 35,000[10]. Although these disasters may lack national impact growth theory, as recommended by Dacy and Kunreuther, can provide insight for the effects of a disaster to the transition of long-run growth.

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[8] Worthington and Valakhani (2004) using an autoregressive moving average model found temporary shocks to the Australian All Ordinaries Index from brushfires, cyclones, and earthquakes, though the direction of the impacts (positive or negative) varies.

[9] Reilly, D., Craig, S. (2005). The London Bombings: This Time, the Financial System Was Better prepared. Wall Street Journal, New York, NY.

[10] McCarthy, K. F. et al (2006)

Disasters natural or man-made result in damage to capital stocks and human capital through the loss of labor. While these damages may be seem extensive their effect on long-run growth of a develop nation are likely still limited. A basic Neo-Classical model of the Solow-Swan model (Solow, 1956; Swan, 1956) is used to demonstrate this assertion, specifically for an event that would case the destruction of capital and not labor (i.e. oil spill). For simplification assume no technological progress, the production function the economy is represented below:

$$Y = F(K, L)$$

Where Y is total output, K is the level of capital accumulation, and L is the level of labor supply. Transforming the equation for per capita output and capital:

$$y = f(k)$$

$$\text{where } y = Y/L, and\ k = K/L$$

Keeping the savings rate *s*, capital depreciation rate δ, and population growth rate *n* constant, the change in per capita capital stock over time becomes:

$$\dot{k} = s \times f(k) - (n + \delta) \times k$$

$$where\ \dot{k} = \frac{dk}{dt}$$

The steady state level of capital accumulation, $k^*, where\ \dot{k} = 0$, satisfies the following condition:

$$s \times f(k^*) = (n + \delta) \times k^*$$

In Figure 1, the steady state can be observed at point A. Now introduce a shock in the form of disaster that damages capital stocks but not human capital (i.e. labor) - as would be the case in an oil spill. The per capita capital decreases, k_d, where $k_d < k^*$. Due to the disaster event the output for the entire economy decreases from the steady state, y^*, to the post disaster level of k_d. The decreased level of capital stock has moved the economy out its steady state level with space now existing between point B and C, this space allows for the growth of per capital accumulation during the recovery process. As part of the recovery process move forward more resources are diverted toward reconstruction or remediation of capital stock than under normal circumstances. This implies that the savings rate for the capital accumulation may become higher than in the pre-disaster level, *s*. The new savings rate is set at s_r (where $s_r > s$), will likely accelerate the speed of recovery, capital re-accumulation, further to point D in Figure 1. However, as the economy recovers, the savings rate should gradually slow to the original rate *s*. As shown in Figure 1 the capital accumulation moves close to the original steady state level of, *k**, from point D to point A.

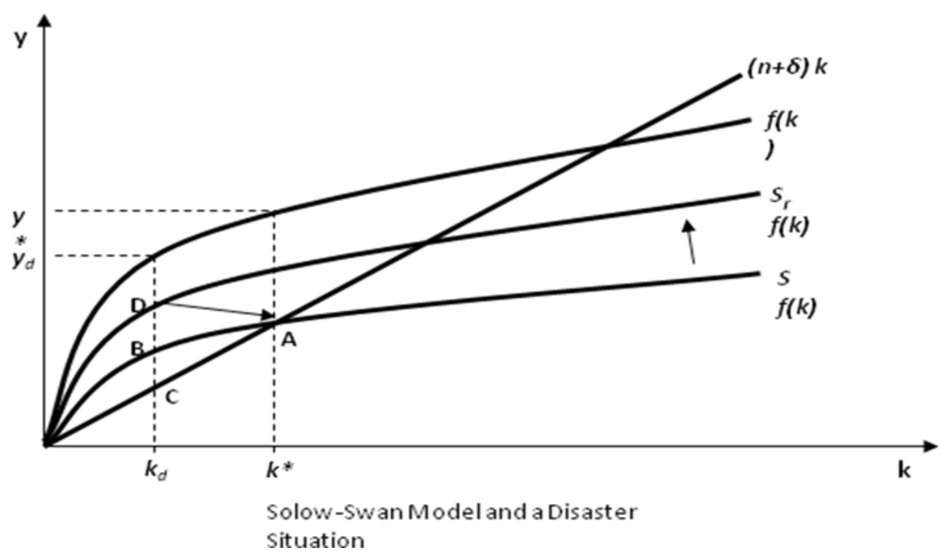

Figure 1: Solow-Growth Model, Impact of Disaster without Loss of Life

Horwich (2000) recommends measuring the impact of a disaster on economic potential as opposed to economic activity. Measuring potential is not a widely practiced method amongst economists that study natural and man-made disasters. However, the recommendation by Horwich remains a promising extension and is discussed in Appendix B.

The main contribution that microeconomic analysis can bring is an understanding of the dynamics of the regional and local economies that is ignited by a disaster event. Following a disaster, while some industries are careening toward oblivion other industries and businesses will see potentially huge increases in their business activities resulting from disasters.

The value of macroeconomic analysis of disaster events is to offer a view of the magnitude of an event. A disaster at the regional level could be devastating, however, when examined with a view toward national impacts the event may be negligible. Macroeconomic analysis assists in revealing how the national economy adjusts and recovers from natural and man-made events. By understanding the dynamics of the total economic impacts of disasters, one can more efficiently allocate disaster response resources to those industries and business in need.

Chapter 3

Common Methods of Analysis

There is several data analysis techniques used to assess the indirect and income effects of disasters. These techniques include surveys, econometric models, Box-Jenkins time series analyses, input-output models, general equilibrium models, and economic accounting (IO) models (Cochrane, 2004; Chang, 2003; Zimmerman et. al., 2005).

Survey Method and Expert Panel

Surveys provide direct information from those impacted or in close association with those directly affected by disasters. They can be flexible in design to accomplish simple data gathering (How much will it/did it cost to rebuild your facility?) to more in-depth approaches (How did you finance your rebuilding? Have you lost customers because of down time? Are you looking to relocate your business?). Tierney (cited in Rose and Liao, 2005) uses surveys to assess impacts on businesses of the 1993 mid-west floods and the Northridge earthquake. The largest problem with survey approaches is non-response bias. The researcher cannot know if the respondents are truly representative of the broader population of disaster victims. Given the psychological trauma associated with disasters, the researcher would have to be diligent in assessing response reliability – respondents' answers may change if questioned immediately after the event versus 6 months later. There could be issues of strategic behavior in the responses such as exaggerating losses in the hope of attracting additional aid. There are also potential logistics problems with surveys. Researchers may not have access to the disaster area immediately and may be unable to locate victims later. Moreover, the most appropriate survey medium would likely be in-person interviews, which are expensive and time consuming.

Case studies conducted by panels of experts are an attractive method from the perspective of thoroughness and accuracy because experts can utilize all of the other methods within their case studies, plus they can impose their subject matter expertise as needed. Unfortunately, case studies have several severe deficiencies First, developing dollar-value metrics is difficult when integrating qualitative methods (i.e., subject matter expertise) with quantitative methods (i.e., whatever models the experts chose to use). Second, the conclusions of the panel could be difficult to understand and could hide biases of those experts. It would be very difficult to standardize the process, especially as the composition of the panels changed. Third, case studies do not run quickly because they require time for panels to be assembled and time to conduct the studies. Hence, this method was not employed.

Econometric Method

Econometric modeling approaches can be used when there is substantial data readily available for the affected region. Using a variety of regression techniques, the fully-partialed[11] effects of a disaster event can be modeled as an intrusion on a series of data. However, data availability can be a problem, as with most techniques. Much of the economic data that would be used are gathered and published with substantial lags, this approach may not be practical until two or three years after the event. Predictive models can help us understand post-disaster dynamics, but most econometric approaches do not

[11] Fully-partialed means that other factors affecting the economy are controlled for statistically so that the estimates relate to only those costs associated with the disaster. Researchers have been unable to accomplish when estimating the impacts of the 1918 Pandemic Influenza.

easily account for product substitution, immediate changes in the imports of goods, or the non-linear nature of production functions inevitable when an economy receives a significant shock. Still, several researchers have offered credible analyses using regression techniques including Ellison, et al (1984), Cochrane (1974), and Guimaraes, et al (1993), among many others.

One econometric modeling approach is to use variations of hedonic pricing models. Hedonic models account for preferences in purchasing decisions. These models are most commonly used in real estate research to describe why some homes are more desirable (higher priced) even when other factors such as size and features are the same. MacDonald *et. al*., (1987) use a hedonic model to assess housing value impacts of being located in a flood-risk area. Brookshire et. al., (1985) examined hedonic price gradients based on earthquake safety attributes for housing. This modeling approach could add valuable insights into consumer behaviors in disaster events, but may not be appropriate if a disaster is without property damage.

A variation on the intrusion model method is an Auto-Regressive Integrated Moving Average (ARIMA) model. This analytic technique takes a Box-Jenkins approach to time series analysis. A Box-Jenkins analysis uses previous values of the study variable to predict the next value. For example, in examining the impacts of a tornado event on local retail sales, the analyst considers trends and patterns in a series of relevant data. The ARIMA model would control for a trend that total retail sales have generally risen over several years, the seasonal variations for Christmas, back-to-school, and other especially busy times, and the fact that if a retailer is successful one month, they will likely be successful the following month. The ARIMA model provides a prediction for what retail sales should be, which can then be compared to what actually happened after the disaster. The difference is an estimate of the disaster's impact on retail sales. The biggest weakness of this approach is being able to account for confounding concomitant events – such as a large retailer closing about the same time as a disaster for unrelated reasons

Agent-Based Modeling

Agent-based modeling (ABM) simulates individual businesses as agents and allows them to interact through buying, selling, and transporting commodities in markets. This fidelity means that ABM produces high-fidelity simulations using detailed facility-level data, making it a good candidate for criticality evaluation. Several drawbacks to ABM exist. These models are extremely complex; hence the data inconsistencies that always arise when acquiring detailed data usually require user-intervention to be resolved. The models run relatively quickly, although not instantly, but the user-intervention substantially increases the overall analysis time and increases the need for ad hoc assumptions that may not be fully supported by the data. ABM models have many desirable properties, such as the ease at which they can simulate the importance of inventories and economic dynamics. ABM models account for direct and some indirect impacts, but do not account for national economic impacts unless the entire world economy is modeled (which is a prohibitively complex model). Therefore, ABM is not applied to this assessment.

Network Models

Network models of supply chains show connections between different commodities. For example, a network model of chemical supply chains can be based upon data from those supply chains about how individual chemicals combine within individual facilities to produce new chemicals. The major deficiency of network modeling is that it does not include a straightforward calculation measured in dollars, and it does not assess economic impacts beyond a very specific supply chain. These deficiencies prevent it from being used in this methodology. Additionally, when examined more closely these network models appear to essentially be Input-Output Models, just renamed.

Input-Output Methodology

Input/output (I/O) models are based originally on the work of Wassily Leontief in the 1930s in which the flow of goods across industries are captured using transaction matrices. For any given commodity there are raw materials, goods, and services purchased as inputs in the production process. Based on economic surveys, we know, on average, which industries produce which commodities and services. These models then provide a description of how demand-satisfying production creates upstream and downstream economic activities. For example, a writing pad is made of backing, paper, ink for the lines, and glue to bind the pages. There are firms that produce each of these inputs. In addition, the paper converter (manufacturer of goods converted from raw paper) hires accountants, computer services firms, and trucking companies, buys advertising space in trade publications, and purchases a host of other goods and services to support its business operations. The I/O models then use data from government organizations such as the Bureau of Labor Statistics to reflect relationships between labor demand for production activities and prevailing salaries, wages, and benefits to estimate not only the value of economic activity associated with a given level of production for a commodity. While subject to well-known limitations, IO models "are useful in providing ball-park estimates of very short-run response to infrastructure disruptions.[12]"

Reviews of IO literature including applications and advancements up to about the late 1980s can be found in Rose and Miernyck (1989). Some discussion of the IO literature pertaining to its applications to estimation of the impact of natural disasters and terrorist events can be found in a number of more recent papers, particularly Bockarjova, et al (2004), Clower (2007), and Okuyama (2003). Some of the more pertinent literature is discussed briefly below.

One of the strengths of the IO technique is that it can and has been applied at almost any geography level subject only to the constraint of data availability. Refining the national IO tables to incorporate a finer spatial disaggregation is necessary for many types of analysis. For example, the Southern California Planning Model has incorporated a level of spatial disaggregation (identifying 308 regions in the LA basin) that enables them to effectively study income distribution impacts in addition to the more traditional economic measures. Gordon et al (2005), and Cho et al (2001), both emphasize that many natural disasters and infrastructure failures are predominantly local phenomena and therefore require modeling at the metropolitan and perhaps even sub metropolitan level. Over the years, several techniques of varying sophistication have been developed for incorporating a spatial dimension to the national IO data. One of the most commonly used techniques involves regionalizing the national IO data through regional purchase coefficients.

[12] Rose, Adam (2006).

More recent techniques focus on representing various networks or infrastructures that connect regions. For example, some IO models include electric power infrastructure (Moore, et al, 2005, Rose and Benavides, 1998), the airline industry (Gordon, et al, 2005), and surface transportation in a sub-metropolitan region (Cho, et al, 2001 and Roy & Hewings, 2005).

Cheng, *et al* (2006) presents an IO model that they use to estimate the economic impacts of terrorist events. They use a hypothetical event in which terrorists cause the outage of a major electric power plant serving the Washington, DC region. Based on the hypothetical scenario they conclude that noticeable economic impacts in terms of lost output and income could occur. In a recent article published in *The Economic Impacts of Terrorist Attacks* Gordon, Moore, *et al*. (2005) analyze a scenario where the twin ports of Los Angeles and Long Beach are attacked by a moderate-sized radiological bomb. They develop an embellished input-output economic model specifically for the LA metropolitan region which could be used to analyze any plausible attack on specific targets in the city.

Computable General Equilibrium Models

Computable General Equilibrium methods are often used for economic impact modeling. They can evaluate the economic impacts to a region or the nation of adding or removing some portion of economic activity. Both IO and CGE evaluate direct impacts and indirect, upstream impacts, but traditional IO methods and some CGE methods ignore downstream impacts, which are important to evaluating economic impacts. However, CGE models are based on nonlinear equations, so they are more difficult to understand, run more slowly, and need greater user intervention. The most important limitation of these models is that they run at a high level of aggregation. For example, hundreds of goods and services at hundreds of business locations may be lumped into a single industry agglomeration.

Chapter 4

Methodology for Evaluating Business Interruption Losses

Economic impacts from the Deepwater Horizon oil spill will first be analyzed from a short-run perspective addressing the microeconomic fall-out of such an event. This is based on Kunreuther's assertion that the short-run is primarily a microeconomic problem since actions of firms will have immediate impacts on the local economies. The long-run analysis will focus on macro-economic impacts; as Kunreuther has discussed, in the long-run the economy adjusts to the microeconomic impacts by adjustments made over time throughout an economy i.e. outside the immediately affect region.

The goal of the methodology is to measure in dollar value the impacts across the state, regional, and the entire U.S. economy that result from the disruption to economic activity in selected industry sectors. It is difficult to address the role of individual businesses, or a single company's network of facilities, or a regional complex of plants in the greater U.S. economy.

Evaluating an individual business location or business net work would require a methodology that starts at a microeconomic level of resolution, i.e., an individual business location, and provides a comprehensive accounting of economic impacts at a macroeconomic scale, i.e., the nation. However, given the difficulty with obtaining firm level data and the complexity and difficulty of modeling firm interactions it is necessary to consider economic analysis methods that calculate economic impacts at the industry sector level

Several consequence-assessment methods were considered to evaluate the economy-wide economic impacts of an oil spill. None of these methods in isolation meet the requirements of a study looking at both the microeconomic short-run impacts and the macroeconomic long-term impacts, so methods have been combined. Hence, the methodology is rooted in traditional economic analysis through use of a static IO model for the short-run impacts. Med- and long-run consequences are evaluated through the incorporation of recent innovations in high speed computing through the use of a dynamic "hybrid" model. This combination is described in the following sections.

Measures of Economic Impact

There is a considerable range of measures used to quantify economic impacts to a region or the entire nation; these include imports, exports, sales, price changes, and business failures[13]. There are several economic impacts that are typically reported in most regional and national economic impact analysis, since they are in some ways common denominators for other measures.

Change in Regional Gross Domestic Product

A change in regional gross domestic product (GDP), or value added. The economic firms in a given geographical region make a direct, accountable contribution to the economic output of that region; summing up the product of those firms is typically then the means of measuring regional GDP. One measure of a firms' contribution is the amount of sales it had over a period of say, one yea, but this measure include significant double counting. For example, if a firm in Region A purchases all of its production inputs from a firm in Region B, then the regional product in Region A double counts the regional product in Region B. A better measure of the true regional product in Region A

[13] To augment these industry or national level impact measures, there are a long list of economic impact metrics used to measure the impacts to individual firms, such as change in net profitability, rate of return to owners, and return on capital investment.

is then the value it adds to the inputs it receives, or its value added. The summation of the value added of all firms in Region A is the better measure of the regional GDP of the firms in the region.

Change in Regional Income

A change in regional income, in economic terms, the value created by the local regional firms is actually created by the workers and the firms' capital equipment and technologies (e.g., land, buildings, machines, and electric power). The value add of a firm is qualitatively equal to its net income (sales minus input costs), which is given to workers (as income) and to the owners (as profits and other returns on investments).[14] The change in regional income, or the returns to workers in the region, is then the typical measure of the economic health of or loss to the inhabitants of a region.

A third, complementary, but less supportable measure of regional impact is any change in employment that results from a change in economic conditions. Changes in regional output, or value added, can cause changes in the levels of employment in affected industry sectors, both within and outside a specific region depending on the length of the disruption. For short disaster dependent disruptions, most workers are likely to keep their pre-disruption employment; longer disruptions may cause permanent layoffs in a subset of industry sectors and regions. For these reasons, employment is excluded as a primary measure of economic impacts from disaster business interruptions.

[14] The U.S. Census Bureau tracks and computes the regional value added and returns to labor, using two different techniques: (1) by directly measuring the regional income for both labor and firms/stakeholders and (2) by measuring sales and input costs. The difference of these two should, in accounting terms equal the returns to labor and capital.

The Regional Economic Accounting (REAcct) Tool

The economic method is based on a framework of inter-industry commodity flows, often termed input-output (IO) analysis and uses multipliers, the most common consequence factor derived from IO analysis, and dynamic econometric models to estimate the total direct and indirect economic impacts of business disruptions[15]. The total economic impact of a disruption is typically grouped into (1) direct impacts, which, occur to those firms directly affected by the disrupting event; e.g., firms directly affected by the event (2) indirect impacts, which occur to firms not directly affected by a disruption but that are indirectly affected (e.g., by the loss of sales to firms in the direct path).[16]

Input-Output Multipliers

Consider a case where a disruption halts the production of Commodity D, looking at the column D column in Table 1. A disruption to D's production reduces D's need for every commodity in its production recipe, specifically commodities B and C. If B and C are then disrupted, then so are their inputs: looking at the B and C columns, one can see that A and B are used as inputs. Since B uses A as an input and vice versa, the production of B is indirectly impacted by its own disruption; that is a disruption can ripple in a circular fashion through the economy. The input-output impact modeling approach uses this circularity to derive mathematical multipliers that estimate these system-wide circular effects.

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[15] While IO multipliers require that the analyst make many strong assumptions about how disaster impacts propogate through the economy, the IO framework does not; what the framework provides is a useful, structured approach for understanding and modeling highly detailed economic processes.

[16] Impact analysis often also separate out the *induced impacts,* which are the impacts to households and their expenditures resulting from lost income.

Table 1: Example of Technology or Use Matrix

Input Commodity	Amount of Input Used per Unit of Output				
A	0	x_{ab}	x_{ac}	0	0
B	x_{ab}	0	x_{bc}	x_{bd}	0
C	0	0	0	x_{cd}	d_1
D	0	0	0	0	d_2

Calculating the indirect impacts of a sector specific disruption are difficult given the circular nature of commodity flows. One can make the relatively strong assumption that the linkages between sectors are tight, that is, any change in the production of a particular industry changes production in intermediate, "feeder" industries in the proportions listed in the US BEA government input-output tables, and one can use an input-output multiplier technique to estimate impacts.

The multiplier approach uses the infinite circularity of tight causality within this technology matrix (A is used in B, which is used in D, which is used in C and B, etc) to compute by how much the production of any commodity in the matrix will decrease if the final demand or output of any given good decreases. Mathematically, if one defines

$$Y = \begin{bmatrix} Y_1 \\ \cdots \\ Y_N \end{bmatrix} = vector\ of\ productions,$$

$$D = \begin{bmatrix} D_1 \\ \cdots \\ D_N \end{bmatrix} = vector\ of\ final\ demands, and$$

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1N} \\ \cdots & \cdots & \cdots \\ a_{N1} & \cdots & a_{NN} \end{bmatrix} = matrix\ of\ input - output\ coefficients.$$

One can formulate the flows mathematically as $AY + D = Y$, this equation states that total demand for output Y is composed of the intermediate demand AY for the commodity by all industries and the final demand D from end users. By solving for Y, one can express total output in each industry as a function of both final demand and the industry technology matrix:

$$Y = [I - A]^{-1} D$$

The numerical terms in the $[I - A]^{-1}$ matrix estimate the effect of a change in end-user demand can have on the output in all industries. It can also be used to estimate the effect that a disruption in output in one or more industries has on the output in all industries, using what are called output-driven multipliers[17]. As described in the following section, the estimates of direct economic impacts to one or more industries are used with the output-driven multipliers to estimate the indirect impacts that occur via this commodity flow-based based mechanism.

Estimating Direct Economic Impacts

Given a particular disruption or change that affects the baseline conditions of the economy, a subset of the overall economy will be directly affected. The two primary subsets are the productive sectors (e.g. firms) and consumptive sector (e.g. households), each of which is located regionally. For each day of business interruption, impacted industry sectors lose economic output or production, resulting in lost income for their employees. The best means for estimating the direct loss in regional GDP is to directly sum up the lost GDP at each firm. Because of the lack of such data, one must instead estimate the lost output and income directly at the industry level as categorized by the North American Industry Classification System (NAICS)[18] . First, is to compute lost

[17] A modified version of the demand-based multipliers.

[18] This can be at the 2,3,or 4 digit NAICS level, depending on the availability of data. Typically the most comprehensive data is available at the 2 or 3 digit NAICS level.

GDP as the average value added per worker nationally (or regionally[19]) times the number of employees in that industry in the disrupted region times the number of days of the business interruption; or

$$Direct\ lost\ regional\ GDP\ for\ industry\ i\ in\ region\ r = \frac{Y_i^{US}}{365 \times E_i^{US}} \times E_i^r \times d_i^r$$

where Y_i^{US} and E_i^{US} are national annual output and employment for industry i, Y_r^r is output in region *r* for industry *i*. Given a set of industry sectors operating in a set of regions, the total regional economic loss to (to *I* industries in *R* regions) can be estimated as,

$$Direct\ lost\ regional\ GDP\ for\ I\ industries\ in\ R\ regions = \sum_{r=1}^{R} \sum_{i-=1}^{I} \frac{Y_i^{US}}{365 \times E_i^{US}} \times E_i^r \times d_i^r$$

A common simplifying assumption is that d_i^r is the same in all industries and regions. Loss in income is as follows,

$$Direct\ lost\ income\ for\ I\ industries\ in\ R\ regions = \sum_{r=1}^{R} \sum_{i-=1}^{I} \frac{I_i^{US}}{365 \times E_i^{US}} \times E_i^r \times d_i^r$$

where, I_i^{US} is the annual national income of workers in industry i.

Estimating Indirect Economic Impacts

Given these impacts to industries that are directly affected by the disruption, other parts of the economy are affected. Consider a regional industry that does not output for an extended period of time; the direct effects of this direct impact include the possible loss of sales to industries that provide input materials to this industry and the possible loss of

[19] This is dependent on availability of data. Some states do calculate this information and can be obtained for free. Some states do not calculate this and it must be estimated at the national level. In the most unique cases, this data may also be available at the county level.

income to the households that work in the disrupted industry. The critical assumption is that there are few if any production, employment, or income "leaks", or substitutions in this flow structure. If, for example, the sale lost by this particular regional industry is offset by increased sales to the same industry in another region, and the employees in the disrupted region migrate to the offsetting region, then there are few indirect impacts. However, this type of offsetting behavior is impossible to capture in the static method being discussed.

Indirect economic impacts are estimated in the following way: given a loss of output in a specific industry sector, as calculated in previous sections, there are indirect impacts. To estimate these indirect impacts the RIMS II final-demand output multiplier are employed. The output driven multiplier is used to estimate the indirect impact on all industries of an industry changing its level of production ($the\ Y\ in\ Y = [I - A]^{-1}D$). One can also use demand-driven to estimate the indirect impact on all industries of changes in the demand for an industry's production ($the\ D\ in\ Y = [I - A]^{-1}D$). Since the goal is the estimate the total impact of a change in one industry's production on all industries, the output-driven multiplier is used to estimate the total (i.e., direct plus indirect) impact of the output change. In equation form, if m_i is the output-driven multiplier (RIMSII) for industry *i* in region *r*, then the total impact of a change in output can be expressed as,

$$Total\ lost\ regional\ GDP\ for\ I\ industries\ in\ R\ regions = \sum_{r=1}^{R} \frac{Y_i^{US}}{365 \times E_i^{US}} \times E_i^r \times d_i^r \times m_i^r$$

and lost income as,

$$Total\ lost\ income\ for\ I\ industries\ in\ R\ regions = \sum_{r=1}^{R}\sum_{i=1}^{I}\frac{I_i^{US}}{365 \times E_i^{US}} \times E_i^r \times d_i^r \times m_i^r$$

While the direct economic impacts occur to known regions of the country, the indirect impacts do not: not all of the intermediate industries that sell to the industries in the disrupted region are also in the disrupted region; likewise, not all of the workers that receive income from the disrupted industries spend their income on commodities produced in the disrupted region. For this particular analysis of the economic impacts of an oil spill in the GOM lost GDP will be the reporting metric given its easy familiarity.

Data

The Bureau of Economic Analysis (BEA) maintains publicly available national input-output data and input-output multipliers down to the county level for purchase. The national data is benchmarked every five years and estimated annually. At a national level the BEA provides more detail on inter-industry relationships than is available at smaller geographic levels. The US Census Bureau provides the number of business establishments and employment by industry and county annually as part of its County Business Patterns Data program. (U.S. Bureau of the Census) Industry employment data is also available quarterly from the Bureau of Labor Statistics (U.S. Bureau of Labor Statistics). The final demand output-driven multipliers, RIMS II, are available for varying fees from the U.S. Bureau of Economic Analysis. Finally, private data sources such as the Dunn & Bradstreet database maintains establishment and employment data for purchase, although this dataset is known to be highly inaccurate.

Advantages and Limitations of Approach

While this approach is simplistic in its understanding and implementation, it has a number of strong assumptions and related limitations of its use.

Advantages

Disruptions in an affected region affect industry sectors in different ways. While an electric power outage will likely affect all businesses. Contaminated coastal waters and beaches will only affect some industry sectors. This method allows for the user to apply business disruptions to specific industries and for varying disruption lengths.

The specifics of the type of business disruption are not necessary for calculations of economic impact. The REAcct method can be applied to both natural and man-made disasters. Because of its simplicity, it can provide approximate estimates of economic impact can be generated quickly by the analyst. The REAcct method is relatively easy to use, thereby reducing costs. It is based on IO methodology, which is well established in the economic literature. REAcct can be linked to Geographic Information System (GIS) which provides impact zone information to the REAcct model, which then estimates economic impact.

Limitations

Depending on the type of business disruption, the actual economic disruption and related restoration can be highly dynamic processes. Individual firms within the affected industries have different levels of on-site and in-transit inventories, and different production processes. The REAcct method is unable to capture the highly complex interactions between firms and industries. There is also the general assumption that once the disruption is over, it is business as usual, this is likely not the case. Some firms may return to pre-event levels gradually over months or years. Some smaller firms may simply disappear due to their inability to adapt to strenuous economic conditions.

Although the literature examining the uses of input-output analysis for consequence analysis is extensive, it remains that traditional economic consequence analysis using input-output methodology calculates only direct economic impacts (the change in production or GDP at a particular level of the supply chain) and upstream economic impacts (the change in production or GDP at preceding levels of a supply chain that produce commodities that are eventually used at a particular level of the supply chain).

Downstream impacts have proven very difficult to predict due to substitution by firms and consumers. Downstream impacts are dependent upon the decisions of firms and consumers. Interactions influenced by market processes (prices) will determine how a disruption propagates downstream. Traditional input-output analysis does not account for these market interactions.

A critical assumption is that there are few if any production, employment, or income leaks or substitutions in this structure given the static nature of the model and its application to short-run impacts. If for example, the sales lost by a particular regional industry are offset by increased sales to the same industry in another region, and the employees in the disrupted region migrate to the offsetting region, then these impacts are not captured in the REAcct model.

REACCT Step-by-Step

The first step in application of REAcct to an actual or hypothetical event in a specific area requires the specification and identification of the area within which the event occurred. Using GIS software, a GIS layer is created which depicts the specific affected area. This layer is overlaid with another GIS layer that represents the US counties. Using this overlaid counties layer, the intersections of the affected area with the counties are determined resulting in a list of the counties within the affected area. The duration of the economic disruption is then determined by analysts based upon knowledge of the event and the affected area. By identifying the affected counties and the duration of the economic disruption the analyst can generate estimates of the amount of economic activity in a specific area and the impact of the event on economic activity using key impact measures such as employment and output.

Step 1

Scenario or event definition is established. Conditions may require that businesses and residence either close, evacuate, or in general production stops due to disaster conditions. Duration of the event are established and GIS layer is overlaid to be representative of the affected region.

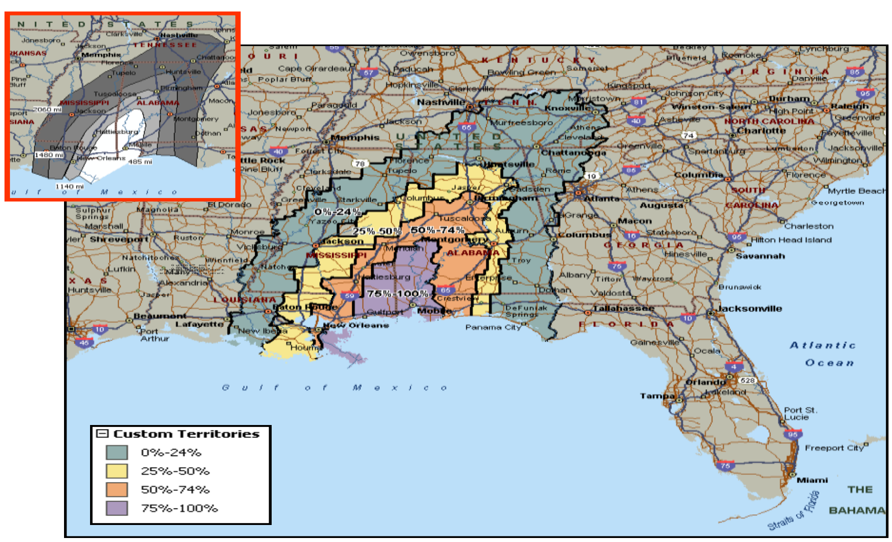

Figure 2: Example of GIS Overlay

Step 2

Economic data is compiled within the REAcct Tool, data as previously described is government collected, therefore consistent and verifiable. At this time the analyst also evaluates specific industry sectors for special considerations. Additionally, counties are also evaluated for uniqueness regarding industry sector makeup or regional uniqueness.

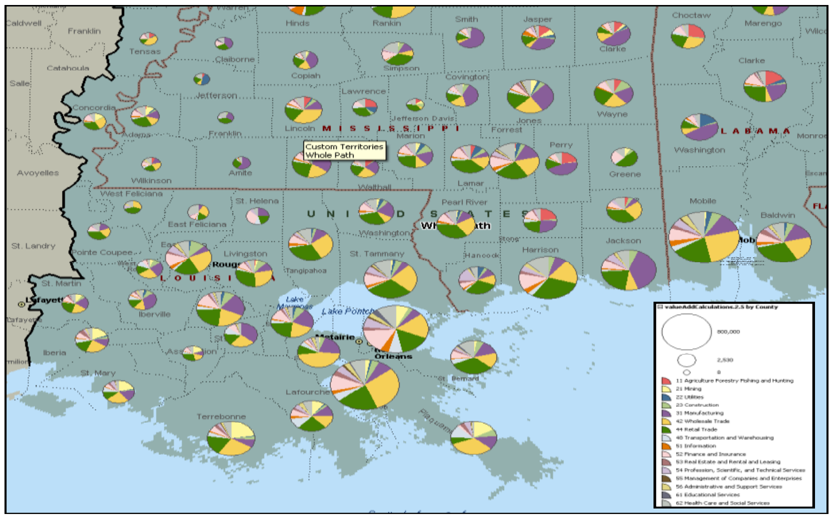

Figure 3: Example of Industry Distribution at the County Level

Step 3

Economic impacts for the affected region, whether that can be a county or a group of counties is calculated and reported. The metric of concern is lost GDP; this can be reported at the industry, county, and region level.

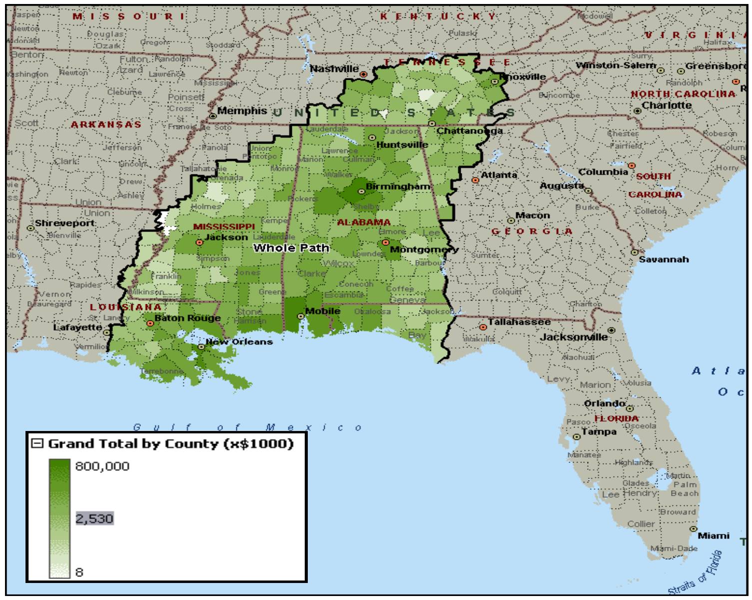

Figure 4: Total GDP Loss

The Regional Economic Model, Inc. (REMI), Model

REMI is a structural set of equations that model the U.S. macro economy, including the aggregate production of goods and services, employment levels and movement across industries, consumer spending, effects of wage and price changes, and international trade. As illustrated in Figure 5, the equations model economic variables such as output, prices, and consumer spending, via theoretical and empirical relationships[20].

[20] Treyz, G. I., D. S. Rickman, and G. Shao (1992)

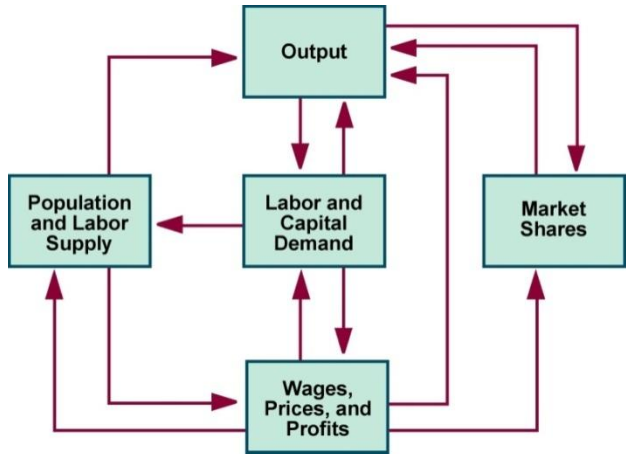

Figure 5: Regional Economic Model, Inc (REMI, model structure

These relationships, developed into parameters with publicly available historical data[21], model the fundamentally dynamic and circular nature of the real economy: output generates employment, employment generates income, income generates demand for and spending on new output, new output generates new employment, and so on.

Variables are grouped to reflect their part in the causal linkages. The output block contains variables representing the amount of goods produced; the variables are divided both by North American Industry Classification System (NAICS)codes; that is, SIC 35, Industrial Machinery Manufacturing, NAICS 333, and by the "demand category" of the good; that is, consumption, investment, government spending, or net exports. Within the output block, an input-output matrix determines inter-industry demand and final demand, by industry.

In Figure 5, The Population and Labor Supply block contains variables that track population levels and migration trends between regions of the country. The Labor and

[21] For example, GDP measures are obtained from the BEA and the *Survey of Current Business*. Data on employment, wages, and personal income come from the BEA and the Bureau of Labor Statistics. The cost of capital is computed from data in the *Quarterly Financial Report for Manufacturing* and from the *Survey of Current Business*. State and U.S. corporate profits tax rates are obtained from the *Government Finances (Revenue)* and the *Survey of Current Business*.

Capital Demand block contains variables that track the factors that affect a firm's decisions about how much product to produce, how many workers to employ, and how much equipment and other capital to acquire. The Market Shares block contains variables that track, by industry, the supply-side and demand-side market shares; that is, the fractions of U.S. production sold to domestic and foreign customers and the fractions of U.S. demand satisfied by domestic production and foreign goods. The bottom block, Wages, Prices, and Profits, contains price-related variables such as the wage rate, the cost of producing goods, the profitability of firms, and the sales prices of goods. All of these variables are used to simulate an economic change or "shock" and to measure the impacts of it.

Each economic relationship in the model is one of three types: a technical relationship, the amount of output from the aluminum castings industry that is used by the automobile industry; a definitional relationship, these are the national income accounts; a behavioral relationship, the change in consumer demand for cars in response to changes in personal income or automobile price.

For example, in Figure 5, the arrow pointing from Output down to Labor and Capital Demand represents a technical relationship stating that industry output determines industry employment. The arrow pointing from Output to Market Shares represents definitional relationships stating that changes in output affect the market shares of industries. The arrow pointing from Wages, Prices, and Profits represents behavioral relationships, such as demand curves, stating that changes in prices affect market shares.

A REMI analysis is carried out in two steps: first, a baseline forecast is computed, in which there is no change to the economy; and second, an alternative forecast is generated, in which a set of simulation variables model a change in the economy. As illustrated in Figure 6 the economic impact of the change in the economy is measured as the differences between the baseline and alternative forecasts.

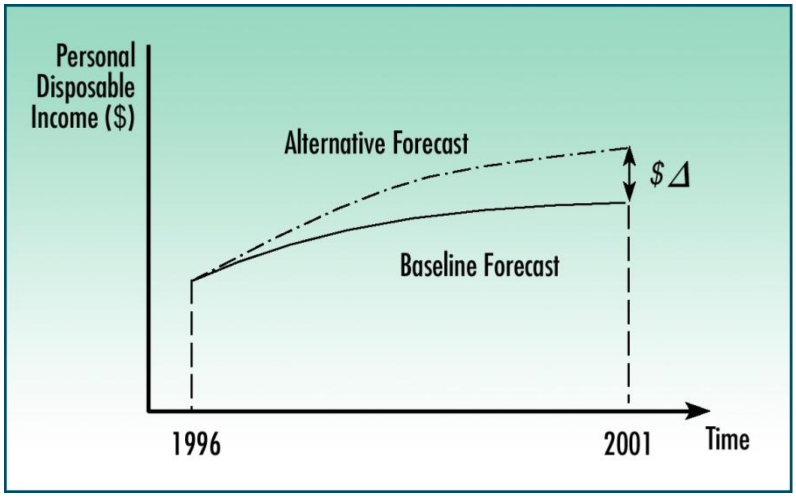

Figure 6: Economic impacts, measured as the difference between impact and baseline forecasts

Advantages and Limitations REMI Model

As with the REAcct Tool, the REMI Model is not a perfect model but it helps the analyst achieve an approximation for economic impacts.

Advantages of the REMI Model

Since it is necessary to try and evaluate natural and man-made disasters before the event has concluded in order to assess which industries may need assistance or to try and estimate where unemployment may become problematic. The REMI Model is an excellent if imperfect choice. It provides the analyst with the ability to forecast out up to 25 years, although anyone could argue this is not reasonable. The REMI model has been peer-reviewed and is used extensively for public policy decisions by numerous states and regions throughout the U.S. The extensive industry breakdown the hybrid-interactions of its internal econometric, input-output, and computable generable equilibrium equations help it to achieve a reasonable approximation of state level and the national economy.

Limitations of the REMI Model

Whereas an oil spill may only affect a specific geographic area for a period of several weeks to several months (years later effects of Exxon Valdez remained), inputs to REMI have to be annualized because the model is developed for annual data. This may mask troughs and peaks in output and consumption that are likely to happen over the course of year in the event of an oil spill. This annual model could mask or smooth many of the effects over a year.

Counterbalancing forces might cause the output of some industries to decline while that of others could increase. REMI does not model the detailed resolution of firm dynamics. For example, consumers may choose to eat less fish out of free of contamination from oil or disbursement chemicals, commercial fishing might suffer quite dramatically during an oil spill, but the beef, pork, and chick producers might benefit. In aggregate, it is unlikely that people will change their eating habits or their allocation of income spent on food; thus, essentially there would be no change.

Capacity constraints could limit increases in output. Increased demand on the remediation services sector could reflect the additional money that would be allocated to clean-up and decontamination, but would not limit the ability of the remediation services sector to provide for those services. REMI does not model the actual details of whether and how the remediation services sector could respond to meet the increased demand.

Additional limitations include the complexity of the REMI Model. Given the numerous and complex equations within the model there remains some mystery of how these relationships result in changes in GDP, employment, and other metrics. This may sometimes require intensive investigation on the part of the user to try and explain the mechanisms occurring within the model.

Chapter 5

Scope of Analysis

The analysis will be conducted under the assumption that the oil has/will foul the beaches and seaports from the middle of Louisiana east to the Panhandle of Florida. The study will primarily focus on all states with counties that border the Gulf of Mexico (GOM), excluding Texas. As of now all NOAA forecasts predict the oil spill moving eastward away from Texas (without the occurrence of a hurricane).

Given the current trajectory of the oil spill/leak, as seen in Figure 7, it appears that the oil has and will continue to wash up on the southeast and coast of Louisiana and as far east as Florida’s panhandle. It remains unclear if, how much, and for how long oil will wash ashore on the beaches of Mississippi, Alabama, and Florida; if little to no oil washes up on the beaches is still possible there may be some economic impacts.

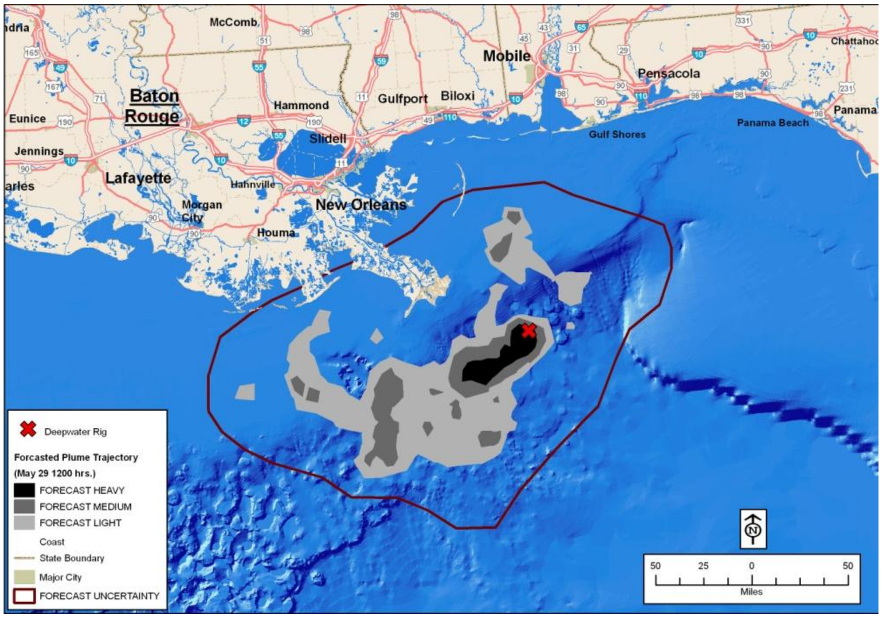

Figure 7: Trajectory of Oil Spill by Parish and County, Based on NOAA May 29, 2010 Forecast[22]

Regional Area of Analysis

The region of study will be limited to the coastline along the GOM. According to various NOAA forecasts and eye witness accounts the oil slick has washed ashore and fouled beaches and ports from Louisiana east toward the Panhandle of Florida; the states considered for this analysis are: Louisiana, Mississippi, Alabama, and Florida.

Texas is excluded from this analysis given the low probability of the oil slick being carried that far west in the Gulf currents. At this time is uncertain whether the oil slick would reach the coastline and ports of all the listed states. However, if the oil spill were to spread, the economic estimates provide an order of magnitude estimate of what could be the economic consequences. Specifically, the study will focus on impacts to the

[22] http://response.restoration.noaa.gov/book_shelf/2087_SOFM24-2010-05-28-1900.pdf; http://response.restoration.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id%28entry_subtopic_topic%29=830&subtopic_id%28entry_subtopic_topic%29=2&topic_id%28entry_subtopic_topic%29=1

coastal counties of these states since their industry sectors will be directly affected by the fouling of seawater, beaches, and ports. Economic impacts will be addressed at the county, state, and national level; these various levels of aggregation will provide a comprehensive view of the economic impact of the Deepwater Horizon oil spill.

Industry Sectors

As discussed in earlier sections, disaster events can have both positive and negative effects on industry sectors. Businesses within one industry sector may suffer disruptions to business as usual affected employees and household income; other businesses may experience a boom period with hiring expansions. Both negative and positive effects on industry sectors must be captured with an economic disaster analysis.

Industry sectors are selected for their relevance to the regional economy. Data on decreased productivity, cancellations, fishery closures, employment, and industry sales were compiled through various news reports, government entities, and business associations such as the Florida Restaurant and Lodging Association. Where data does not exist, inputs will be based on historically similar events, primarily the Exxon Valdez oil spill. Each data point will help to frame the inputs for the short-, medium-, and long-run analysis.

Tourism

Table 2 lists the counties along the Gulf Coast that are currently and likely to continue experiencing changes in tourism related industries (in year-over-year measurements) due to decreased tourism or increases in population related to the spill. In the NAICS definition there is no explicit entry for tourism. Tourism will be defined as: Amusements/Gambling/Recreation, Accommodations, and Food and Drinking venues.

Recreational fishing is also reported as subset of the NAICS codes representing general recreation. Table 2, also lists the County level daily GDP contribution of all tourism related industries to the overall State GDP.

Table 2: Daily Contribution of Tourism to State GDP for the Disruption Zone

State	County Name	Daily Contribution ($ millions)	Daily percent contribution
Louisiana	Terrebonne	0.4405	0.08%
	Lafourche	0.2344	0.04%
	Jefferson	1.9632	0.35%
	Plaquemines	0.0603	0.01%
	Orleans	3.1061	0.55%
	St. Bernard	0.0730	0.01%
	St. Tammany	0.7949	0.14%
Mississippi	Hancock	0.3359	0.12%
	Harrison	2.5216	0.86%
	Jackson	0.4051	0.14%
Alabama	Mobile	1.2720	0.23%
	Baldwin	0.9096	0.17%
Florida	Escambia	1.0237	0.05%
	Santa Rosa	0.3082	0.01%
	Okaloosa	1.2212	0.06%
	Walton	0.5877	0.03%
	Bay	1.0020	0.05%
	Gulf	0.0294	0.00%
	Franklin	0.0593	0.00%
	Walkulla	0.0530	0.00%
	Jefferson	0.0118	0.00%
	Taylor	0.0328	0.00%

Reports by numerous sources, local newspapers, national newspapers, and national television network news, indicate that prior to the Memorial Day Holiday the Panhandle of Florida and the Coast of Alabama were experiencing a drop in bookings and increased cancellations from the previous year. The Wall Street Journal[23], CNN[24],

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[23] http://online.wsj.com/article/SB10001424052748704414504575244672233144154.html
[24] http://www.cnn.com/2010/TRAVEL/05/28/spill.memorial.day.tourism/index.html?hpt=C2

and Time[25] magazine all have quoted Carol Dover, Florida Restaurant and Lodging Association President, as stating that cancellations in the panhandle rose anywhere from 30[26] to 50[27] percent. The Mayor of Dauphin Island, Alabama was quoted in the Wall Street Journal stating that estimates for tourist cancellation rates for the summer "have topped 50 percent"[28]. Although much of the information that was reported may be speculative, at the time it was the "best" source for data on the current state of tourism in the Gulf Coast.

In Louisiana, where the most oil has washed ashore, the tourism reports are mixed. As of May 1st 2010, the year-over-year measurement, the Greater New Orleans Hotel and Lodging Association had an occupancy increase of 5.7 percent[29] from the previous year. This indicates that tourism in Louisiana counties will continue without disruption. It appears that tourism is being offset by an increase in population driven by the arrival of recovery workers, BP employees, and media.[30]

Public perception affects how consumers will make vacation decisions. Various reporting of tar balls being deposited on beaches anywhere in Florida could affect tourism in Florida counties below the Panhandle. Effects on tourism outside of the pan-handle will have to be considered for this study.

Restrepo et al. (1982) found no significant decrease in tourism in the state of Texas following the Ixtoc I oil spill. Thorgrimson et al. (1990) reported severe labor

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[25] http://www.time.com/time/printout/0,8816,1990589,00.html
[26] http://www.frla.org/frla-news/item/133-news-update-may-28-2010
[27] The Florida Restaurant and Lodging Association webpage does not have a news release explicitly stating the 50 percent decrease in lodging bookings that Carol Dover is verbally stating to various media outlets.
[28] http://online.wsj.com/article/SB10001424052748704414504575244672233144154.html
[29] http://www.gnohla.com/latest-news/new-orleans-on-top-str-reports-us-performance-for-week-ending-1-may-2010.html

[30] http://www.cnn.com/2010/TRAVEL/05/28/spill.memorial.day.tourism/index.html?hpt=C2

shortages following the Exxon Valdez spill, specifically in visitor related industries throughout the state due to traditional service industry workers seeking high-paying clean-up jobs. Crowley surveyed businesses and found that 59 percent of businesses in the most spill affected areas reported spill related cancellations and 16 percent reported business was less than expected (compared to the previous year) due to Exxon Valdez oil spill. Crowley reported tourist spending decreased 8 percent in South and central Alaska and 35 percent in Southwest Alaska from the previous summer spending, these were the two major spill affected areas.

The McDowell Group (1990) conducted an extensive survey of businesses, visitors and potential visitors of Alaska post Exxon Valdez oil spill. Tourist surveys aimed to extract information on expenditures on, use of, and satisfaction with state attractions, facilities, and transportation modes. 16 percent of tourists reported that their trips were negatively impacted by the oil spill; of these negatively affects visitors, half avoided Prince William Sound. Reported expenditures by visitors in unaffected regions of Alaska increased by 4 percent over the previous year; in regions affected by the spill reported expenditures fell by 10 percent. Visitors also reported having difficulty finding lodging and charter boats in the areas of affected by the spill. The population of the Continental U.S. was surveyed through cold calls and business reply cards; of the card respondents 4 percent reported cancelling planned trips to Alaska; 1 percent of phone respondents reported cancelling a planned trip to Alaska. Respondents who lived Seattle and Portland were studied separately; 16 percent had planned trips to Alaska before the oil spill and 10 percent cancelled or delayed their travel following the oil spill.

To assess the impacts to regional businesses, business owners and publicly available information was used. Approximately 60 percent of tourist related businesses had cancellations. However, only 16 percent reported decreased activity when compared to the previous year. Some businesses reported increased activity from the previous year due to cleanup related activities. In Regions closest to the spill some businesses such as air taxies, car rentals, charter boats, lodging, etc. all reported average or above average bookings. Business located in areas closest to the spill reported 28 percent increase in business; businesses outside the directly affected region reported an 11 percent increase in business. All respondent businesses reported labor shortages and pressure to pay higher wages to compete with clean-up related jobs.

Recreational Fishing

Recreational fishing in the Gulf of Mexico also makes an overall economic contribution. The largest tourism draw to the coasts of Louisiana is the recreational fishing industry. State comparisons are illustrated in Table 3. Combined, recreational and commercial fishing along the Gulf Coast in 2008 accounted for over 325,000 jobs and in excess of $22.5 billion in sales[31]. Specific county by county data for employment data is near impossible to verify. Recreational fishing is subject to the same fishing restrictions as those imposed on commercial fishing.

[31] NOAA Technical Memorandum NMFS-F/SPO-109, April 2010

Table 3: Comparison of Recreational Fishing, Economic Metrics Between Gulf Coast States, 2008[32]

Gulf Coast State	Trips	Jobs	Total Sales ($ millions)
Louisiana	4,540,890	25,590	2,297
Mississippi	968,800	2,930	383
Alabama	1,671,081	4,719	455
Florida Gulf Coast	16,928,072	54,589	5,650
Regional Totals	**24,445,989**	**113,372**	**12,073**

According to previous research by economists, fishing trips and sport fishing opportunities were reduced by the spill due to the number of fishing boats/vessels diverted from fishing activities throughout Alaska to clean-up operations in Prince William Sound. Haneman and Carson (1992) examined the effect of the ExxonValdez oil spill on the recreational fishing industry of Alaska. The authors compared trips and days fished from the year prior to the event and the trips and days fished from the event year. They also used a second method based on economic projections to try and estimate the impact. In the location of the oil spill Hanemann and Carson found that non-residents fished less than non-residents (non-resident fishing was virtually unchanged.) Hanemann and Carson explain the lack of recreational fishing by residents to be related to the lack of available recreation time since many residents were working the clean-up; and the congestion at some fishing sites as well as contamination of fisheries in the spill area decreased fishing quality.

The continued presence of non-resident anglers was likely due to advertisements proclaiming the quality of fishing conditions and often trips are planned in advance without much incentive for delay or cancellation. In the summer of 1989 there was a significant influx into Prince William Sound of local spill workers, Alaskan spill workers,

32 NOAA Technical Memorandum NMFS-F/SPO-109, April 2010

and non-resident spill workers to seeking short-term employment opportunities in connection with the oil spill cleanup.

Hanemann and Carson (1992) suspect these non-residents contributed to a small increase in other recreational activities in the area of the oil spill. The authors reported that in the South-central non-oil spill - Valdez, Cordova, Kodiak, and Homer – area the number of days spend fishing decreased while the number of anglers increased. They explain that the desire to conduct recreational fishing outside the affected area increased but the number of available boats had decreased due to their diversion to the clean-up efforts. Hanemann and Carson estimated that the dollar value of lost fishing days ranged from \$3.6 million to \$50.5 million. Restrepo et al. (1982) found the recreation dollar losses related to the Ixtoc I oil spill did not exceed \$1 million.

Commercial Fishing and the Seafood Sector

On May 25th 2010, NOAA extended the closed fishing area in the Gulf of Mexico. The closed area now covers 60,683 square miles; this is approximately 25 percent of federal waters in the Gulf of Mexico. Fishing waters immediately off the coast of Louisiana are closed; however, the fishing seasons vary at the federal and state level depending on species. Given the lack of information regarding the range of fishing operations and the seasonality of fishing restrictions and limits the fishing industry it is assumed that commercial and recreational fishing will decrease by some amount.

Within the NAICS codes there is no single entry that covers all fishing related activities. NOAA defines the commercial seafood industry sector as the harvest, processing, wholesale distribution, and retail. Among the individual sub-sectors, retailers account for 75 percent of total sector employment. [33] Table 4 is a summary of jobs and total sales in the seafood sector by Gulf States. [34]

Table 4: Comparison of Seafood Sector, Economic Metrics between Gulf Coast States, 2008[35]

Gulf Coast State	Landing Revenue ($ millions)	Total In-State Sales Generated ($ millions)	Jobs Supported
Louisiana	273	2,034	43,711
Mississippi	44	391	8,575
Alabama	44	445	9,750
Florida	170	5,657	108,695
Regional Totals	**707**	**10,540**	**213,272**

Nationally 8.3 billion pounds of finfish and shellfish were harvested by commercial US fishermen in 2008 for which they received approximately $4.4 billion in revenue[36]. Shrimp were the highest valued product in 2008 generating $450 million dollars[37]. By weight, walleye, Pollock, and menhaden accounted for the majority of the weight during the 2008 season[38]. Figure 8, shows the zones (Fisheries and Habitats) at risk from the oil plume trajectory for Brown Shrimp and King Mackerel.

[33] http://www.nmfs.noaa.gov/
[34] The harvest, processing, wholesale distribution, and retail sale is combined.
[35] http://www.st.nmfs.noaa.gov/st5/publication/index.html; "Fisheries Economics of the United States 2008, Economics and Sociocultural Status and Trends Series"
[36] http://www.st.nmfs.noaa.gov/st5/publication/index.html; "Fisheries Economics of the United States 2008, Economics and Sociocultural Status and Trends Series"
[37] http://www.st.nmfs.noaa.gov/st5/publication/index.html: "Fisheries Economics of the United States 2008, Economics and Sociocultural Status and Trends Series"
[38] "Fisheries Economics of the United States 2008, Economics and Sociocultural Status and Trends Series", published by the National Marines Fisheries Service, NOAA Technical Memorandum NMFS-F/SPO-109, April 2010

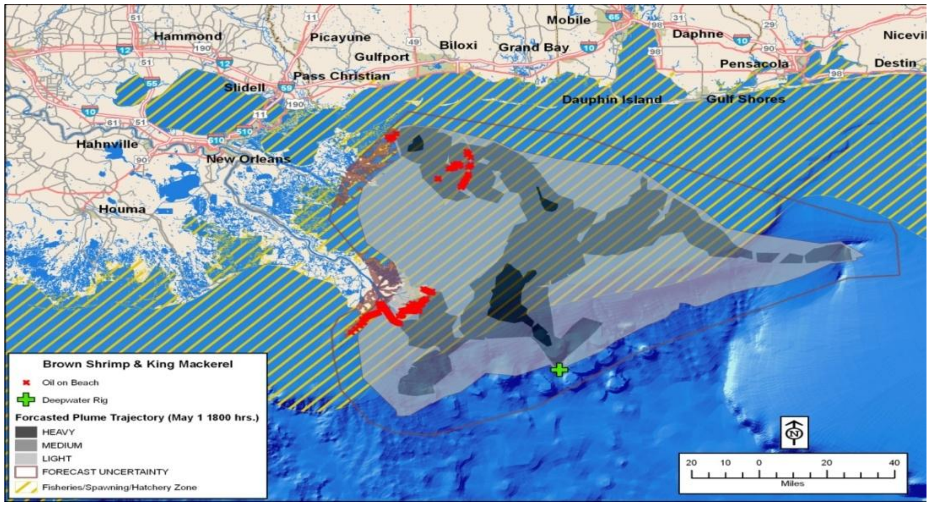


Figure 8: Forecast Plume Trajectory for April 30, 2010, Relative Habitat Zone for Brown Shrimp and King Mackerel

Figure 9 displays the zones (Fisheries and Habitats) at risk from the oil plume for the following fish: gray snapper, greater amberjack, lane shrimp, red drum, spiny lobster, and stone crab. In the Gulf 2008 revenues were dominated by shrimp. Wholesale prices vary within the Gulf region; Texas harvested less shrimp than Louisiana but generated higher revenues. Between the two states, Texas and Louisiana, 153 million pounds of shrimp were harvested and generated $287 million in revenue.[39] Currently the fishing water of Texas is not expected to be threatened by the oil spill and will not be considered for this analysis. Although GOM states contribute significant commercial fishing revenue, 80 percent of all fish consumed within the US is imported from other countries, demonstrating that the US appetite for fish is largely provided for outside of the GOM.[40]

[39] "Fisheries Economics of the United States 2008, Economics and Sociocultural Status and Trends Series", published by the National Marines Fisheries Service, NOAA Technical Memorandum NMFS-F/SPO-109, April 2010

[40] http://www.fda.gov/NewsEvents/Testimony/ucm115243.htm

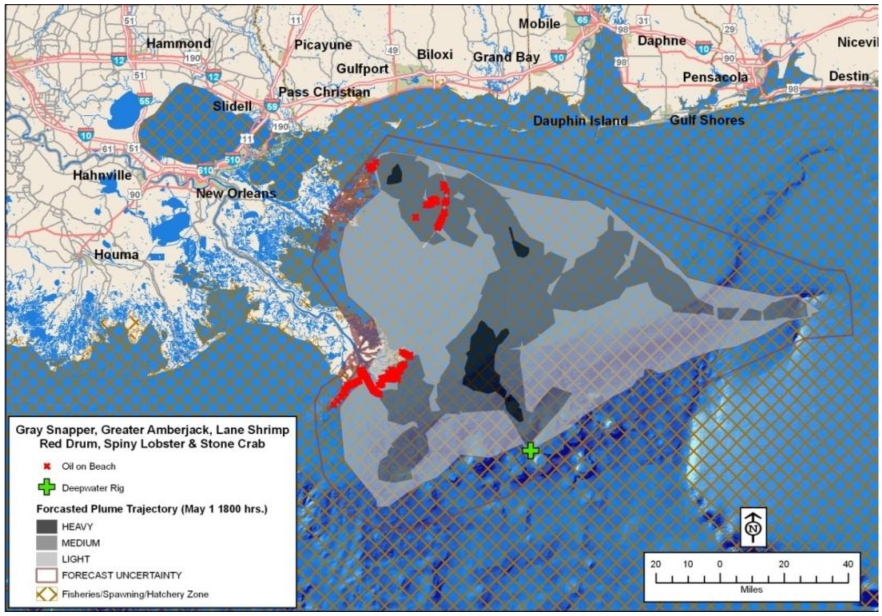


Figure 9: Forecast Plume Trajectory April 30, 2010, Relative habitat Zone for Gray Snapper, Greater Amberjack, Lane Shrimp, Red Drum, Spiny Lobster, and Stone Crab[41]

Many of the workers associated with the commercial fishing industry are self-employed or employees of small businesses. These self-employed and small businesses are not required to report specific employment information for the Economic Census since revealing such information is of a proprietary nature[42]. Although the totals are not available at the county level, they are available at the state level. At the county level, instead of reporting a specific number of employees, a range of employees is reported. For example in the column for Paid Employees instead a number, the column will show a range of 100-249 employees. Within the REAcct calculation this challenge was overcome by taking the mean for the industry sector employment for every county where this occurred. There likely exists other data sources but currently the BEA Economic Census

[41] http://sero.nmfs.noaa.gov/

[42] The field for employees is often left blank with a "D" in place of a number. D = Withheld to avoid disclosing data of individual companies; data are included in higher level totals.

and Business County Patterns remain the most reliable, defensible sources. The Labor Department claims to have more accurate data but is unwilling to share the data.

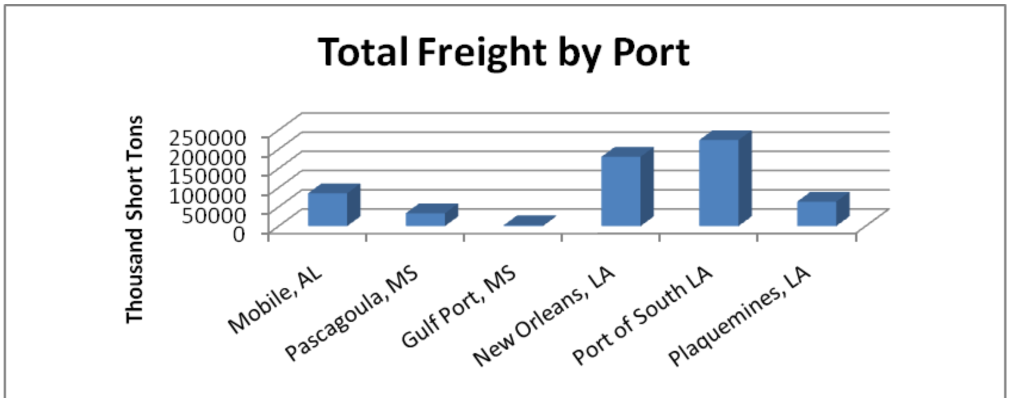
Given the similar nature of the Deep Horizon oil spill to that of the Exxon Valdez oil spill in Prince William Sound, Alaska it is reasonable to assume that there would likely be a similar change in employment in the GOM. Laborers and private firms that typically work in the commercial and seafood (fisheries) sectors will have an incentive, in the form of wages and contract fees, to switch from fishing and fishery activities to clean-up activities. Of, course this work would be short-term (1-year or less) but would offer a monetary incentive.

Retrepo et al. (1982) found that the Ixtoc I oil spill did not have a significant direct or indirect economic impacts on the output of the Texas fishing industry. The commercial value of the catch in the year prior to the spill and in the year the spill occurred did not have a measurable difference. Restrepo et al. also point out that it was reported that the commercial species of fish in Texas GOM waters did not test positive for aromatic hydrocarbons.

Garza-Gil et al. (2006) estimated fishing sector losses following the Prestige oil spill for the Galacian coast in Spain with also some region by region comparisons. Between November and December of 2002 and in the first 6-months in 2003 when many fisheries were closed for fishing; produced tons of fish decreased by approximately 10 percent and related sales declined by approximately 17 percent. Over a longer period November 2002 to December 2003 fishing related income losses were much larger, ranging from 59 percent in Coruna-Ferrol, 47 percent in Costa da Morte, and 36 percent in Pontevedra-Vigo.

Water Transportation

The ports and waterways depicted in Figure 10 and Figure 11, transport mainly non-container bulk commodities that tend to be high volume goods. With the largest portion of the port activity in the GOM occurring within the state of Louisiana.



[43]**Figure 10: Total commodity freight by port (2008)**

Domestic freight activity, freight between ports, is largely made of the transport of energy related commodities, petroleum products and coal, Figure 11. Disruption of the flows of these commodities could have national impacts through the price mechanism if as was seen with the interruption of petroleum distribution during Hurricane Katrina.

[43] Waterborne Commerce of the United States, Calendar Year 2008, Part 2 – Waterways and Harbors Gulf Coast, Mississippi River System, and Antilles

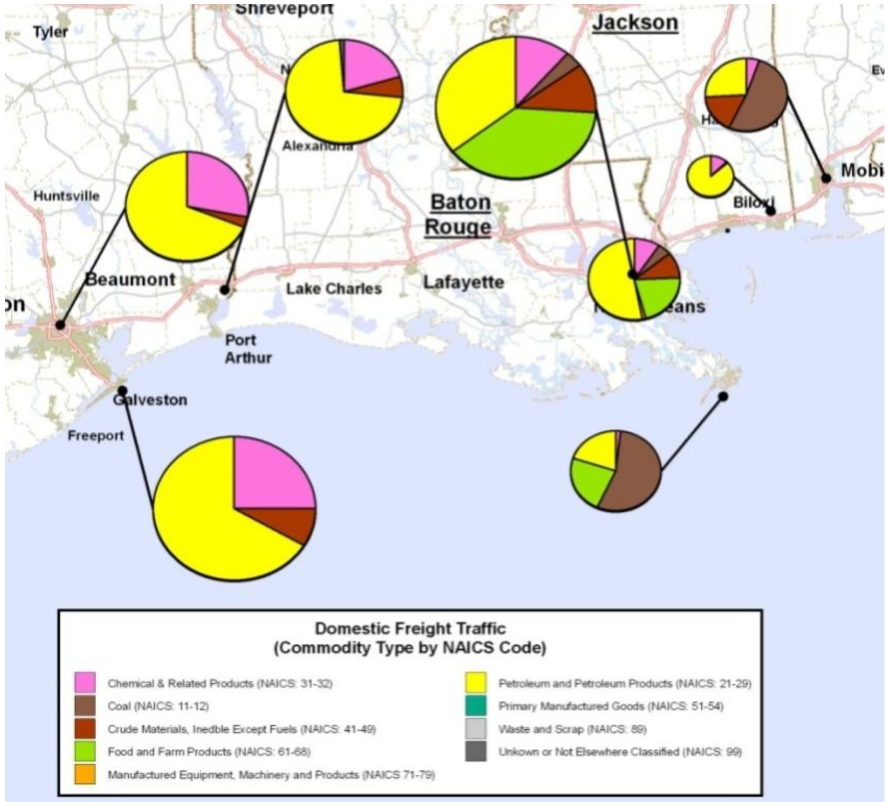


Figure 11: Domestic Commodity Freight, Gulf of Mexico Ports/Waterways (2008)[44]

As shown Figures 12 and 13, the most abundant foreign (import and export) and domestic commodity freight through these ports and waterways is petroleum and agriculture products.

[44] Waterborne Commerce of the United States, Calendar Year 2008, Part 2 – Waterways and Harbors Gulf Coast, Mississippi River System, and Antilles

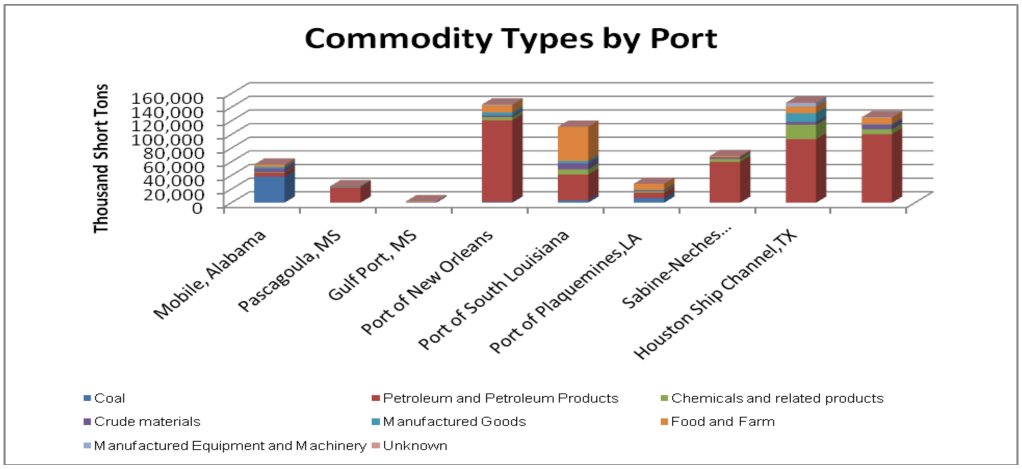


Figure 12: Foreign (Import and Export) commodity by freight by port/waterways, Gulf of Mexico (2008)[45]

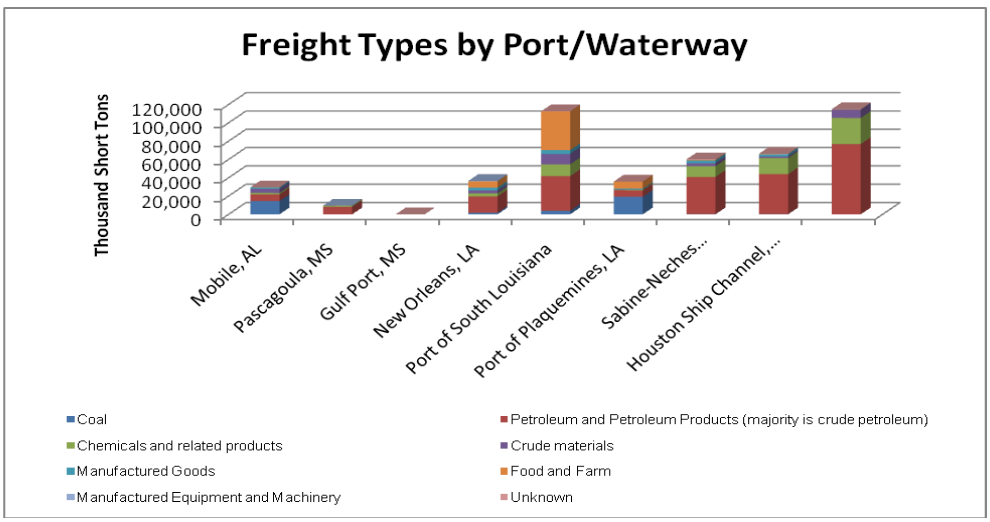


Figure 13: Domestic commodity freight by Port/Waterways, Gulf of Mexico (2008)[46]

Most transported petroleum product is crude petroleum, which is typically of lower value than refined petroleum. Finding alternative ports for petroleum products will vary by petroleum product type and the technology available at individual ports.

The transported agriculture products are on average low dollar value goods (corn and soybeans) per unit weight or volume when compared with other exports and imports.

[45] Waterborne Commerce of the United States, Calendar Year 2008, Part 2 – Waterways and Harbors Gulf Coast, Mississippi River System, and Antilles

[46] Waterborne Commerce of the United States, Calendar Year 2008, Part 2 – Waterways and Harbors Gulf Coast, Mississippi River System, and Antilles

There may not be an economically viable alternative way to move low value, heavy goods such as grains other than by barge. When ranked by dollar value, the Port of New Orleans ranks 27th nationally, total trade value is $12 billion[47]. For commodities destined for export, particularly agriculture, movement of goods along the inland waterways for transfer to ocean-going vessels is not an option, unless, these agriculture goods could reach the Great Lakes and be transported out through the St. Lawrence Seaway. Transportation of corn is fairly steady throughout the year as shown in Figure 14, transportation of soybeans tends to be more seasonal as shown in Figure 15.

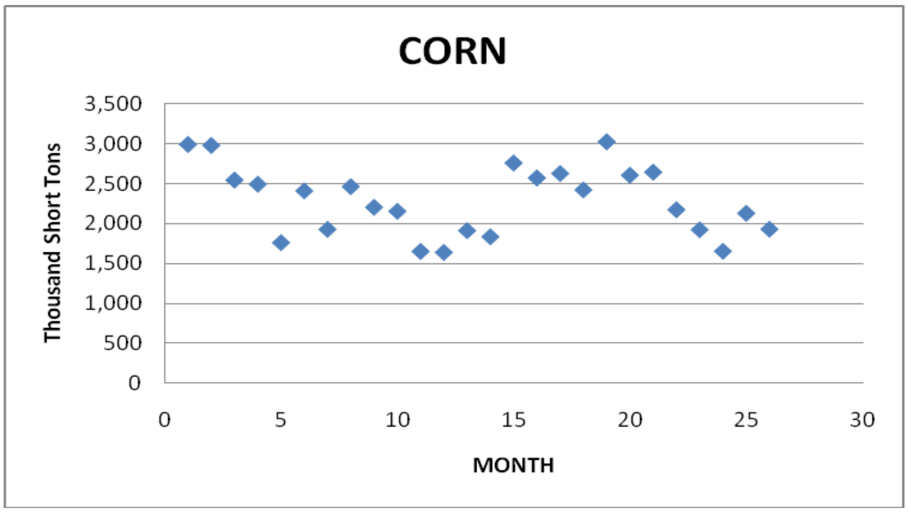


Figure 14: Monthly transportation of corn, January 2008 - February 2010[48]

[47] Top 63 Ports by Trade Value (US$) for USA-NAFTA Partner Trade by Vessel: 2008
[48] http://dataweb.usitc.gov/

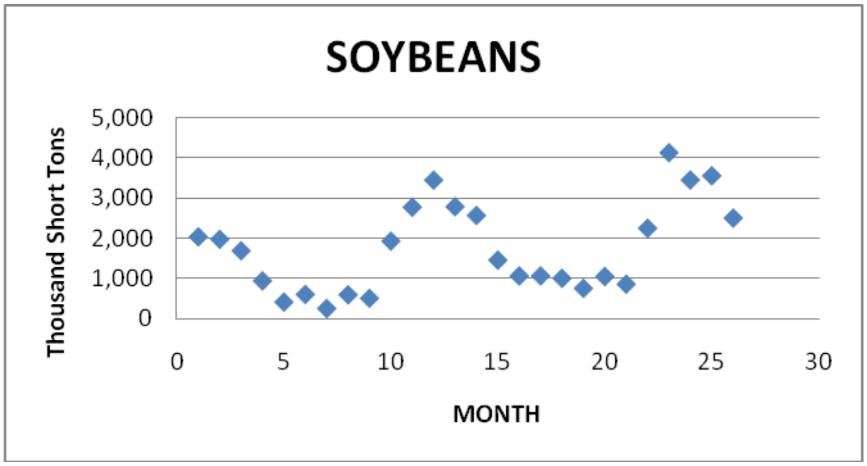


Figure 15: Monthly transportation of soybeans, January 2008 - February 2010[49]

The US Coast Guard (USCG) has not imposed restrictions on the shipping lanes in the GOM. However, if conditions with respect to the oil slick were to change shipping lanes could be closed. Review of events since the beginning of May suggest no significant impacts on shipping and warehousing industry, based on the near shore oil forecast for Friday, May29th.[50] Since the start of the spill shipping has been successfully routed around the oil slick. Diversions to avoid weather are routine in the shipping industry.

If the USCG were to impose mandatory decontamination before entry of any port on the GOM the impact should be minimal. This will likely be dependent on how long it takes to decontaminate individual ships. As of, May 5th 2010, the USCG took the precautionary action of placing two decontamination stations on the Lower Mississippi for vessels entering the Southern Pass. One station is located near Venice, LA and the other is near Bootheville, LA. Ariving vessels with a “visible sheen” will be cleaned

[49] http://dataweb.usitc.gov/

[50] http://response.restoration.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id%28entry_subtopic_topic%29=832&subtopic_id%28entry_subtopic_topic%29=2&topic_id%28entry_subtopic_topic%29=1

before entering the Mississippi. Decontamination method is assumed to be pressurized steam cleaning. The same method was employed following a barge spill in July 2008 within the Port of New Orleans, approximately 1,190 hulls were decontaminated.[51]

The Port of New Orleans reports no cancelled ship calls to date. Only one commercial hull has required cleaning before upstream transit on the Mississippi Waterway was permitted.[52] At the Port of Pascagoula vessel assessments for oil are required but there are no reports of commercial delays of restrictions.

Crude Oil Production and Exploration

The US GOM currently produces approximately 1.3 million bbl/day of crude oil. Oil drilling firms are represented by the NAICS code for the Mining industry sector since they are not technically producing oil. The Deepwater Horizon event has not caused any interruption of GOM crude oil production, shipping, or refining. Because of this the estimated potential effects of the Deepwater Horizon event on the petroleum industry are likely to be nonexistent. The production of crude oil production depends on the functioning of off-shore platforms; operation of these platforms has not been disrupted. If production were disrupted a release of oil from the Strategic Petroleum Reserve would most likely offset reductions in crude oil production.

Impacts of this recent event on the oil market, if any, may occur over a longer time frame (years). Market effects would be driven by long-term policy decisions to restrict off-shore drilling[53].

[51] Tuler, Seth, Weble, Thomas, Lord, Fabienne, and Dow, Kristin, "A Case Study Into the Human Dimensions of the DM-932 Oil Spill in New Orleans," April 2010.
[52] Port of New Orleans Release, May 25, 2010; http://63.243.112:8083/prsrel052510.pdf

[53] Analysis of long-term policy change Appendix C.

Remediation and clean-up

The current unemployed in the GOM may find short-term employment opportunities working the clean-up. The quick influx of labor into Prince William Sound following the Exxon Valdez oil spill proves that many of the clean-up associated activities are low-skilled enough that not many unemployed would be excluded from finding work. Outside of monetary incentives, local Gulf Coast Residents may have a personal interest in clean-up in order to preserve their local environments and livelihoods.

Hanemann and Carson (2003) found that residents of Alaska that would have otherwise been employed in commercial fishing, recreational fishing support, and fisheries in 1989, were now busy working the clean-up of the Exxon Valdez – they were prevented from fishing by lack of time, lack of boats, and better employment opportunities with the cleanup rather than water quality.

Given the uncertainty regarding the amount of oil leaking below the surface and the final overall outcome of the event, the following is assumed. The Figure 16 shows order of magnitude oil spill clean-up cost estimates, based on actual historical clean-up cost data. For the Deepwater Horizon spill at current estimate daily flow rates (5,000 bpd) accumulated over a period of 30 to 60 days[54].

[54] http://www.nytimes.com/2010/04/29/us/29spill.html

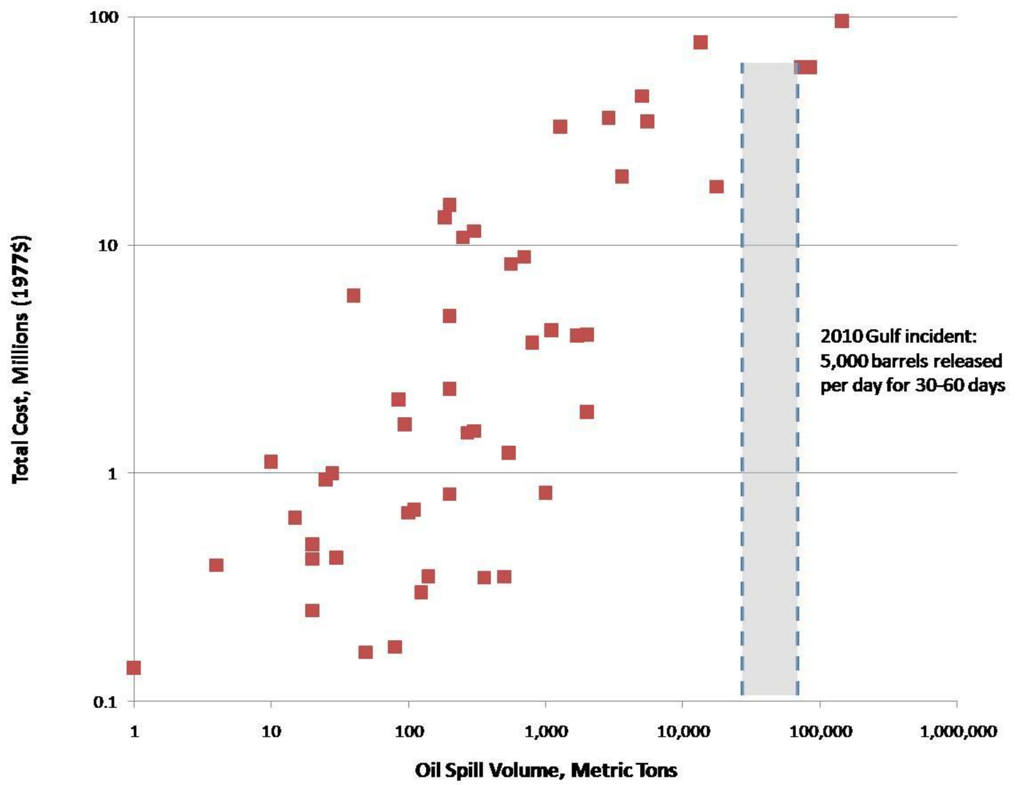


Figure 16: Order of Magnitude Oil Spill Clean-Up Costs for Deepwater Horizon, Based on Historical Estimates

Cleanup costs will largely be borne by British Petroleum (BP); BP profits will correspondingly be reduced. Profits are one of the 4 main categories of income representing fundamental economic value, the others wages, interest, and rent will be transferred to one of the other three categories of income, probably wages. Previously unemployed resource in the GOM will experience an economic gain from the clean-up effort. Damage to public resources (fouled beaches, marshes, and wildlife populations will generally go uncompensated. Remediation and clean-up will only be analyzed in the medium- and long – run due to the limitations of adjusting remediation and cleanup estimates within the REAcct calculation.

Duration of Economic Impacts and Adjustments

As discussed in the section on disaster economic analysis it is likely that disruptions to the regional economy may have short, medium, and long-run effects, at least in portions of industry sectors. When discussing disruptions to economic activity it is important to consider the time frame of interest because the disruptions can appear to have decidedly different consequences depending upon the time horizon for which they are being evaluated. In a market-driven economy these short- to long-run effects should be considered natural, albeit potentially disruptive, parts of how the economy adjusts to changes in its conditions.

Short-run

The primary impact of disruptions in the short-run (days to weeks, up to one year) is the restructuring of the supply chain as it adapts to the new economic conditions. When buyers cannot purchase goods from their usual sources, they either seek these goods from new sources or purchase acceptable, substitute goods. This restructuring can come with an additional cost for the buyers, but in the instance when they are able to obtain the necessary goods, they at least remain able to continue their business.

If a disruption is large enough, the necessary goods may not be obtainable and production may need to be halted. Halts in production may be absorbed depending on the length of the disruption and the nature of the segment of the industry that is disrupted. For example, a short disruption in the production of a good with a large inventory may not produce downstream consequences if the facility has enough excess capacity to compensate for lost production. Similarly, if the supply of a good is restricted, but downstream production has large inventories and/or excess capacity, the effects of the disruption to production in final products may be mitigated. In the short-run there is often not much time for sustainable price adjustments; what is often observed is price gauging that is not sustainable by the market.

It is unclear whether the oil slick will reach all of the other GOM states. Although, the presence of oil is not necessary for changes in economic activity, simply the impression that contamination might occur will likely be enough to affect the level of business activity in the short-run. The inability to produce goods during short periods may have severe impacts on a local, regional, and even national scale. There is tremendous uncertainty surrounding the extent and duration that the coastline of GOM will be affected. To determine how sensitive economic impacts will be to disruption durations for modeling simplicity the short run analysis will consider business disruptions lasting 30, 60, and 120 days.

Medium-Run and Long-Run Effects

The primary medium- and long-run effects of disruptions are changes in capital stock (e.g., the closing, relocation, or construction of new facilities) and the loss of the product caused by changes in that stock. However, when using measures like GDP, it is unlikely that a single manufacturing firm or collection of small businesses will have a substantial long-run effect on the overall, aggregate economy. The disruption of a single firm or its inventory likely would have a relatively minor change in the aggregate economy, due to the myriad of other short-run, medium-run, and long-run effects in play. Economies change in many ways over time and normally adjust via market mechanisms.

Even during large-scale disasters, the economy will adjust via price changes and substitution (Rose, 2007). Over a slightly longer time, prices may adjust in response to changes in the availability of a good. Depending upon the situation, changes in prices may be negligible to severe. Price increases in a good will affect the firms that require the good as an input; however, they will benefit any firm that continues to produce the good or holds inventories of the "good". For example, if the effects of a disruption last a sufficiently long period, the price changes caused by the disruption may persist and influence investment decisions. Price increases in a particular industry sector will entice investment in facilities that produce the same good, thereby mitigating the long-run effect of the loss of the facility production.

Given the level of uncertainty regarding the oil spill amounts and length of time it will take the region to return to pre-Deep Horizon activity. It is assumed that economic activity could be disrupted for as long as 10 years, which is a reasonable assumption given reports that up to 15 years after the Exxon Valdez spill the regional economy was still suffering from the effects. Medium- and long-run economic analysis will consider industry sector impacts that last 1, 5, and 10 years out.

Chapter 6

Short-Run Scenarios and Assumptions

The economic analysis approach builds chronologically on three time periods. With a proposed four-step process for estimating the economic impacts of the Deep Horizon oil spill. The first step in the economic estimate will be to evaluate the prompt losses in business and economic activity that occur throughout the coastline of the GOM, relying on information from the media and local business organizations. The business loss estimates are aggregated to the appropriate industry sector by NAICS code. The second step is to use the REAcct calculation methodology to estimate the short-run business disruption losses. The third step is to gather real-time event data or data from historically similar events to estimate medium- and long-run business interruptions. The fourth and final step is to use the applicable output from REAcct and all other data to serve as inputs into the REMI model to estimate medium- and long-run economic impacts.

Short-Run Analysis

The map in Figure 17 shows the coastal counties that are at risk of having oil wash ashore fouling beaches and contaminating ports. This area is referred to as the Disruption Zone; it is assumed that some portion of businesses in this region will experience a disruption to business as usual due to the effects of the oil spill. The disruption region in purple encompasses only coastal counties from Louisiana up to the Panhandle of Florida. Each REAcct run will differ by made to industry sectors. Scenarios considered for analysis are detailed in the following subsections.

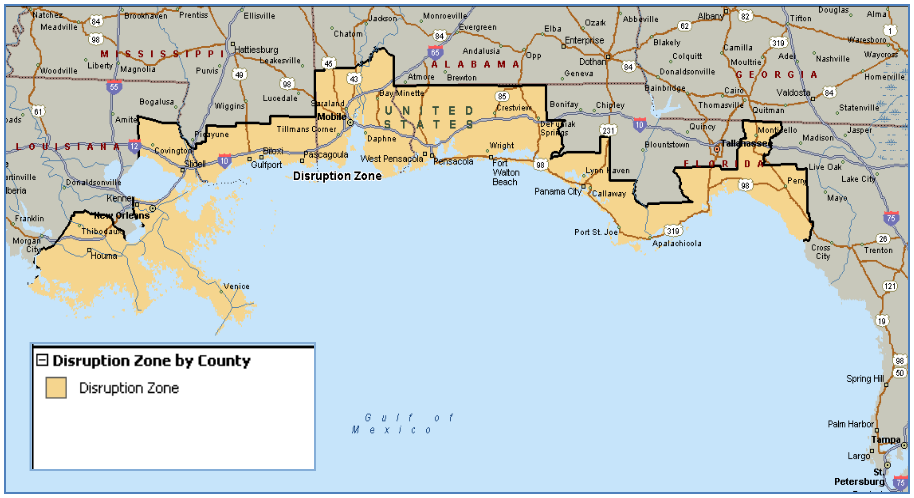


Figure 17: Coastal Counties in Disruption Zone, Based on NOAA Projections of Plume Trajectory

Short-Run Scenarios Assumptions and Inputs

The following section outlines scenarios that were developed to provide a snapshot of possible industry sector impacts and associated estimated economic impacts at the county, state, and national level.

Scenario 1: Worst-Case, Assumptions and Inputs

It is assumed oil fouls seawater, beaches, and seaports equally with no regard for differences. Specifically, economic activity that is dependent on the health of the water and coastline of the GOM is affected; all related economic activity could be disrupted for 30, 60, and 120 days by the percentage detailed in Table 5 .This assumption of Worst-Case will help to provide a bounding estimate for the analysis.

Table 5: Industry Disruptions for Disruption Zone, by County and Scenario

	Percent Decrease in Business Activity		
State	**County Name**	**Scenario 1: Worst-Case**	**Scenario 2: Severe**
Louisiana	Terrebonne	100	50
	Lafourche	100	50
	Jefferson	100	50
	Plaquemines	100	50
	Orleans	100	50
	St. Bernard	100	50
	St. Tammany	100	50
Mississippi	Hancock	100	50
	Harrison	100	50
	Jackson	100	50
Alabama	Mobile	100	50
	Baldwin	100	50
Florida	Escambia	100	50
	Santa Rosa	100	50
	Okaloosa	100	50
	Walton	100	50
	Bay	100	50
	Gulf	100	50
	Franklin	100	50
	Walkulla	100	50
	Jefferson	100	50
	Taylor	100	50

Scenario 2: Severe, Assumptions and Inputs

Speculation remains regarding the closing of seaports, tourism, and resumption of crude oil drilling. As conveyed in the industry sector discussion decreased tourist activity has been reported to be as much as 50 percent[55]. This may be an extreme assumption but

[55] http://online.wsj.com/article/SB10001424052748704414504575244672233144154.html

with regard to how some aspects of the Alaskan economy were affected by the Exxon Valdez oil spill it is a reasonable assumption. Specifically, for the commercial fishing and mining (oil drilling) industries this may not be far from reality given the ban on all fishing and the moratorium on exploratory drilling in the GOM. This scenario is likely extreme for the tourism related other industry sectors. Although, the Florida Restaurant and Lodging Association is reporting that some bookings in some Panhandle counties have dropped by 50[56] percent. Counties south of the Panhandle of Florida have not reported decreased bookings related to the Deepwater Horizon oil spill but could suffer from association, a decrease of 25 percent for a short amount time is reasonable assumption. Industries assumed to experience disruptions are: Accommodations; Amusements, gambling, and recreation; Food and Drinking Venues, Fishing, Food Manufacturing, Mining, Water Transportation, and Warehousing and Storage. Industry sector adjustments are detailed in Table 5.

Scenario 3: Real World, Inputs

This scenario was developed to most accurately reflect current reports of decreased, negligible, and increased economic activity in the region affected by the Deepwater Horizon oil spill. Scenario 3 is based on reported changes to regional business activity and allows for variability by county. The Real-World scenario will look less daunting than the previous two scenarios. It attempts to remove the speculation and simply make adjustments based on currently available reliable information. Most notably,

[56] The Florida Restaurant and Lodging Association webpage does not have a news release explicitly stating the 50 percent decrease in lodging bookings that Carol Dover is verbally stating to various media outlets.

there are several county specific industries that are not expected to experience a change in either direction.

As discussed in previous sections, the Florida Restaurant and Lodging Association was reporting declines in business and the Louisiana Hotel and Lodging Association was reporting an increase in tourist related business activity. Louisiana speculated that the inundation of spill related workers and media contributed to the lack of disruption to tourism related businesses. For Labor Day weekend, counties across the GOM (except LA) were reporting 30 to 50 decrease in occupancy when compared to the previous year. With reports of tar balls washing ashore in the Florida Keys some trip cancellations were reported for counties south of the Panhandle of Florida. Previous sections also discussed the concern over port closures was likely overblown blown since the ports were not reporting decreased activity. Fishing restrictions remain in place for approximately 37 percent of GOM waters and will likely continue for some time until further testing is completed[57]. The moratorium on drilling in the GOM is still effect, but will likely not last beyond 6-months. The Real-World scenario attempts to digest this information and use it to estimate economic impacts for 30, 60, and 120 day. Table 6 displays the details of the adjustments specific industry sectors by county.

[57] http://www.noaa.gov/100days/Keeping_Seafood_Safe.html

Table 6: Scenario 3 - Industry Disruptions for Disruption Zone by County

		Percent Decrease in Business Activity			
State	County Name	Water Trans/Warehouse and Storage	Amuse/Accom/Food and Drinking	Fishing/Food Processing	Mining
Louisiana	Terrebonne	0	0	37	100
	Lafourche	0	0	37	100
	Jefferson	0	0	37	100
	Plaquemines	0	0	37	100
	Orleans	0	0	37	100
	St. Bernard	0	0	37	100
	St. Tammany	0	0	37	100
Mississippi	Hancock	0	30	37	100
	Harrison	0	30	37	100
	Jackson	0	30	37	100
Alabama	Mobile	0	30	37	100
	Baldwin	0	30	37	100
Florida	Escambia	0	30	37	100
	Santa Rosa	0	30	37	100
	Okaloosa	0	30	37	100
	Walton	0	30	37	100
	Bay	0	30	37	100
	Gulf	0	30	37	100
	Franklin	0	30	37	100
	Walkulla	0	30	37	100
	Jefferson	0	30	37	100
	Taylor	0	30	37	100

Chapter 7

Medium- and Long-Run Assumptions and Inputs

As discussed previously, natural and man-made disasters will create impacts (some negative and others positive) that will linger beyond a year. Oil from the Deepwater Horizon spill could wash ashore for many years after the initial event. Cleanup activities could last for more than one year; this would spur additional spending in the remediation and clean-up related industry sectors. Therefore, in addition to the decreased business activity in some industries there will be increased business activity in other industries. This increased activity is often controversial; some analysts consider this increased activity a boom to the local economy. While others argue this is simply representative of funds that would have been better used in a different capacity and therefore not a boom regionally and much less so at a national level.

Recovery/clean-up efforts may inhibit the return of tourism dollars. Commercial and recreational fishing may continue to be banned if water in the GOM is deemed unsafe. Beaches could remain clean for some time but local businesses may find that public perception prevents tourists from returning. Hence, any recovery may not be immediate but will be staggered over years. In Alaska local businesses report that tourism has yet to return to pre-Exxon Valdez levels.[58] Hence, it is appropriate to use a model that is adept at multi-year economic analysis, the REMI model.

Medium-Run Inputs

A REMI analysis is carried out in two steps. First, a baseline forecast is computed, in which there is no change to the economy. Second, an alternative forecast is

[58] http://www.ens-newswire.com/ens/mar2004/2004-03-25-11.html; http://news.nationalgeographic.com/news/2004/03/0318_040318_exxonvaldez.html

generated, in which a set of simulation variables are input into the model to generate a change in the economy. The economic impact of the change in the economy is measured as the differences between the baseline and alternative forecasts.

Transformation of REAcct Results for Inputs into REMI

Short-run estimated GDP reductions by industry generated by REAcct[59] were used to calculate a first approximation of adjustments. However, as demonstrated the REAcct calculation method lacks the dynamics to help analyze how the economy will adjust over time. A medium-run analysis is conducted to assess the one-year impacts of 60-day disruption to business activity. [60] Scenarios will be based on the three original scenarios: Worst-case, Severe, Real World. All results are annualized at the state level to be compatible with the REMI model[61]. The medium-run assumes impacts are only experienced for one-year, after which the economy returns to normal.

REAcct results, which were based on a 30, 60, and 120 day durations, would not capture the full extent of economic disruption in the oil spill area. GDP reductions by industry generated by REAcct were used to calculate proportionate annualized inputs by industry for the REMI model. These estimated reductions in GDP, were used to approximate declines by industry sector in the REMI Model. The short-run reductions in GDP from REAcct provide a starting place from which to simulate decreased demand and supply at the annual level by industry in the REMI Model.

Originally all Scenarios assumed some amount of business interruption , for example, Worst Case states that activity in the industries listed in Table 4 will completely

[59] These initial durations ranged from 30, 60, and 120 days.
[60] This assumes that that the region is only affected for one "summer" season, and does not take into account seasonality of the industry sectors affected.
[61] The transformation is detailed in Medium-run Scenario 1, repetition not necessary.

shut down for 30, 60, and 120 days by county and industry sector. To translate this for use within the REMI, an annual model, inputs must be transformed from the county level to the state level. For example, the Accommodation sector is represented in both the REAcct model and the REMI model. However, 100 percent decrease in Accommodation in one county does not translate into a 100 percent decrease in Accommodation for the state. This reduction in the county is some percentage of Tourism activity in the state, this annual percent reduction of a 60-day disruption is detailed in Tables 7, 8, and 9, without the represented increase in activity due to remediation and clean-up.

Demand and Supply Shocks

As seen with the any disaster event natural or man-made - SARS outbreak in East Asia or September 11th - one of the major immediate impacts will result from individual behavioral responses related to the news of an oil spill. As discussed in previous sections any industry related to tourism (accommodations, restaurants, and recreation) could see a sharp in activity or production as a result of decreased demand. Input variables were developed to reflect the postponement of these expenditures by consumers in the REAcct calculation, which were transformed into annual reductions for demand of these "products" within the REMI Model. This set of demand shocks has a direct impact on sales and employment because firms find that sales decline, and in some cases, inventories build up. An indirect effect could be firms laying off portions of their labor force due to the business interruption associated with the oil spill.

Supply Shocks

As the oil spill advances across the GOM, the ceasing of operations for some businesses will increase (for this analysis fishing, mining, and food production). These disruptions are the result of prohibitions on activities deemed unsafe during the oil spill. The substantial decline in these activities could have significant economic consequences in terms of goods and services that will no longer be available in the economy.

Table 7: Medium-Run, Change in Industry by State, Scenario 1: Worst Case

	Worst Case: Annual Percent Decrease by Industry, REMI Input							
State	**Food Manuf**	**Fishing**	**Mining**	**Water Trans.**	**Warehouse / Storage**	**Amuse. / Rec.**	**Lodging**	**Food / Drinking**
Alabama	0.2	1.8	4.5	14.6	4.1	7.4	8.3	6.9
Florida	0.1	0.9	7.6	0.6	0.4	1.0	2.5	2.8
Louisiana	1.2	0.8	20.7	31.6	6.9	20.2	13.5	18.2
Mississippi	0.1	0.1	0.9	8.7	1.7	17.3	13.6	7.2

Table 8 Medium-Run, Change in Industry by State, Scenario 2: Severe

	Severe: Annual Percent Decrease by Industry, REMI Input							
State	**Food Manuf**	**Fishing**	**Mining**	**Water Trans.**	**Warehouse / Storage**	**Amuse. / Rec.**	**Lodging**	**Food / Drinking**
Alabama	0.2	0.9	2.2	7.3	2.0	3.7	4.2	3.5
Florida	0.1	0.5	3.8	0.3	0.2	0.5	1.2	1.4
Louisiana	1.2	0.4	10.3	15.8	3.4	10.1	6.8	9.1
Mississippi	0.1	0.1	0.5	4.3	0.9	8.6	6.8	3.6

Table 9 Medium-Run, Change in Industry by State, Scenario 3: Real World

	Real World: Annual Percent Decrease by Industry, REMI Input					
State	Food Manuf	Fishing	Mining	Amuse. / Rec.	Lodging	Food / Drinking
Alabama	1.0	0.7	4.5	2.2	2.5	2.1
Florida	0.2	0.2	7.6	0.3	0.7	0.9
Louisiana	0.2	0.3	20.7	0	0	0
Mississippi	0.4	0.1	0.9	5.2	4.1	2.2

Table 10, displays the input values for remediation and cleanup; cleanup is based on analysis from previous sections. Clean-up costs are only considered at the medium-run and long-run since it is an activity that is assumed to continue beyond the oil spill time-horizon. The increased in remediation and clean-up is distributed across all four states according to exposed coastline and reported landfall oil sightings; the highest estimate of costs is selected $288.37 million[62].

Table 10: Medium-Run, Remediation and Clean-up, Scenario 1: Worst Case

	Worst Case: Annual Increase
State	Remediation and Clean-up ($ million)
Alabama	43.2
Florida	86.5
Louisiana	115.3
Mississippi	43.2

[62] Converted to 2010 dollars from $80 million 1977 dollars.

Long-Run Analysis and

The REMI model is to estimate long-run economic impacts; the analysis is carried in the same manner, however, now over a longer time-frame[63]. Inputs will be distributed over 5 and 10 year intervals instead of just one year.

Long-Run: 5 - Year Assumptions and Inputs

The short- and medium-run analysis examined inputs for 3 different scenarios, two of which were based more on assumptions than past incidents or real-time information. As of August 2010, it was apparent that the Worst Case and Severe scenarios were not likely to materialize. For the long-run analysis only the Real World scenario will be considered and distributed over 5- years. Inputs for the 5 - year analysis are presented in Tables 11, through 16. Inputs for the Real World analysis were annualized and then distributed over 5 years. It is assumed that over the course of fives the level of disruption will eventually subside over time. The first year of disruptions remain as initially estimated; beginning in the second year the initial disruptions decrease in the following manner 50 percent (Year 2), 70 percent (Year 3), and 90 percent (Years 4 and 5).

Table 11: 5- Year REMI Inputs, Scenario – Real World

	Annual Percent Decrease - Food Manufacturing				
State	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Alabama	1.04	0.52	0.31	0.10	0.10
Florida	0.19	0.09	0.06	0.02	0.02
Louisiana	0.17	0.08	0.05	0.02	0.02
Mississippi	0.37	0.18	0.11	0.04	0.04

[63] Analysis is carried out in two steps. First, a baseline forecast is computed, in which there is no change to the economy. Second, an alternative forecast is generated, in which a set of simulation variables are input into the model to generate a change in the economy. The economic impact of the change in the economy is measured as the differences between the baseline and alternative forecasts.

Table 12: 5 – Year REMI Inputs, Scenario – Real World

	Annual Percent Decrease - Fishing				
State	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Alabama	0.65	0.33	0.20	0.07	0.07
Florida	0.23	0.12	0.07	0.02	0.02
Louisiana	0.29	0.15	0.09	0.03	0.03
Mississippi	0.05	0.03	0.02	0.01	0.01

Table 13: 5 – Year REMI Inputs, Scenario – Real World

	Annual Percent Decrease - Mining				
State	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Alabama	4.48	2.24	1.34	0.45	0.45
Florida	7.64	3.82	2.29	0.76	0.76
Louisiana	7.65	3.82	2.29	0.76	0.76
Mississippi	0.93	0.47	0.28	0.09	0.09

Table 14: 5 – Year REMI Inputs, Scenario – Real World

	Annual Percent Decrease - Amusement and Recreation				
State	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Alabama	2.23	1.11	0.67	0.22	0.22
Florida	0.30	0.15	0.09	0.03	0.03
Mississippi	5.18	2.59	1.56	0.52	0.52

Table 15: 5 – Year REMI Inputs, Scenario – Real World

	Annual Percent Decrease - Accommodation				
State	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Alabama	2.50	1.25	0.75	0.25	0.25
Florida	0.75	0.37	0.22	0.07	0.07
Mississippi	4.07	2.03	1.22	0.41	0.41

Table 16: 5 – Year REMI Inputs, Scenario – Real World

	Annual Percent Decrease - Food and Drinkning Venues				
State	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Alabama	2.07	1.04	0.62	0.21	0.21
Florida	0.85	0.43	0.26	0.09	0.09
Mississippi	2.16	1.08	0.65	0.22	0.22

With a tremendous lack of specifics still surrounding clean-up cost estimates, inputs will be based on the order of magnitude estimate presented in the section that discussed Remediation and Clean-up. Clean-up estimates were initially estimated for an oil spill that accumulated over 30 to 60 days; it will now be assumed clean-up activity will continue beyond the first year of impacts, as presented in Table 17. Based on the order of magnitude estimate, $288 million for a 3 to 60 release in previous sections; it is assumed that $288 million will cover the first 60 days of cleanup. With clean-up for 1-year estimated at $1.7 billion by assuming that $288 is the cost at every 60 – day interval. Assuming that after the first year of the oil spill clean-up costs will decrease by some amount, represented by the following estimate: Year – 2, decrease by 20 percent; Year – 3, decrease by 30 percent; Year 4, decrease by 50 percent, Year – 5, decrease by 70 percent.

Table 17: 5 – Year REMI Inputs, Scenario – Real World

	Remediation and Clean-up ($ million)				
State	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year5**
Alabama	259	259	181	130	78
Florida	519	519	363	260	156
Louisiana	692	692	484	346	208
Mississippi	259	259	181	130	78

Long-Run: 10- Year Assumptions and Inputs

As with 5-Year long-run analysis it is apparent that the Worst Case and Severe scenarios were not likely to materialize. For the 10-Year long-run analysis only the Real World scenario will be considered and be annualized and distributed over time, Tables 18 to 22. It is assumed that over the course of 10-Yerars the level of disruption may persist for some time, with especially difficult business conditions the first two-years and then subsiding overtime. Starting with Year 3 disruptions decrease the initial disruption by 25, 50, 75, and 90 percent for all industries except clean-up and remediation.

Table 18: 10 – Year REMI Inputs, Scenario – Real World

	Annual Percent Decrease – Food Manufacturing									
State	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Alabama	1.04	1.04	0.78	0.52	0.16	0.16	0.10	0.10	0.00	0.00
Florida	0.19	0.19	0.14	0.09	0.03	0.03	0.02	0.02	0.00	0.00
Louisiana	0.17	0.17	0.13	0.08	0.03	0.03	0.02	0.02	0.00	0.00
Mississippi	0.37	0.37	0.28	0.18	0.06	0.06	0.04	0.04	0.00	0.00

Table 19: 10 – Year REMI Inputs, Scenario – Real World

	Annual Percent Decrease - Fishing									
State	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Alabama	0.65	0.65	0.49	0.33	0.10	0.10	0.07	0.07	0.00	0.00
Florida	0.23	0.23	0.18	0.12	0.04	0.04	0.02	0.02	0.00	0.00
Louisiana	0.29	0.29	0.22	0.15	0.04	0.04	0.03	0.03	0.00	0.00
Mississippi	0.05	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.00

Table 20: 10 – Year REMI Inputs, Scenario – Real World

	Annual Percent Decrease - Amusement and Recreation									
State	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Alabama	2.23	2.23	1.67	1.11	0.33	0.33	0.22	0.22	0.00	0.00
Florida	0.30	0.30	0.23	0.15	0.05	0.05	0.03	0.03	0.00	0.00
Mississippi	5.18	5.18	3.89	2.59	0.78	0.78	0.52	0.52	0.00	0.00

Table 21: 10 – Year REMI Inputs, Scenario – Real World

	Annual Percent Decrease - Accommodation									
State	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Alabama	2.50	2.50	1.88	1.25	0.38	0.38	0.25	0.25	0.00	0.00
Florida	0.75	0.75	0.56	0.37	0.11	0.11	0.07	0.07	0.00	0.00
Mississippi	4.07	4.07	3.05	2.03	0.61	0.61	0.41	0.41	0.00	0.00

Table 22: 10 – Year REMI Inputs, Scenario – Real World

	Annual Percent Decrease - Food and Drinkning Venues									
State	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Alabama	2.07	2.07	1.55	1.04	0.31	0.31	0.21	0.21	0.00	0.00
Florida	0.85	0.85	0.64	0.43	0.13	0.13	0.09	0.09	0.00	0.00
Mississippi	2.16	2.16	1.62	1.08	0.32	0.32	0.22	0.22	0.00	0.00

As previously discussed in, there is significant lack of information surrounding clean-up costs. Inputs will be based on the order of magnitude estimate presented earlier. Clean-up estimates were initially estimated for an oil spill that accumulated over 30 to 60 days; it will now be assumed clean-up activity will continue beyond the first year of impacts, as presented in Table 23.

Based on the order of magnitude estimate, $288 million for a 3 to 60 release; it is assumed that $288 million will cover the first 60 days of cleanup. With clean-up for 1-year estimated at $1.7 billion by assuming that $288 is the cost at every 60 – day interval. Assuming that after the first year of the oil spill clean-up costs will decrease by some amount, Table 23.

Table 23: 5 – Year REMI Inputs, Scenario 3 – Real World

	Remediation and Cleanup ($ millions)									
State	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Alabama	259	207.2	155	104	52	26	13	6	3	0
Florida	519	415.2	311	208	104	52	26	13	6	0
Louisiana	692	553.6	415	277	138	69	35	17	9	0
Mississippi	259	207.2	155	104	52	26	13	6	3	0

Chapter 8

Results: Short-, Medium-, and Long-Run GDP Impacts

Short-run results serve to give the analyst a first approximation of the possible GDP of the man-made event. They are not very helpful in providing detailed insight but can assist in framing future analyses and providing order of magnitude estimates.

Scenario 1 - Worst Case: Estimated GDP Impacts

Table 24 shows estimated economic losses based on the REAcct calculations for the disruption zone by state. Louisiana and Florida experience the largest GDP losses for each short-run time frame. Direct GDP losses range from $92 million to $3 billion; Total GDP losses range from $185 million to $ 11 billion GDP losses. Terrebonne and Orleans Parishes in Louisiana have the largest GDP losses, Table 24 , likely attributable to the Port Fourchon and the Port of New Orleans as well as the numerous oil and gas extraction companies located in the area.

Table 24: Short-Run GDP Losses by State for Scenario 1 – Worst-Case

	Scenario 2: Total GDP Losses by State ($ millions)					
	30 Days		60 Days		120 Days	
State	Direct	Total	Direct	Total	Direct	Total
Alabama	92	298	185	596	370	1,193
Florida	158	497	316	995	632	1,989
Louisiana	828	2,753	1,657	5,507	3,313	11,013
Mississippi	103	293	206	586	413	1,170

Table 25: Total GDP Losses by County for Scenario 1– Worst-Case, Disruption Zone

	Total GDP Losses by County (millions)			
State	**County**	**30 Days**	**60 Days**	**120 Days**
Louisiana	Terrebonne	772	1,546	3,091
	Lafourche	284	569	1,137
	Jefferson	462	926	1,815
	Plaquemines	210	421	841
	Orleans	883	1,766	3,532
	St. Bernard	27	54	110
	St. Tammany	112	225	450
Mississippi	Hancock	29	60	119
	Harrison	215	431	862
	Jackson	47	94	189
Alabama	Mobile	215	167	334
	Baldwin	84	429	858
Florida	Bay	97	193	387
	Escambia	98	197	393
	Franklin	6	11	23
	Gulf	3	6	12
	Jefferson	2	4	9
	Okaloosa	107	214	429
	Santa Rosa	120	240	480
	Taylor	8	16	32
	Wakulla	5	10	20
	Walton	50	102	204

For Alabama's two coastal counties, Baldwin and Mobile, the largest GDP losses stem from Mining (oil and gas extraction) and Food and Drinking Venues, Figure 18. The

Mining industry contributes to most to GDP losses likely due to the 163 companies in oil and gas exploration and extraction with an estimated 2, 023 employees. [64].

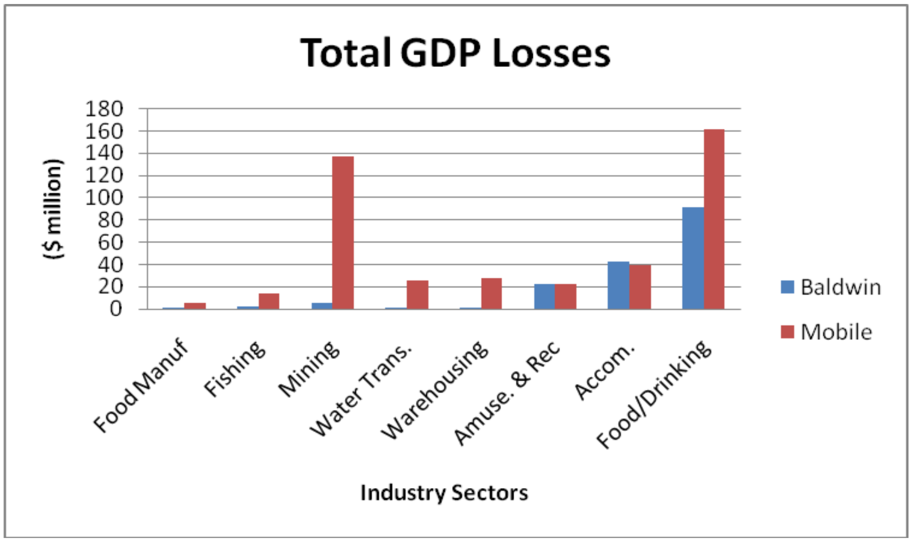


Figure 18: Total GDP Losses, Alabama Counties by Industry, 60-days, Scenario 1-Worst Case

For Mississippi the reduction in business activity in Tourism related industry sectors is surprisingly detrimental for coastal Mississippi, Figure 19, this is likely related to presence of large legal gambling related activities; southern Mississippi's economy may be more reliant on gambling than oil and gas extraction. For both Louisiana and Mississippi the GDP contribution of the Mining Industry (Crude Oil drilling) is larger than all the other selected industries.

[64] Dunn and Bradstreet, 2008.

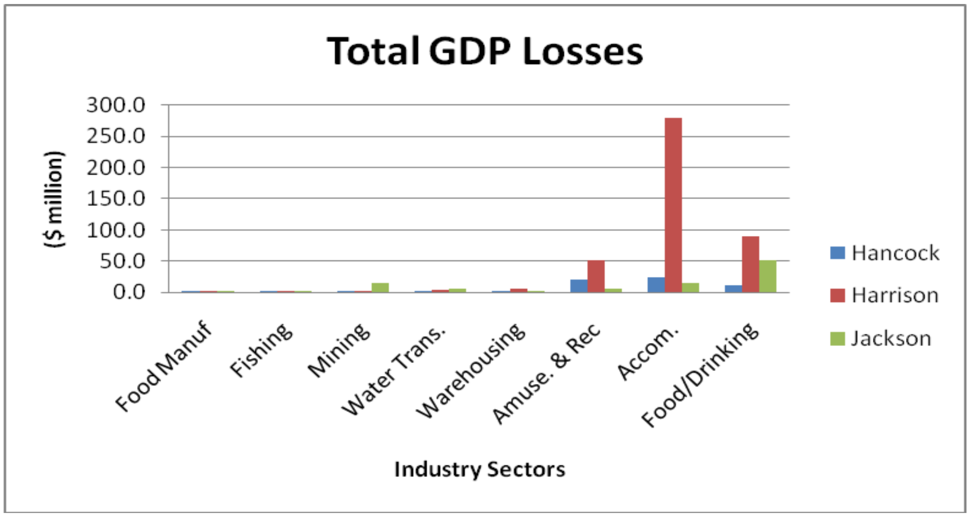


Figure 19: Total GDP Losses, Mississippi Counties by Industry, 60-days, Scenario 1-Worst Case

As suspected, for the Panhandle of Florida, the main contributor to GDP is tourism, with the exception of Santa Rosa County, FL, Figure 20. Santa Rosa County is home to an inland oil and gas field in Jay, FL; a drilling ban in the GOM would not affect this field since it is not located offshore. This is relevant at a county level, however, at the state level Southern Florida contributes more tourist dollars overall.

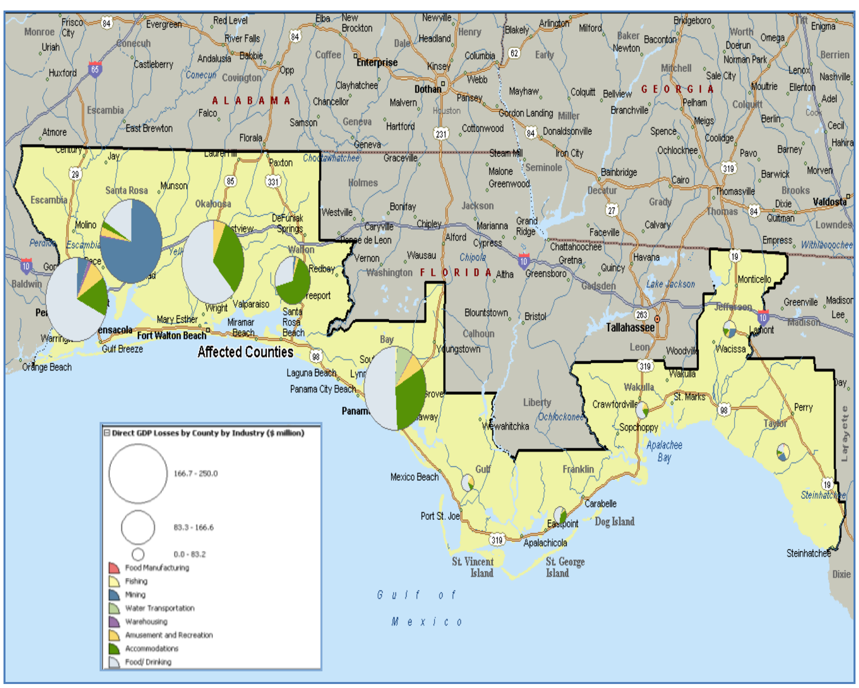


Figure 20: Industry Impacts, Florida Counties by Industry, 60-day, Scenario 1 – Worst Case

For each parish selected for analysis the main contributors to GDP are Mining and Water Transportation, as shown by Figure 21. As shown in Figure 21, Terrebonne and Jefferson Parishes in Louisiana have the greatest total GDP losses; the magnitude of these losses is likely attributable to the large presence Mining and Water Transportation industries, Port Fourchon (main activity is transportation of oil and gas products from the GOM) is located within Terrebonne Parish.

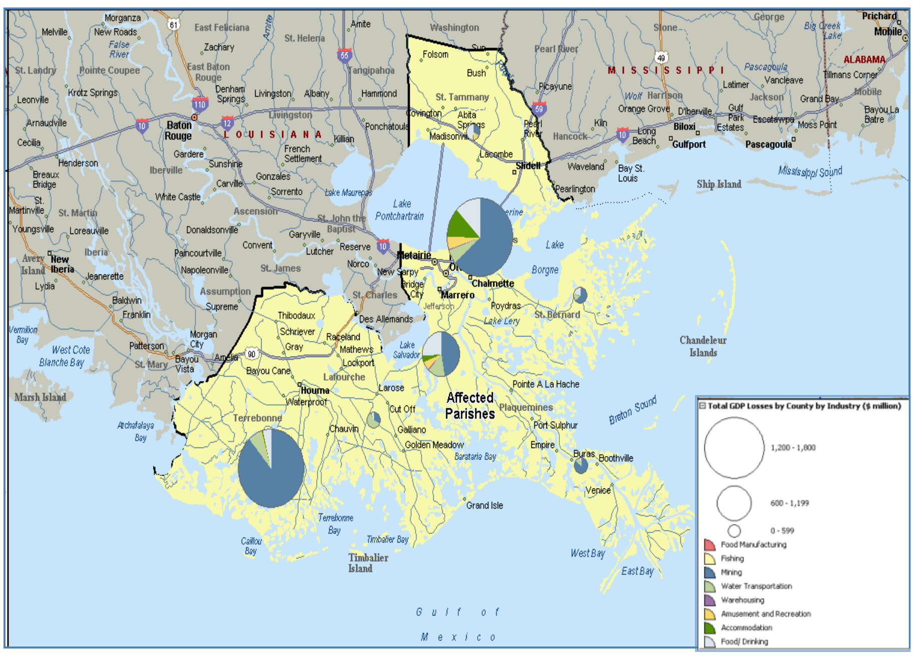


Figure 21: Industry Impacts, Louisiana Parishes by Industry, 60-day, Scenario 1 – Worst Case

Both parishes are home to large ports and drilling operations that service agriculture and the petroleum industry. The contribution to lost GDP of Tourism related industries at the county level is dwarfed by Mining and Water Transportation.

Scenario 2 - Severe: Estimated GDP Impacts

Estimated GDP losses by state and county for Scenario 2, based on the REAcct calculations, are presented in Tables 26 and 27 . Louisiana and Florida experience the largest GDP losses for each short-run time frame; Louisiana's GDP loss is significantly larger than all other GOM states. Direct GDP losses by state range from $46 million to $2.7 billion; Total GDP losses range from $103 million to $ 5.5 billion. The results of Scenario 2 are essentially a 50 percent reduction of Scenario 1. The lack of dynamic behavior in the REAcct model results in output that does not provide detailed insight to the functioning of the regional GOM economy.

Table 26: GDP Losses by State for Scenario 2 – Severe

	Scenario2- Severe: Total GDP Losses by State ($ millions)					
	30 Days		60 Days		120 Days	
State	Direct	Total	Direct	Total	Direct	Total
Alabama	46	149	92	298	185	596
Florida	79	249	158	497	316	994
Louisiana	414	1,376	828	2,753	1,657	5,506
Mississippi	52	146	103	292	207	585

Table 27: Total GDP Losses by County for Scenario 2 – Severe

State	Total GDP Losses by County ($ millions)			
	County	30 Days	60 Days	120 Days
Louisiana	Jefferson	231	463	926
	Lafourche	142	284	569
	Orleans	442	883	1,766
	Plaquemines	105	210	42
	St. Bernard	14	27	55
	St. Tammany	56	113	225
	Terrebonne	386	773	1,545
Mississippi	Hancock	15	30	60
	Harrison	108	216	431
	Jackson	24	47	94
Alabama	Baldwin	42	84	167
	Mobile	107	215	429
Florida	Bay	48	97	193
	Escambia	49	98	197
	Franklin	3	6	11
	Gulf	1	3	6
	Jefferson	153	2	4
	Okaloosa	60	107	215
	Santa Rosa	4	120	240
	Taylor	8	8	16
	Wakulla	2	5	10
	Walton	25	51	102

Mobile County Alabama experiences larger GDP losses than Baldwin. From Figure 22[65] the 50 percent reduction in business activity most negatively affects Mining and Food and Drinking venues, Baldwin County, AL is the larger of the two counties by population.

[65] Total GDP Losses are depicted for 60-day disruption only; the pattern of losses would be identical for any other time frame.

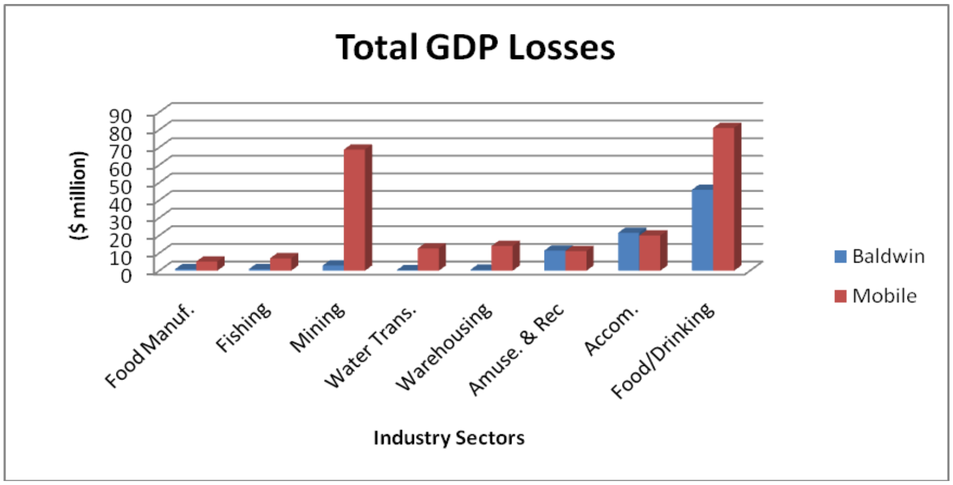


Figure 22: Total GDP Losses, Alabama Counties by Industry, 60-days, Scenario 2 – Severe

For Hancock, Harrison, and Jackson Counties in Mississippi GDP losses are dominated by Tourism related industry sectors, Figure 23. The largest GDP losses occur in Harrison County, MS, which has a large number of both hotels and legal gambling facilities.

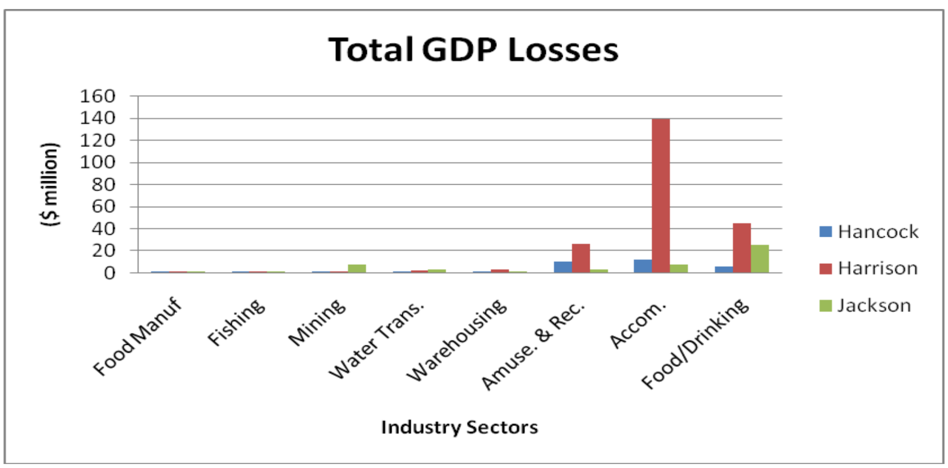


Figure 23: Total GDP Losses, Mississippi Counties by Industry, 60-days, Scenario 2 - Severe

In the state of Florida, as shown in Figure 24[66], GDP losses are once again dominated by Accommodations and Food and Drinking Venues; demonstrating the county level reliance on tourist related activities. Santa Rosa County Florida is the exception, losses related to oil and gas extraction dominate GDP losses; these losses would likely not manifest since the drilling occurs inland in northern Santa Rosa County at a field in Jay, FL. Tourism industry sectors may be important at the county level; however, the contribution to GDP on a daily basis is small as initially shown in Figure 24.

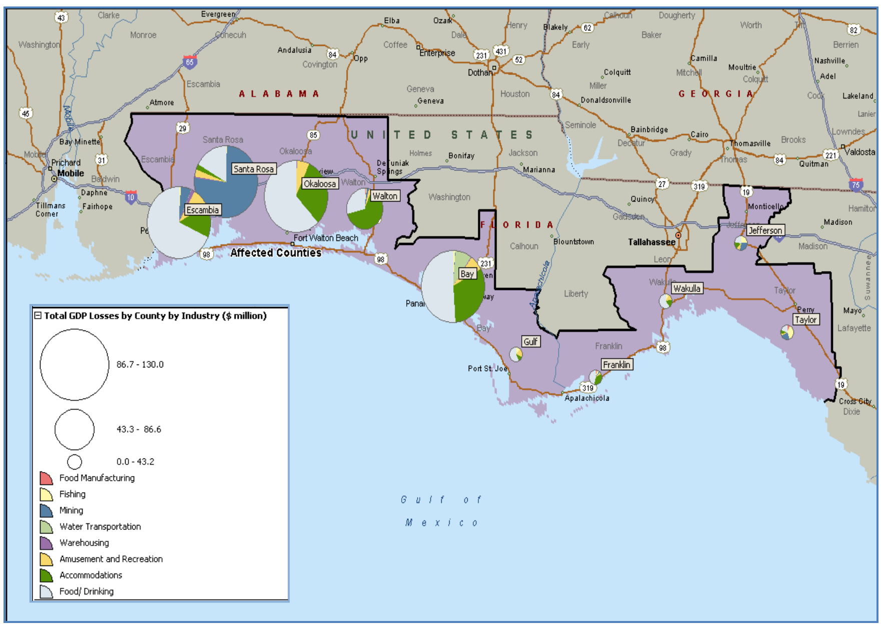


Figure 24: Industry Impacts, Florida Counties by Industry, 60-day, Scenario 2 – Severe

For each Parish in Louisiana Mining contributes to the most to GDP losses, Figure 25, with the exception of St. Tammany Parish, LA. Orleans Parish, LA second largest losses occur in the Accommodations industry sector, likely due to the popularity of New Orleans as a tourist destination. The economies of the outer Parishes that sit on

[66] Total GDP Losses were only graphically represented for the 60 day disruption since it is apparent that whether the disruption is 30 or 120 days the results static and linear.

the GOM are not often regarded as tourist destinations beyond the attraction of recreational fishing. The outer Parishes are dependent on Mining and port related activities to sustain local business activity.

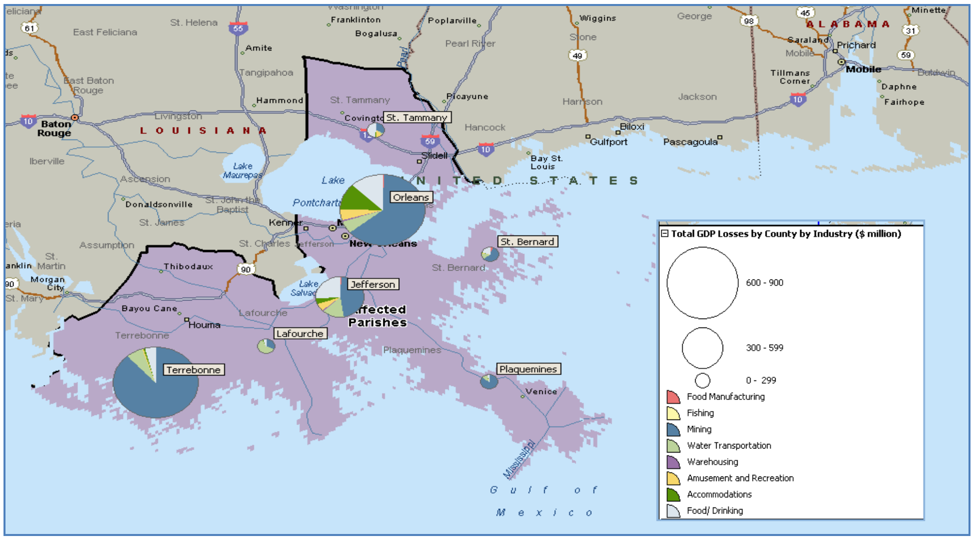


Figure 25: Industry Impacts Louisiana Parishes, 60-day Disruption, Scenario 2 - Severe

Scenario 3: Real World – Results

Scenario 3, aimed to capture the real-time reporting of changes to business activity in the GOM. These changes (not all negative) to business activity were applied by industry sector at the county level. In the Real World scenario the assumed decline in business activity for each industry is smaller than in previous analyses, except for Mining, a ban on drilling was still in effect when the data was gathered, Total GDP losses by County are presented in Table 28.

Table 28: Total GDP Losses by County for Scenario 3 – Real World

	Total GDP Losses by County ($ millions)			
State	**County**	**30 Days**	**60 Days**	**120 Days**
Louisiana	Jefferson	80	160	320
	Lafourche	34	69	138
	Orleans	208	416	832
	Plaquemines	6	13	25
	St. Bernard	66	133	266
	St. Tammany	6	13	25
	Terrebonne	14	27	55
Mississippi	Hancock	9	17	35
	Harrison	66	132	265
	Jackson	21	41	83
Alabama	Baldwin	30	60	120
	Mobile	122	243	489
Florida	Bay	27	53	107
	Escambia	33	67	134
	Franklin	2	4	9
	Gulf	0.9	2	4
	Jefferson	1	2	5
	Okaloosa	32	65	130
	Santa Rosa	99	199	399
	Taylor	5	10	21
	Wakulla	2	3	6
	Walton	17	34	68

As was seen with the two previous Scenarios, Mobile County AL experiences larger GDP losses than Baldwin County, AL. As seen in Figure 26, Mining contributes the most to GDP losses, followed by Food and Drinking Venues.

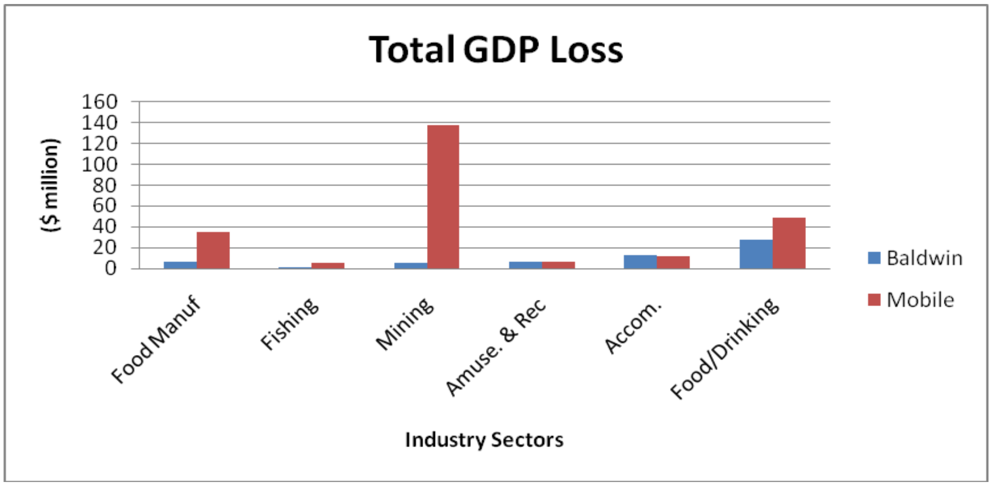


Figure 26: Total GDP Losses, Alabama Counties by Industry, 60-days, Scenario 3 – Real World

In Mississippi, with the exception of Jackson County, the tourism related industry sectors contribute the most to GDP losses, Figure 27. An extension of the drilling ban will likely not be as detrimental to southern Mississippi as a continued decline in tourist activity.

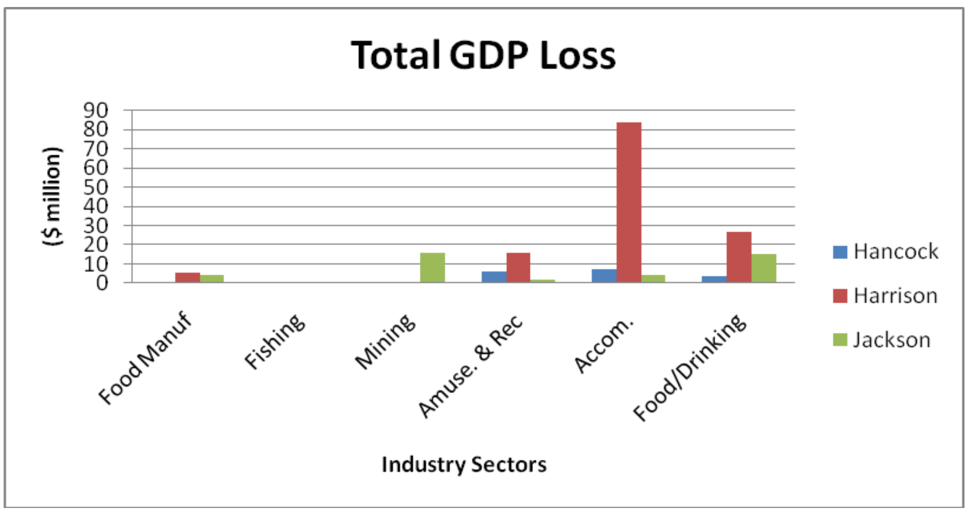


Figure 27: Total GDP Losses, Mississippi Counties by Industry, 60-days, Scenario 3 – Real World

For the Florida Panhandle, the tourism related industry sectors contribute the most to GDP losses. Santa Rosa County, FL would likely not suffer the magnitude of losses as depicted in Figure 28, due the fact that the location of oil and gas extraction is inland at a field in Bay, Florida and is not affected by a ban on Gulf water drilling.

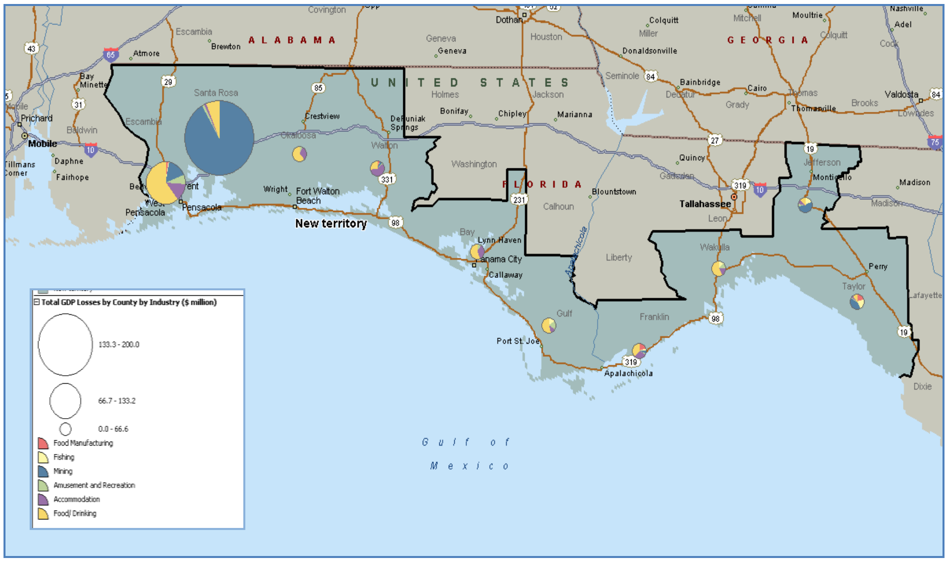


Figure 28: Industry Impacts, Florida Counties by Industry, 60-day, Scenario 3 - Real World

To reflect real-time conditions only the Mining industry sector is negatively affected by the oil spill[67]. Louisiana Parishes GDP losses are related to Mining and the continued ban on GOM fishing activities; although Mining completes dwarfs Fishing and Food Processing, Figure 29. Throughout the GOM Fishing related losses appear to be very small when compared to the other industry sectors affected by the spill.

[67] As discussed earlier, the tourism industry sectors are reporting increased business or no declines in activity due to spill related population increases.

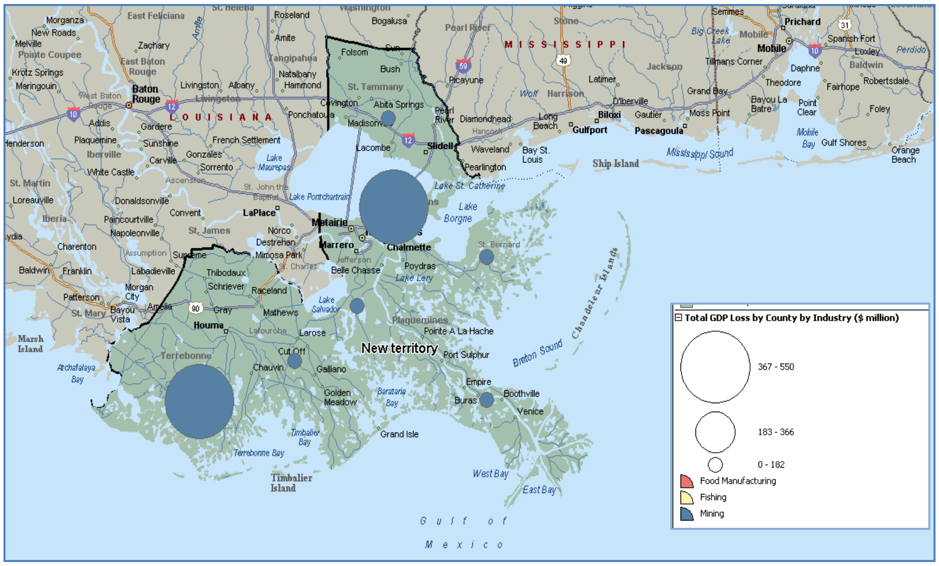


Figure 29: Industry Impacts, Louisiana Counties by Industry, 60-day, Scenario 3 - Real World

Medium-Run: Estimated GDP Impacts

For Scenario 1: Worst Case – one-year impact – the macroeconomic impact is a GDP loss of $7 billion, less than 1 percent of annual national GDP, Table 29. Demonstrating that nationally there would not be much impact from the oil spill.

Table 29: Changes in GDP and Consumption, National Level, Scenarios 1, 2, and 3

Macro indicators in billion dollars	Worst Case	Severe	Real
Gross domestic product (GDP)	-7	-5	-3.5
Consumption	-0.82	-0.62	-0.043

At the state level, Table 30, Louisiana and Florida have the largest change in GDP $2.3 and $1.7 billion respectively. Louisiana and Florida are expected to have the largest losses since they also have the largest economies and a larger number of affected counties compared to Alabama and Mississippi. Analysis of Scenario 2 - Severe, provided expected results; they are essentially half of the results for Scenario 1. Scenario 3 resulted in an estimated national GDP loss of $3.5 billion; state GDP losses, ranged from $0.2 to $1.2 billion; as with the previous scenarios the largest losses occurred in Louisiana and Florida. Table 31 displays changes in employment[68] for one year impacts; employment losses mirror GDP losses.

Table 30: Medium-Run, Change in GDP by State, Scenario 1, 2, and 3

	Change in GDP ($ billions)		
States	**Worst Case**	**Severe**	**Real**
Alabama	-0.59	-0.03	-0.2
Florida	-1.7	-0.8	-0.5
Louisiana	-2.3	-1.9	-1.2
Mississippi	-0.6	-0.3	-0.2

Table 31: Medium-Run, Change in Employment by State, Scenario 1, 2, and 3

	Change in Employment (thousands)		
States	**Worst Case**	**Severe**	**Real World**
Alabama	-19	-9	-6
Florida	-40	-20	-12
Louisiana	-57	-42	-15
Mississippi	-19	-9	-6

The added spending on clean-up activities and the assumed associated increased employment does not appear to be enough to offset employment losses in these four states. Industries with the highest employment losses are: food service, sales / office administration, and building / grounds workers. These job types are ones that are strictly

[68] Economic impact can either be shown by changes in GDP or employment. They are different ways of saying the same thing.

and loosely tied to the tourist industry sectors. At the time of the incident there was no evidence of increased tourism activity in neighboring states due to decreased activity in Alabama, Florida, and Mississippi. Therefore, substitution by tourists is not accounted for in the analysis.

A second Medium-Run REMI analysis was conducted with clean-up removed from the inputs. National GDP losses increased to $11 billion, Table 32; at the state level the largest GDP losses again occur in Louisiana and Florida, Table 33; employment losses again mirror GDP losses. In the Worst Case scenario national GDP losses increase by $4 billion; however, there is very little change in GDP for the Severe and Real World scenarios. At the state level GDP losses increase slightly but not enough to be a recognizable difference with or without cleanup activity for one year.

Table 32: Medium-Run, Changes in GDP and Consumption, National Level (Clean-up Removed)

Macro indicators in billion dollars	Worst Case	Severe	Real World
Gross domestic product (GDP)	-11	-6	-4
Consumption	-4	-0.68	-0.049

Table 33: Medium-Run, Change in GDP, Scenario 1 and 2, and 3 (clean-up removed)

	Change in GDP ($ billions)		
States	Worst Case	Severe	Real
Alabama	-0.6	-0.4	-0.3
Florida	-1.8	-1	-0.6
Louisiana	-2.4	-2	-1.3
Mississippi	-0.7	-0.3	-0.2

The subtraction of clean-up from the REMI runs demonstrate that spending on cleanup did not offset the business disruption losses for a one year analysis. As in the above scenarios the largest employment losses were in the service sectors, specifically food preparation; GDP losses with and without clean-up costs, as an input did not differ greatly.

Long-Run: 5 – Year, Results

For review, long-run inputs were based on the Real World assumptions of Scenario 3. Inputs were based currently available data that was reported by business organizations and the media. Local businesses and tourists were not surveyed.

Nationally GDP increases by $1.9 billion in Year – 2, Table 34, with a small gain in the first year; after Year – 3 GDP appears to be returning to pre-event levels. However, any gains in GDP are less than 1 percent, therefore, not very significant gains.

Table 34: Long-Run, 5-Year, Changes in GDP and Consumption, National Level, Scenarios 1, 2, and 3

Macro indicators in billion dollars	Year 1	Year 2	Year 3	Year 4	Year 5
Gross domestic product (GDP)	0.72	1.9	0.69	-0.19	-0.13
Consumption	0.008	0.022	0.001	-0.014	-0.004

Examination of the state GDP, Figure 30, a similar GDP spike is apparent in Year – 2. Clean-up and remediation is the only positive input into the REMI model; an increase in output is likely due to the increased business activity in this industry sector. Whereas the decrease in Mining activity dominated GDP losses in previous analyses, the addition of distributed clean-up activity could be responsible for trend in the GDP gains[69].

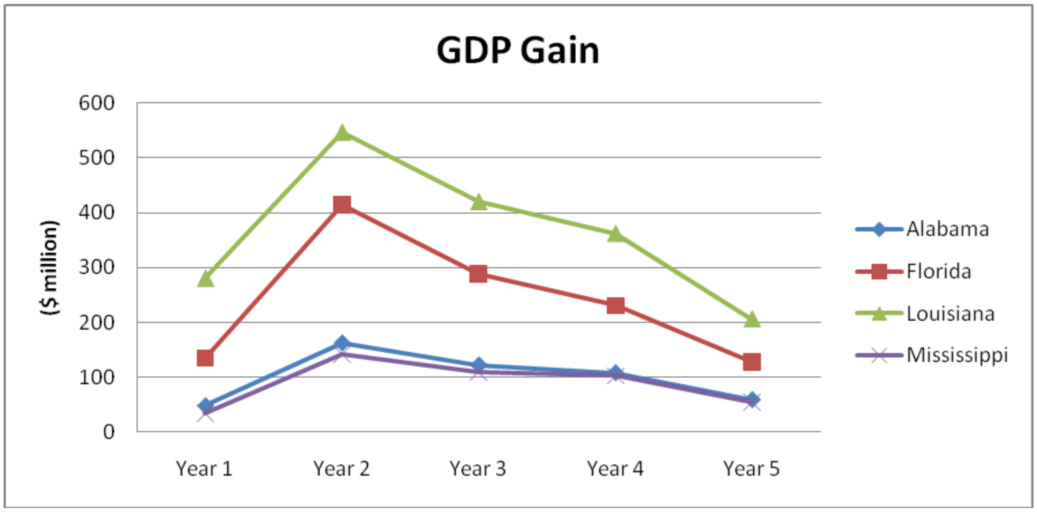


Figure 30: Long-Run, 5-Years, Change in GDP by State

Louisiana also has increased employment in all sectors, with the strongest gains in clean-up related jobs[70]. Figure 31 displays the percent change in employment for all states[71]. The major employment losses for Florida, Mississippi, and Alabama occur in the service sector, specifically food preparation; with strong employment gains in clean-up related employment[72]. Louisiana does not experience jobless in food prep; both at the state and national level the decrease in the Mining industry (oil and gas extraction) does not affect fuel prices. For all commodities and years prices remain stable. Imports for fuel were observed to change by less than 1 percent. Price adjustments observed in cleanup

[69] To be examined in the sensitivity analysis.
[70] Waste, remediation, and clean-up related employment is defined as: transportation and moving materials occupations, construction and extraction occupations, and maintenance and repair occupations.
[71] Employment data by occupation and sector is too numerous to display in any comprehensively clear manner.
[72] Waste, remediation, and clean-up related employment is defined as: transportation and moving materials occupations, construction and extraction occupations, and maintenance and repair occupations.

related industries could be magnified in reality due to supply constraints of necessary clean-up related goods.

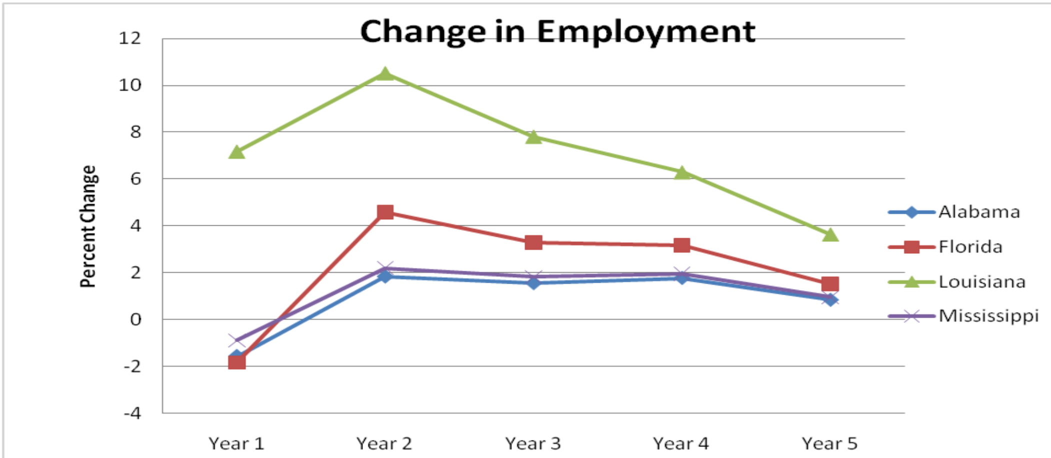


Figure 31: Long-Run, 5-Years, Percent Change in Employment

Long-Run: 10 – Year, Results

Recall, long-run inputs were based on the Real World assumptions of Scenario 3. Inputs were based currently available data that was reported by business organizations and the media. Local businesses and tourists were not surveyed. The 10 – Year analysis was run for a total of 15 years, with inputs distributed over the first 10 years as detailed in Section 7.

At the national level there is very little percent change in GDP, employment, and consumption, GDP is graphed in Figure 32. The initial introduction of spending in the clean-up and remediation industry sector appears to be have stimulated the economy at the national level, although by very small.

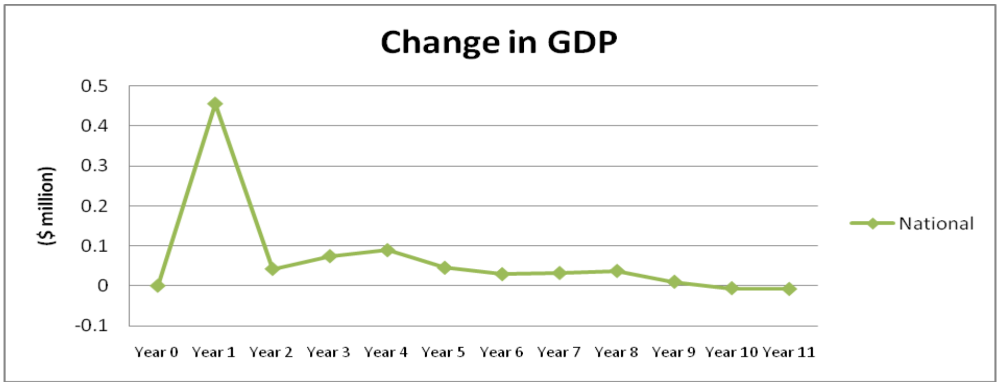


Figure 32: Lon-Run, 10-Year, Change in National GDP

By state there are GDP gains of around a few hundred million at most for the state of Louisiana. All other states have minor gains but nothing much different from a zero percent change in GDP; the dollar change in GDP by state is displayed in Figure 33. As business disruptions and clean-up activities are spread out over time the effect on the regional economies appears to slowly diminish with minor positive and negative fluctuations. Similar to the 5-Year run, imports for fuel were observed to change by less than 1 percent. For all commodities and years prices remain stable.

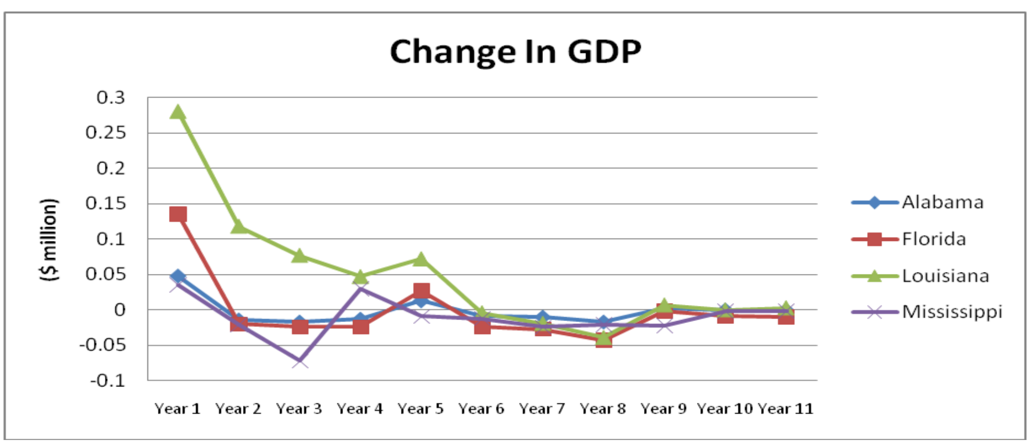


Figure 33: Lon-Run, 10-Year, Change in by State

Employment by industry is similar to the results of the 5-Year analysis. With a 2 to 0.5 percent decrease in food preparation occupations, for all states. By percentage

Mississippi and Alabama have the greatest losses, likely due to the fact that so much of their Tourism is concentrated in their two most southern coastal counties. Louisiana and Florida have tourism related industries distributed throughout their states; in fact there are likely larger tourism enticements outside the counties considered for this analysis; with only a small portion of their states affected this outcome is somewhat expected. There could be price adjustments observed in cleanup related industries and these could be magnified in reality due to supply constraints of necessary clean-up related goods.

For further investigation a sensitivity analysis was conducted to assess the sensitivity of GDP to input/parameter changes.

Chapter 9

Sensitivity Analysis and Discussion of Drilling Moratorium

Sensitivity Analysis is used to determine how "sensitive" a model is to changes in the value of the parameters of the mode and to the structure of the model. For this analysis the focus is on parameter sensitivity. Parameter sensitivity is usually performed as a series of tests in which the analyst sets different parameter values to see how a change in the parameter causes a change in the dynamic behavior of the stocks. By showing how the model behavior responds to changes in parameter values, sensitivity analysis is a useful tool in model building as well as model evaluation[73].

Sensitivity test help the modeler to understand dynamics of a system. Experimenting with a wide range of values can offer insights into behavior of a system in extreme situations (i.e. economic impacts of disasters). Discovering that the system behavior greatly changes for a change in a parameter value can identify a leverage point in the model – a parameter whose specific value can significantly influence the behavior of the system.

National Level Parameters

The first exploration examines parameters at the national level. Changes were made to the parameters listed in Table 35; parameters were selected based on assumptions of which parameters are expected to have to most influence on the REMI Model. For example Remediation and Clean-up is selected because it was earlier perceived to be offsetting losses in all other industries; increases of 1, 5, and 15 percent

[73] Model evaluation is not part of this evaluation.

were implemented. Mining (oil and gas extraction) was chosen because it appears to often dominate Tourism losses. The industry sector for Accommodations was selected as the general representative of all Tourism industries. Fishing and Food Manufacturing were not selected because it is generally difficult to apply changes to industry sectors that encompass so many categories and difficult to separate out results. Decrease of 1, 5, and 15 percent were initiated for one year.

Table 35: Sensitivity Analysis, Percent Change in Parameters, National and State Level

	National and State Parameter Selection		
Parameter	1st Run	2nd Run	3rd Run
Remediation and Cleanup	1	5	15
Mining	-1	-5	-15
Accommodations	-1	-5	-15

As the magnitude of the shocks increased so did the percent of the change in GDP. For each shock (Small, Medium, and Large) Remediation and Clean-up had the smallest effect, Accommodations were second in impact, and Mining (oil and gas extraction) had the most substantial effect on GDP as shown in Figures 34 to 36, This outcome was expected given the observed results from the modeling efforts. Oil and gas are tied into – as demonstrated by their large multipliers – many industries and will likely always have substantial impacts. When modeling changes in the oil and gas industries special care should given to how parameters are adjusted since GDP is especially sensitive to changes in these parameters.

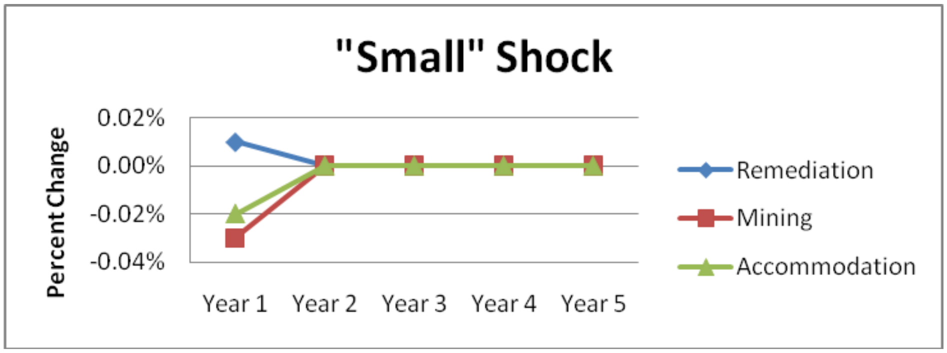


Figure 34: National Parameter Evaluation, Small Adjustment

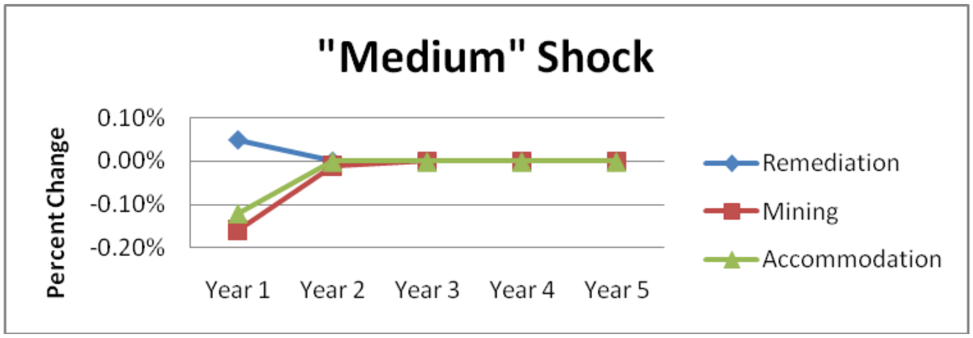


Figure 35: National Parameter Evaluation, Medium Adjustment

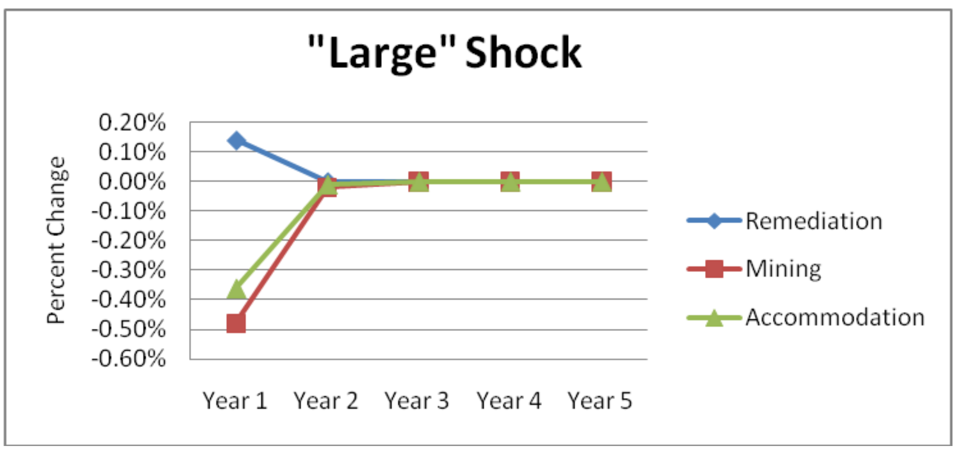


Figure 36: National Parameter Evaluation, Large Adjustment

State Level Parameters

The second exploration examines the selected parameters at the state level. This is necessary given that each state may be uniquely dependent or non-reliant on specific industry sectors. Industry sectors selected are the same that were selected for the national level analysis, Table 35.

Remediation and Clean-up

State evaluation of parameters provided more interesting results compared to the national level; likely due to the natural smoothing that occurs due to macroeconomic system interactions. An increase in remediation and clean-up activity has no effect when the “Small” change is made, Table 36 ; a minor effect with the “Medium” change, Table 37; with the “Large” change there is a more marked impact on GDP, Table 38; Louisiana, experiences the largest adjustment and this impact extends into the second year.

Table 36: Remediation, Parameter Evaluation, Small Change

	Increase of 1 Percent Remediation and Clean-up				
State	Year 1	Year 2	Year 3	Year 4	Year 5
Alabama	0.00%	0.00%	0.00%	0.00%	0.00%
Florida	0.00%	0.00%	0.00%	0.00%	0.00%
Louisiana	0.00%	0.00%	0.00%	0.00%	0.00%
Mississippi	0.00%	0.00%	0.00%	0.00%	0.00%

Table 37: Remediation, Parameter Evaluation, Medium Change

	Increase of 5 Percent Remediation and Clean-up				
State	Year 1	Year 2	Year 3	Year 4	Year 5
Alabama	0.02%	0.00%	0.00%	0.00%	0.00%
Florida	0.03%	0.00%	0.00%	0.00%	0.00%
Louisiana	0.06%	0.00%	0.00%	0.00%	0.00%
Mississippi	0.03%	0.00%	0.00%	0.00%	0.00%

Table 38: Remediation, Parameter Evaluation, Large Change

	Increase of 15 Percent Remediation and Clean-up				
State	Year 1	Year 2	Year 3	Year 4	Year 5
Alabama	0.06%	0.00%	0.00%	0.00%	0.00%
Florida	0.08%	0.00%	0.00%	0.00%	0.00%
Louisiana	0.17%	0.01%	0.00%	0.00%	0.00%
Mississippi	0.08%	0.00%	0.00%	0.00%	0.00%

Mining

Changes to the Mining parameter for oil and gas extraction had no effect on state GDP for any state when a 1 percent change was implemented, Table 39. A 5 percent decrease - "Medium" change - in activity resulted in GDP impacts in every state, with lingering effects for Louisiana, Table 40. When the parameter was further influenced – "Large" change - the effects for Louisiana increased and the duration increased, Table 41. This behavior could be inferred from the results of the medium- and long-run analyses and the associated job and GDP losses.

Table 39: Mining, Parameter Evaluation, Small Change

	Decrease of 1 Percent Mining				
State	Year 1	Year 2	Year 3	Year 4	Year 5
Alabama	0.00%	0.00%	0.00%	0.00%	0.00%
Florida	0.00%	0.00%	0.00%	0.00%	0.00%
Louisiana	0.00%	0.00%	0.00%	0.00%	0.00%
Mississippi	0.00%	0.00%	0.00%	0.00%	0.00%

Table 40: Mining, Parameter Evaluation, Medium Change

	Decrease of 5 Percent Mining				
State	Year 1	Year 2	Year 3	Year 4	Year 5
Alabama	-0.02%	0.00%	0.00%	0.00%	0.00%
Florida	-0.01%	0.00%	0.00%	0.00%	0.00%
Lousisiana	-0.24%	-0.01%	-0.01%	0.00%	0.00%
Mississippi	-0.05%	0.00%	0.00%	0.00%	0.00%

Table 41: Mining, Parameter Evaluation, Large Change

	Decrease of 5 Percent Mining				
State	Year 1	Year 2	Year 3	Year 4	Year 5
Alabama	-0.07%	0.00%	0.00%	0.00%	0.00%
Florida	-0.02%	0.00%	0.00%	0.00%	0.00%
Lousisiana	-0.73%	-0.04%	-0.02%	-0.01%	0.00%
Mississippi	-0.15%	-0.01%	-0.01%	0.00%	0.00%

Accommodations

Changes to the parameter for Accommodations provided the most surprising results. Every state experienced an immediate impact on GDP for the "Small" change, Table 42; none of the other parameters had this effect. When the Accommodation industry sector was adjusted to the "Medium" level, shock effects for all states extended into the second year, Table 43; this is interesting because it begins to imply that changes to this industry may have lingering effects beyond the initial year of shock, this was unexpected. When evaluating the "Large" change to the Accommodation parameters it was shocking to find that Mississippi experience the greatest GDP effect, Table 44; GDP impacts for all states carried beyond the first year. This implies two things: first, that all state's economies rely on Tourism related industries to some extent and changes to these industries may have lingering effects; second, that the economy of Mississippi could be surprisingly dependent on Tourism when compared with the economies of other three states. The dependence of Mississippi on Tourism related industries is likely due to the relative size of their economy to the other states. Louisianan and Florida have larger economies and more than a few very strong industry sectors, meaning a shock to one industry sector may not be completely devastating to these states. Mississippi has a much smaller economy and any shock to Tourism would likely have far reaching and comparatively more devastating effects.

Table 42: Accommodations, Parameter Evaluation, Small Change

	Decrease of 1 Percent Accommodations				
State	Year 1	Year 2	Year 3	Year 4	Year 5
Alabama	-0.01%	0.00%	0.00%	0.00%	0.00%
Florida	-0.03%	0.00%	0.00%	0.00%	0.00%
Lousisiana	-0.01%	0.00%	0.00%	0.00%	0.00%
Mississippi	-0.01%	0.00%	0.00%	0.00%	0.00%

Table 43: Accommodations, Parameter Evaluation, Medium Change

	Decrease of 5 Percent Accommodations				
State	Year 1	Year 2	Year 3	Year 4	Year 5
Alabama	-0.04%	0.00%	0.00%	0.00%	0.00%
Florida	-0.13%	-0.01%	0.00%	0.00%	0.00%
Lousisiana	-0.07%	0.00%	0.00%	0.00%	0.00%
Mississippi	-0.18%	-0.01%	0.00%	0.00%	0.00%

Table 44: Accommodations, Parameter Evaluation, Large Change

	Decrease of 15 Percent Accommodations				
State	Year 1	Year 2	Year 3	Year 4	Year 5
Alabama	-0.12%	-0.01%	0.00%	0.00%	0.00%
Florida	-0.38%	-0.02%	-0.01%	0.00%	0.00%
Lousisiana	-0.22%	-0.01%	-0.01%	0.00%	0.00%
Mississippi	-0.53%	-0.02%	-0.01%	0.00%	0.00%

Moratorium on GOM Drilling Analysis: 5 – Year Ban

An additional set of long-run scenarios will be run, with only the Mining sector affected. The purpose of this analysis is to examine the effects of a long-term policy change on GOM drilling, all else held constant. This is not meant to reflect the current state of business operations in the GOM related to the Deepwater Horizon oil spill.

Assumptions and Inputs: 5-Year Drilling Moratorium

Mining (oil and gas extraction) will be adjusted to more closely reflect the "rough-hand" estimate presented in Appendix D; instead of only some counties being affected by a drilling ban, the ban will be distributed across the entire GOM, including Texas. For example, the GOM will lose 20 percent of production every year to reflect more accurately reflect a possible extension of the moratorium on exploratory drilling for 5-years. The REMI was run for 10 years to assess how long the effects of a moratorium may linger.

A second run was conducted with the assumption that after the 5-year ban on drilling it will take another 5-years to return to pre-event level of production. Every year after the moratorium is lifted production gains 5 percent until it returns to normal. Impacts are now distributed over a total of 10-years instead of 5-years, the REMI model was run for a total 15 years to assess how long the effects may linger.

Results: 5-Year Drilling Moratorium

In the first year of the drilling moratorium GDP declines by approximately $33 billion, Figure 37, employment declines by 403,000. The decreases in both GDP and employment are dramatic and demonstrate the national fallout that could arise from a continued ban on drilling in GOM waters.

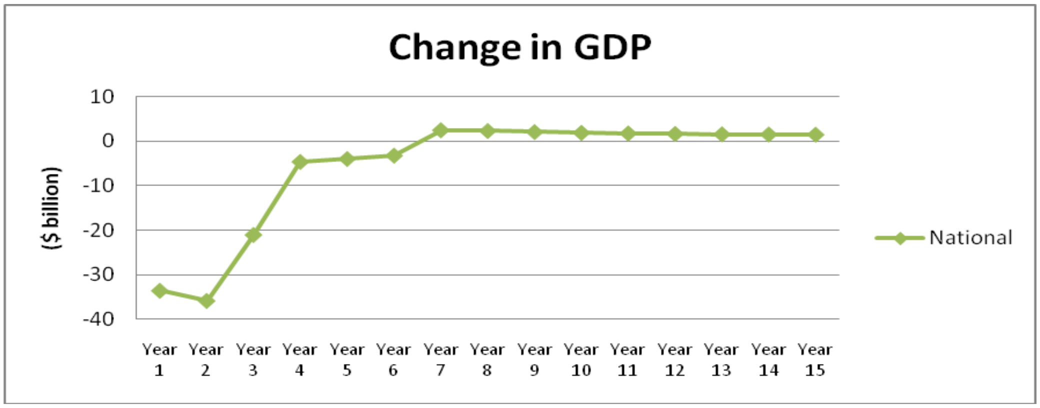


Figure 37: 5-Year Moratorium on Gulf of Mexico Drilling, Change in GDP

However, Figure 38 demonstrates that the decrease in both GDP and employment is actually less than a 1 percent decline for both measures.

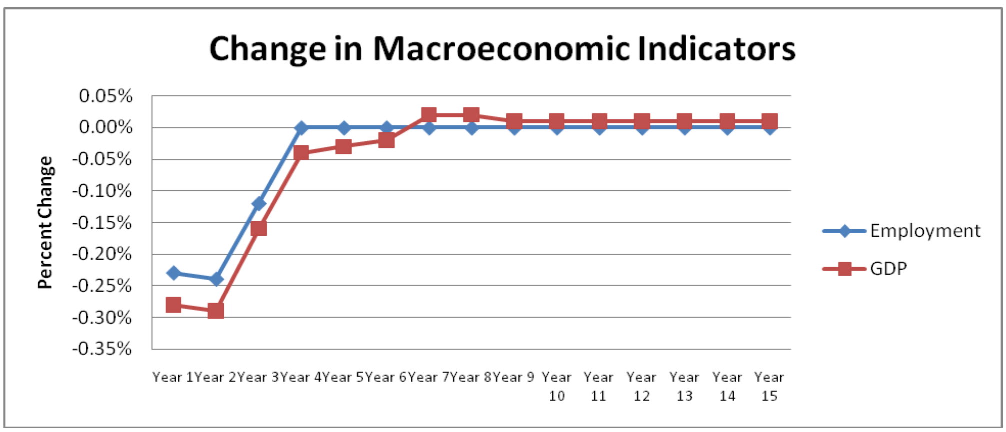


Figure 38: 5-Year Moratorium on Gulf of Mexico Drilling, Percent Change in National Employment and GDP

For all GOM states Private Non-Farm employment drops dramatically by as much as 13 percent in Texas and 9 percent in Mississippi, as depicted in Figure 39. At the regional level these are huge losses; currently (Summer 2010) there were very few job losses reportedly linked to the ban on GOM drilling. Many speculated that drilling firms had halted layoffs in the hopes that the ban would be short lived. This demonstrates that if the ban were in place for a long period of time there would be associated job losses in every GOM state.

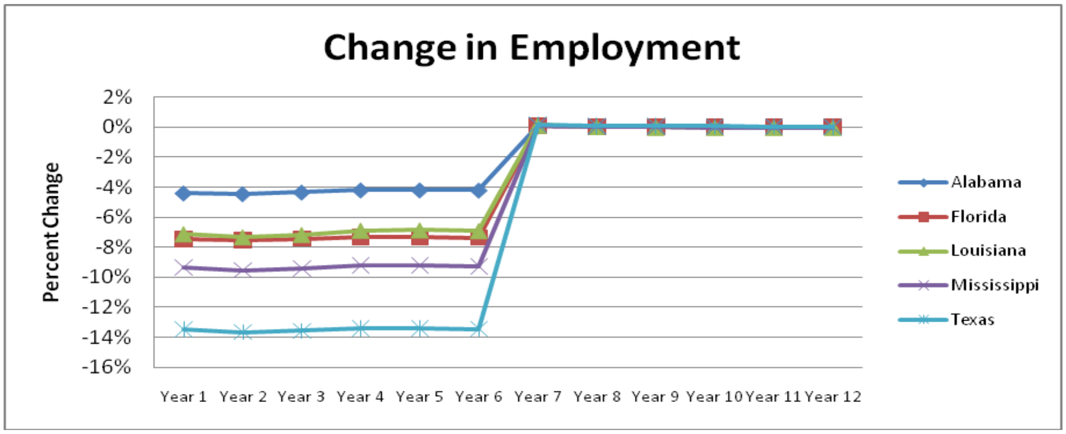


Figure 39: 5-Year Moratorium on Gulf of Mexico Drilling, Percent Change in Employment by State

Dramatic decreases persist for the duration of the moratorium and promptly return once the moratorium is lifted, this is likely an exaggeration of adjustments. In reality when the ban is lifted Mining (oil and gas extraction) will not immediately resume at previous levels. It is difficult to assume at what level activity will resume or if some activity will never return given possible changes in technologies[74] or political climate, anyways this remains quite speculative.

With no adjustments made regarding consumer demand the REMI Model seeks to bring equilibrium back. One mechanism for accomplishing this is to replace the missing supply by increasing imports from the Rest of the World. Imports from the Rest of the World for Mining (oil and gas) increase by a range of 1 to 6 percent; of course this is not enough to replace what is lost due to the moratorium.

The analysis of the moratorium on drilling distributed the impact over 10-years. At the national level the percent change in Employment and GDP is similar to the first

[74] Any assertions in either direction would require in-depth analysis beyond the capabilities of this report.

run, Figure 40; the largest difference is the recovery pace. This is likely more reflective of the real world since oil and gas extraction would not immediately return to pre-moratorium on drilling levels.

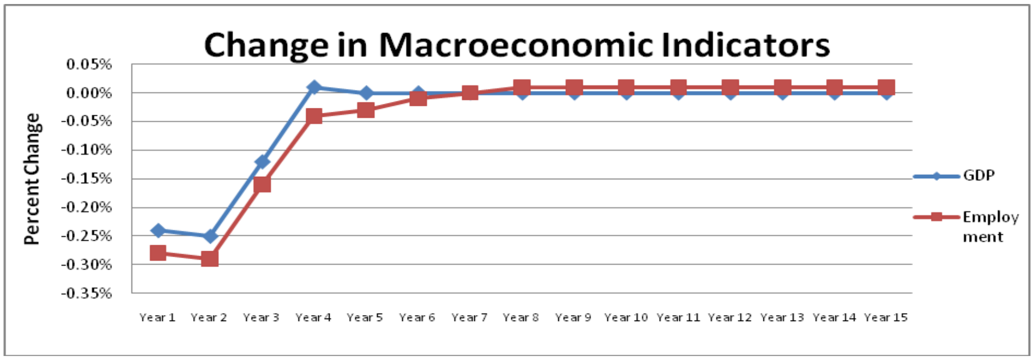


Figure 40: 5-Year Moratorium on Gulf of Mexico Drilling with Recovery, Percent Change in Employment and GDP

The comparison of the percent change in employment between the states reveals the most difference. In the REMI run with no recovery, employment drops steeply, in the run with recovery the initial percent change in employment ranges from -2.5 to 0.1 percent, a much less dramatic decline, Figure 41. This employment effect is surprising; inputs were double and triple checked for accuracy. This implies that the REMI model is internally trying to balance employment losses with future employment "gains," as such; a mechanism must be driving industry sectors to retain employees. This outcome requires further investigation.

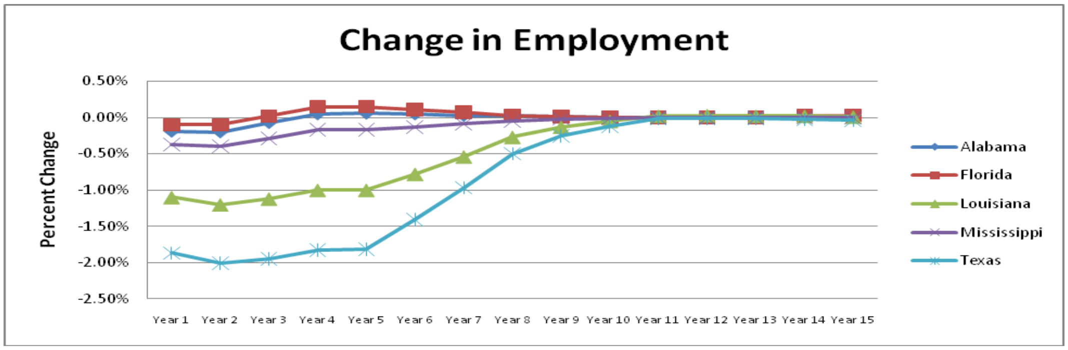


Figure 41: 5-Year Moratorium on Gulf of Mexico Drilling with Recovery, Percent Change in Employment by State

All industries lose employment but by less than 1 percent in all states. The increase in fuel prices is less than 0.5 percent, with imports of fuel increasing, likely preventing a dramatic price increase[75]. In both runs, Rest of Nation Imports is increasing by 20 and 40 percent respectively. This should be further investigated; it may be offsetting the changes in employment. As the model seeks to return to equilibrium it assumes other locations in the nation can make up for lost production oil and gas in the GOM. Future analysis should try to hold it constant to prevent this offsetting behavior.

[75] An additional analysis might consider looking at a situation where imports are delay slightly.

Chapter 10

Future Research and Conclusions

It would be desirable to update this analysis with new data in the assumed affected industry sectors as it becomes available over the next 3 to 5 years. It would also be of value to separate out any of the effects of the economic downturn on the industry sector selected from those of the Deepwater Horizon oil spill. It has been asserted that the economic downturn played a larger role in the decline of business activity in the Gulf of Mexico than the oil spill. Additionally, there may be some data from 2009 to support this argument, specifically in Tourism related industry sectors. The evaluation of alternatives to the GDP metric would also be useful for evaluating conditions outside of business interruption losses.

Improvements to Data

Although survey methods were discounted for their significant time requirement, the opportunity to survey local businesses, visitors, and potential visitors would greatly enhance the analysis. If there is not enough time for survey implementation perhaps access to retial sales information or local sales tax data would provide an approximate measure of declines in business activity. The short-run microeconomic analysis drives the medium- and long-run assumptions and any improvement in data acquisition would provide for a more realistic interpretation of events.

Improved data acquisition would also apply to the increase activity in remediation and clean-up. There may be industries that are not obviously related to this type of work but none the less benefitted; this would include any increase in local population that may be attributable to clean-up related jobs. This data could be captured through decreased unemployment claims or an increase payroll taxes by firms that would have contributed to the clean-up effort. Improved information regarding substitution would also be desirable. There was some anecdotal information regarding changes in vacation destinations but no reliable estimates; the percent changes in Tourism related industries did not spawn any increased Tourism activity in neighboring states.

Alternative metrics

Business interruption losses may be sufficient to understanding how impacts to firms may affect a region or nation but will likely be insufficient for fully evaluating the economic impacts of man-made and natural disasters. Beyond business interruptions individuals may suffer negative health affects, businesses may incur additional costs regardless of whether a disaster is currently occurring, human capital may be negatively affected through death or migration, and the true economic potential of a region or nation may be permanently handicapped.

Economic Potential

Economic potential can be measured by the level of capital stock including unused capacity in the economy. For example, other Japanese ports and most notably the Port of Singapore took on much of the trade activity while the Port of Kobe was under repair. Aditionally, Horwich (2000) suggests that human capital is the dominant economic resource and points out that 99.8 percent of the population in the earthquake impact zone survived the event. Horwich includes the economic value of life at $2 million per person, plus the $114 billion damage to capital stock, to estimate the capitalized value of the Hanshin earthquake on Japan at $127 billion ($114 billion +(6500*$2 million)). Horwich calculates Japan's total resource value by capitalizing

GDP (about $5 trillion in 1995) at a real interest rate of 3 percent for a total of $167 trillion ($5 trillion/0.03), which includes the value of a highly skilled workforce. Using this approach, the Kobe earthquake had a total impact of 0.08 percent of the economic potential of Japan's economy. According to Horwich, much of the economic activity lost due to the physical damage was regained in the form of rebuilding and repair. Some may take issue with the assumptions Horwich makes in his calculations, they offer an indication of the resilience of the economy of large industrialized nations. However, there is some indication that countries with smaller economies may possess economic resilience to natural and man-made disasters.

One week after the Indonesian tsunami of 2004, the Indonesian and Malaysian stock markets had gained value from the pre-disaster level, the Thai stock market declined only slightly, and the Sri Lankan markets were down only a few percentage points (Becker, 2005). Tavares (2004) using an ordinary least squares regression analysis calculates that natural disasters lower US GDP by 0.052 percent per year.[76] However, the same may not hold for smaller countries with more specialized economies.

Unique Costs

Auffret (2003) finds that natural disasters are an important determinant of economic volatility in Caribbean economies, which is attributed, in part, to consumption shocks due to underdeveloped or ineffective risk management mechanisms. Tourism-based economies are subject to market responses to disaster events – or predictions of disaster events – over which they have no control.

[76] This does not include the impacts of Hurricane Katrina. In comparison, Tavares (2002) found that currency crises decreased average economic output by 1.9% in the nations included in his model.

The other factor that minimizes the impacts of most disasters is their short duration. Waters recede, storms pass, and shaking stops. But for some types of disaster, the threat of an event can have long-term business interruptions and therefore an effect on macroeconomic performance – specifically the threat of terrorism (man-made disaster). Tavares (2004) estimates that the continuous threat of terrorist attacks reduces gross domestic product in Israel by 4 percent annually. The Basque region of Spain, which has experienced decades of separatist terrorist activities, looses about 10 percent of its *potential* economic activity due to the threat of terrorism. Terrorism impacts national economies in three ways: 1) increased risk decreases business insurability meaning that risk is not spread across a greater number of economic actors, 2) trade costs are increased leading to lower levels of international transactions, and 3) increased public and private spending for security and defense decreases capital available for investment (Tavares). Area especially prone to man-made or natural disasters will almost always have higher operating costs those businesses outside the region. An evaluation of these costs will help to evaluate the true economic losses associated with disasters. These costs occur before a disaster occurs. In other words, these businesses are incurring increased costs which may translate to increased revenues or decreased revenues in the region in which they exist.

Hobijn (2002) estimates that increased security costs incurred after 9-11 has reduced US economic activity by 0.66 percent annually. The resilience a given economy has to disaster events is largely dependent on national resources committed to mitigation, planning, and response. As national income rises, disaster costs tend to rise, but relative costs as well as the number of lives lost decrease (Dacy and Kunreuther, 1969; Freeman et al., 2003).

Human suffering

However, aggregated analyses at the macroeconomic level miss the intensity of regional and local impacts that create comparative winners and losers when disaster strikes. Additionally, macro level analysis often fails to identify and address disaster impacts and vulnerability across populations at differing social strata. As an overall economy gains wealth, it is often the case that low income populations are forced to reside in lower-cost / higher-risk areas compounded by their inability to afford insurance (Barnett, 1999; Scanlon, 1988; Vatsa, 2004), demonstrated by the socio-economic demographics of the now infamous Ninth Ward of New Orleans. The often horrific images of the low-income victims of Hurricane Katrina and their disproportionate death rate and losses brought into focus how disaster events can disproportionately affect the poorest segments of the regional population. When the national or regional economy recovers in terms of production and employment, specific regions, groups, and individuals may still be experiencing negative economic impacts.

An endeavor to estimate the "human misery" associated with man-made or natural disasters will help to provide greater understanding of how such events affect vulnerable populations or lower income populations. This may be particularly pertinent to an area like the GOM since in all measures of economic well-being - education, income, and life expectancy – the region typically rates relatively low. The GDP metric does not convey the true amount of disproportionate hardship that is likely experienced from hurricanes and oil spills.

There is also the evaluation of additional health costs associated with those living in disaster prone areas. As publicized with the Exxon Valdez and Deepwater Horizon oil spills, local residents claim to suffered increased poor health associated with both oil contaminants and dispersants chemicals. Since it is likely their poor health may extend the remaining lifetime an estimate of the costs will provide information on increased health-care spending and lower life-time wages because of illness. This would provide context beyond business interruption losses to further increase the understanding of economic impacts of disasters.

Conclusions

The theoretical discussion and analysis of natural and man-made disasters is important to advancing in the study of disaster economics. While disasters are not frequently occurring and damages from natural and man-made disasters very considerably by types of disasters, to regional differences, and by industry sector affects. The general framework for economic disaster analysis as mapped out by Dacy and Kunreuther can assist the analyst by guiding one's empirical research. Dacy and Kunreuther demonstrated that it is not enough to examine only Micro effects or Macro effects but that both types of analysis have a role to play in the short-run and long-run, respectively.

The objective of this paper was to apply a generalized framework of Economic Disaster Analysis to the Deep Horizon oil spill in the Gulf of Mexico (GOM) over the short, medium, and long-run to estimate business interruption losses. The region of focus was specifically coastline at risk from the oil plume trajectory; this area included coastline of Louisiana, Mississippi, Alabama, and the Panhandle of Florida. This study was concerned with the: the industry sectors that are likely to be negatively or positively affected due to the oil spill; the estimated Gross Domestic Product (GDP) loss at the county, state, and national level; discussion of industry sectors that will be able to recover and those that may be permanently lost. The analysis was conducted under the assumption that the oil could/will foul the beaches and ports from Louisiana east to the Panhandle of Florida.

As the framework put forth by Dacy and Kunreuther suggested there was first a short-run analysis to evaluate the microeconomic impacts of a disaster. Since it is difficult to model interactions at the firm by firm level (data constraints and modeling complexity are both hurdles), economic impacts were estimated at the industry level.

The short-run analysis was conducted using the REAcct Tool, which estimated direct and total GDP losses. Results demonstrated variations in impact depending on the reliance of the local economy on specific industries. The Panhandle of Florida's economy is more dependent on Tourism than Mining, although the county of Santa Rosa was less dependent on Tourism than neighboring counties. The Magnitude of GDP losses in southern Mississippi provided the interesting insight of how reliant they are on tourism related industries, mostly all associated with the expansion of gambling in southern Mississippi. Tourism is an important industry in the state of Louisiana, but southern Louisiana is much more dependent on the oil and gas related industries given that most tourist attractions are located further inland toward New Orleans. The Total GDP losses of business disruptions were quite small; as a result indirect impacts were barely note worthy.

The Deepwater Horizon oil spill has not threatened any industry with permanent loss of operations, as demonstrated in Scenario 3: Real World. In fact, according to information and data inferred through real-time source, most industries seem to have performed better than initially assumed. This is not to imply that individual businesses may have been permanently lost. In the short-run, it is assumed (in Microeconomic Theory) that individual firms have the ability to adjust to short-run disruptions. Although, as a disruption lengthens individual firms may be in danger of failure; at the Micro level it is assumed some businesses may relocate or the disappearance of one firm is made up in the long-run through the introduction of new businesses in the same region or in another region. There is likely an incentive for the lost production to make up by another firm either locally or outside the affected region.

Application of the short-run assumptions to the medium- and long-run analyses revealed low economic impacts at the national level. This regional occurrence seemed to have little effect outside the GOM. There was the assumption of decreased tourism in the GOM; however, most of Florida’s tourism is concentrated outside the Panhandle. Therefore percent of Tourism related industry sectors was actually quite low. And with no reported loss of Tourism in the state of Louisiana, in fact one could argue there may be an uptick in activity. The introduction of Remediation and Clean- up activities does seem to support the Solow-Swan model. Increased spending on capital, for clean-up, speeds up growth in the long-run to help the economy return to pre-event levels. The amount of savings put toward the purchase of new capital will affect the rate of recovery. However, one should be careful not to confuse this with an economic gain. Funds allocated toward clean-up would likely have been used to invest in new technologies or other production enhancing endeavors; this investment that is likely permanently lost.

However, on average the percent change in employment was below 1 percent. It may be of interest to note that in the midst of the moratorium on drilling job losses were not as high as predicted due to firms choosing to pay employees during this break in production. With the assumption that the moratorium on drilling is not a long-term policy change, impacts are mainly offset by remediation and clean-up. Overall, the lack of spectacular economic losses at the state and national level may lend support to and specifically Horwich's assertion that in a developed country there is some level of protection from the negative impacts of natural and man-made disasters; or that it may be necessary to evaluate impacts through another measure as outlined in the section discussing future work.

The research presented in this document does not claim to be the final economic impact of the Deepwater Horizon oil spill. The research presented does try to capture the associated business interruption losses associated with this type of disaster. The analysis was conducted while the oil spill was in progress; therefore, many of the assumptions presented are fruitful for challenge. However, given the available information at the time of the man-made disaster the numbers presented should be considered a useful first approximation of the economic impact of business interruptions associated with the Deepwater Horizon oil spill.

Appendices

Appendix C

Examination of Long-Term Policy change

A moratorium on drilling would likely not immediately impact current production, but would impact the ability to make new discoveries. New discoveries serve to replace declines in production and add new production. The impact of a moratorium depends mainly on its duration.

The rate of mature oil "field" production decline in the GOM has been estimated to be approximately 20 percent per year. Assuming 1 bbl/day production from mature "fields", this means it is necessary to add approximately 200,000 bbl/day in production capacity each year in order to keep production constant[77]. An estimate of the likely impact of a 6-month moratorium of all drilling the GOM will be a decline in production from 1.3 million bbl/day to 1.2 million bbl/day a year from now, given no other events i.e. hurricanes. It may be possible to make up this loss with higher than normal rates of drilling once the moratorium is lifted.

If a 5-year moratorium were to be imposed a preliminary estimate would follow the same logic. GOM production starts at 1 million bbl/day in 2010, and declines by 20 percent each year, newly discovered GOM production remains constant at 0.3 million bbl/day, and production in the rest of the US remains constant at 3.65 million bbl/day. Total US production of crude oil could drop from 4.95 million bbl/day in 2010 to 4.25 million bbl/day in 2014, as shown in Figure 42. This amounts to approximately a 12 percent decrease in domestic production over a five year period.

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[77] GOM oil production peaked in 2002 at 1.7 million bbl/day. Since then, production has decline, which means that discoveries have not been sufficient to fully replace lost reserves.

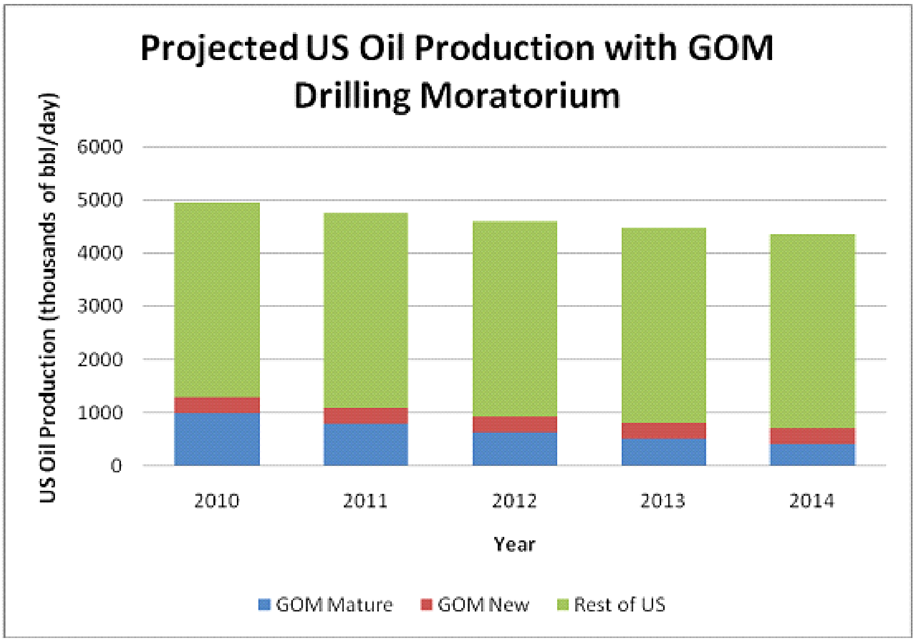

Figure 42: Estimated decline in crude oil production, with imposed Gulf of Mexico drilling moratorium

A brief moratorium (of a few months) on drilling in the US GOM will likely have little impact on current production rates. However, it would introduce a delay in making new discoveries an getting the new production on line. An extended moratorium (up to 5 years) would mean that the oil drilling industry would not be able to replace declining production with new “fields” An extended moratorium on drilling would have a negative impact on the oil related industry sectors of the GOM., including large firms and ports (Port Fourchon) and all related labor. However, it is unlikely such a policy would extend past more than 6-months.

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