LOST CONSUMER SURPLUS FROM NATURAL DISASTER

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ABSTRACT

Throughout the 20th century, the Gulf Coast has been repeatedly struck by hurricanes and tropical storms. While increasingly accurate hurricane forecasts have reduced the risk of life safety by allowing for greater pre-disaster preparation and evacuation, these events still can have ta tremendous impact on economic activity. One of the most often overlooked aspects of the disaster's impact is its effect on consumer surplus. This paper assesses the loss in consumer surplus resulting from hurricane impact and disruption to normal economic activity in Northwest Florida for the period from 1995-1998.

INTRODUCTION

Hurricanes have historically struck the United States with an average frequency of one every four years. Over the last two decades this frequency has increased, and in any given year, an average of two hurricanes are likely to make landfall (Smith 1999). The Gulf Coast in particular has been struck by five hurricanes since 1995. While improvements in meteorological forecasting has resulted in the reduction of loss of life and injuries associated with tropical storms and hurricanes, these natural hazards can still cause tremendous economic impact. Gulf Coast damages in the 1990's were in excess of $5 billion, and over $30 billion for the state of Florida alone.

The economic impact of a hurricane or tropical storm depends upon a number of factors including, storm intensity, geographic zone of impact, level of damage, level of disruption and dislocation, resource availability, and the level of in-built response mechanisms. Differences in the level of severity, physical, and sectoral impact imply that no two events are completely comparable.

Economic costs arising from impact are generally assessed in terms monetary damages to homes and businesses, changes in sectoral or overall employment levels, and changes in income (Guimaraes et. al 1994; West and Lenze 1994; Vogel 1998). The threat or impact from weather related natural hazards may also cause disruptions to ordinary economic activity from minor inconveniences such as power outages of short duration and delays to economic transactions to more serious disruptions from extended loss of utilities and public services for days and weeks, and the long-term shut-down of bridges, roads, and other transportation networks..

The impacts arising from these inconveniences could best be described as losses in welfare to both consumers and producers and is generally overlooked in the natural hazards literature. Quantifying this type of impact is not quite as straight forward as measuring for example, direct damages, or the overall change in employment. In the next section of this study the economic effects of a natural disaster are summarized. Following that discussion, the welfare issues are explored in greater detail. The impact of hurricanes on Northwest Florida are then examined focusing on these welfare issues.

DISASTER IMPACT

Hurricanes and tropical storms that make landfall are responsible for three levels of economic impact—direct, indirect, and induced. Direct impacts are the result or immediate consequence of the disaster impact such

as physical damage, loss of life, and injury. Indirect impacts are losses that are the result of changes in the level of activity arising from damage to the physical economic infrastructure. Increases in unemployment or losses in income resulting from plant shut downs or business interruption fall into the category of indirect impact. Induced impacts arise as a result of changes or alterations to regional demand and supply relationships.

In the short run the natural disaster may cause changes in employment levels, income, and prices. General and sectoral employment changes are the result of damage or destruction to residential, commercial, or industrial facilities disrupting normal economic activity. Employment in sectors such as construction may experience a rise in employment and income as a result of reconstruction and recovery activities. A post-disaster change in employment may be due to factors other than the natural disaster such as recession or expansion in the rest of the country.

Income will be affected by changes in the overall level of employment, sectoral changes in employment, and adjustments to the number of hours worked. Income from rents, capital, and proprietors income may all be affected as well due in part to direct impact damages, temporary population displacement, and changed traffic patterns.

Overall, disasters tend to cause a short run decrease in wealth. When deductibles and insurance limitation are taken into account, insurance coverage is typically incomplete. Even with additional government disaster relief and assistance, households will generally have to dip into savings and other holdings in order to completely rebuild damaged homes or replace lost property.

The possible primary long run effects of a natural disaster are permanent changes in employment and income, the acceleration of pre-existing economic trends, and changes in regional growth and development. Long run changes are attributable to factors such as incomplete sectoral or economic recovery, and disruption to regional sectoral linkages. The disaster may act as a catalyst for sectoral expansion or decline, especially through price and valuation changes, accelerating pre-existing trends. Following the disaster, for example, price and land valuation changes may lead the owners and operators of land intensive activities such as farming and mining, to reevaluate their operations.

While the natural disaster event impacts an area without regard to socioeconomic status, its impacts are not neutral within the community. A number of studies have pointed to distinct differential welfare and distributional effects related to socioeconomic status as a result of direct direct impacts, the distribution of aid, and the recovery process (Dacy & Kunreuther, 1969; Cochrane, 1975; Bolin et al, 1983; Jovel, 1990; Bates & Peacock, 1993).

Cochrane (1975, 77-79) argues that property damage measured on a percentage basis of total dollars is skewed towards higher income groups, since these groups tend to have more valuable property holdings. Individuals from higher income groups are also subsidized at a greater rate in terms of aid and loan polices due to their greater ability to qualify for recovery loan programs. Higher event intensity generally reduces the individual reconstruction as a result of greater levels of post-disaster government assistance that flows into the community (Dacy & Kunreuther, 1969; Kunreuther, 1973, 1978; Palm and Hodgson 1992).

Some groups, such as the elderly, and the socially disadvantaged, are impacted more than other groups. Bolin (1983) has found differential impacts due to ethnic and racial differences. Property and monetary losses from natural disaster tend to increase with socioeconomic status, however, as a percentage of income, higher income groups are less dramatically affected (Palm & Hodgson, 1992). Variation in housing quality and conditions, access to resources, and insurance coverage, are important determinants of the distributional aspects of a disaster event's impacts (Dash et al 1996; Peacock & Girard, 1996; Peacock, 1993).

MEASURING ECONOMIC IMPACT AND WELFARE ISSUES

Direct, indirect, and induced impact can be measured in a variety of ways. Howe and Cochrane (1993) have outlined a number of standardized methods for measuring direct and indirect impact using commonly accepted financial accounting techniques. Other studies, such as Chang (1979; 1983;1984), Ellson, Milliman, & Roberts (1982), Guimaraes, Hefner, & Woodward (1992), Gordon & Richardson (1992), West & Lenze

(1994), and Vogel (2000), utilize techniques from econometrics to CGE modeling to estimate the short run and long-run impacts from natural disasters.

All costs and impact estimates should be based upon the "with and without the event" criteria developed by Ellson, Milliman, and Roberts (1982, 1984). As an example, suppose that the pre-event annual output of a manufacturing facility employing twenty-five individuals was one thousand units. Post-event output is five hundred and employment drops to fourteen. Ascertaining the disaster's impact requires an answer to the question, what would output and employment have been in the absence of the event. If the economy had been going into recession, factory output and employment may have been falling, so the disaster impact must be estimated as a net effect, accounting for the recessionary effect.

The general approach for estimating short and long-run impact involves using an econometric or I/O type of model to establish baseline employment and income for the impacted community without the event (Chang 1979, 1983,1984; Ellson, Milliman, & Roberts 1982; Guimaraes, Hefner, & Woodward 1992; Gordon & Richardson 1992; West & Lenze 1994). Regional forecasts of output, income, and employment with and without the event are then generated. Post-event levels can then be compared to forecast levels, i.e., multipliers and changes in multipliers, employment levels, income, retail sales, and other economic variables.

Measuring losses in terms of property damage, output, employment, and income, highlights only a portion of a disaster's impact. Not all of the economic impact arising from disruption to economic activity will be picked up in the disaster accounting process. Time shifting of some production processes and consumption activities may eliminate output losses, and actually show up as increases in wage income or sales tax revenues in future periods. This however ignores losses that may arise from the inconvenience of bridge closures, power outages, loss of telephone and cable services, and other similar activities. Commuters that are forced to reroute their trip to work may end up driving additional miles, raising gasoline tax revenues, for example.

Howe and Cochrane (1993) give some guidance in measuring some of these disruption costs. For production interruption they recommend that the reduction in value added should be used to estimate the costs from the disaster. In the case that the resources (labor and capital inputs) find some temporary alternative uses, then the difference between original income payments to these resources and the new temporary income should be used. Estimating value added may be difficult, and is not limited to market-based activities. Household value added from household production and amenities must also be accounted for. Some costs from changes in commuter patterns, lost power, and other household-based activities may not be easily monetized.

These costs may be estimated using more ad hoc methods, and in general, represent part of the uncompensated costs from a natural disaster. The cost to firms and households in the aftermath of a natural disaster may be measurable, and include lost consumer and producer surplus. Demand data for the impacted region though, is generally incomplete, and some of these losses will have to be estimated more informally.

UNCOMPENSATED COSTS OF DISASTERS IN FLORIDA'S PANHANDLE

Hurricanes Erin and Opal in 1995 caused a combined total of $3.7 billion in damages to business, government, and residential property in the Florida Panhandle (Mayfield 1995; Rappaport 1995). Erin struck in early August, causing approximately $700 million in property damages and disrupted the second half of the areas tourist season. Two months later, Opal struck the area, causing $3 billion in property damages, with much greater destruction to the tourism infrastructure. The Panhandle was again struck by hurricanes in August, 1997 with Hurricane Danny, and in 1998, with Earl in early September, and Georges later that month (Mayfield 1998).

Storm damage knocked out electric power and other utilities, to area homes and businesses, closed bridges, and caused traffic to be rerouted. The beach road from Pensacola Beach to Fort Walton Beach was not fully restored for close to a year following Erin and Opal, adding an additional twenty miles to the trip. For services such as lost electrical power, residents had to live without air conditioning and other amenities. These interruptions resulted in lost output, lost revenues, losses to consumer and producer surplus, and extraordinary repair costs.

Table 1

	Erin		Opal		Danny		Georges
8/3/95	215,000	10/5/95	216,000	7/19/97	7,000	9/28/98	95,000
8/4/95	132,650	10/6/95	135,000	all restored		9/29/98	40,000
8/5/95	89,000	10/7/95	61,000			9/30/98	all restored
8/6/95	32,250	10/8/95	all restored				
8/7/95	8,600						
8/8/95	all restored						

*number of business and household customers without power

Electric power costs for the Gulf Coast are 3.518 cents per kilowatt hour, with an average household use of 1115.75 kilowatt hours per month, giving a monthly average monthly bill of $38.71, or $1.2905 per day for 36.683 kilowatt hours per day. Household power loss for hurricanes Erin, Opal, Danny, and Georges are shown in Table 1. Power outages for hurricanes lasted for up to a week, as crews from Gulf Power worked to repair power lines and restore power. Hurricanes Danny and Georges resulted in shorter outages, with power being restored for all customers within several days.

The figures given in Table 1 reflect the total number of households that were without power at the end of each day. Data from Gulf Power reveals that the restoration of service was an ongoing process, with business and household service being restored throughout each of the days reported. Estimates of lost revenues and consumer surplus assume that power is restored on this intermittent basis, including the interim reporting periods. Lost electric power revenue estimates as a result of hurricanes along the Gulf Coast are reported in Table 2.

Losses in consumer surplus are based upon price elasticity of demand estimates for the Southeastern United States provided by the Haas Center for Business and Economic Research of the University of West Florida. Demand functions were derived by using constant elasticity of demand estimates of -0.5 and -0.75. Consumer surplus was then estimated from the Marshallian demand estimates (Kim 1997; Irvine and Sims 1998). Despite the some theoretical weaknesses of using this ad hoc demand functions, they do provide some indication of Hurricanes Erin, Opal, Danny, and George impact on consumer surplus along the Gulf Coast. Using a price of $ 0.03518 per kilowatt hour, and an average household usage of 13,389 kilowatt hours per year, the demand functions are, 1) $Q= (2511.2853)P^{-.5}$, and 2) $Q= (1087.6021)P^{-.75}$.

Table 2

	Erin		Opal		Danny		Georges
8/3/95	$277,350	10/5/95	$294,881	7/19/97	$6,675	9/28/98	$ 87,751
8/4/95	$199,633	10/6/95	$142,472		all restored	9/29/98	$ 38,715
8/5/95	$132,277	10/7/95	$ 68,561			9/30/98	all restored
8/6/95	$ 66,590	10/8/95	ll restored				
8/7/95	$ 16,647						
8/8/95	all restored						
Total	**$692,657**		**$505,914**		**$6,675**		**$126,469**

Estimated loss in revenues to Gulf Power resulting from power outages.
Assumes a daily power cost per average customer of $1.2905 a day.

The loss in consumer surplus per day, per customer for an elasticity of demand of -0.5 is approximately $1.29 for a half day, and $2.588 for one full day. For an elasticity of demand of -0.75, the loss in consumer surplus per day is $0.86 for a half day, and $1.72 for a full day. Loss estimates are based upon the number of households without power per twenty-four hour period. Thus, the loss in consumer surplus increases with each day of power loss, while the number of businesses and households without power declines (see Tables 3 and 4).

The estimated total loss in consumer surplus from power outages for the four hurricanes is between $1.8 million to $2.7 million. This is most likely an underestimate of the total loss in consumer surplus arising from the disruption of other activities as well. Consumers were forced to forgo a variety of activities and endure hardships not ordinarily faced as a result of storm related damage and impact. In some cases, for services such as cable television and telephone service, customers service may have been disrupted with no immediate reduction in billing and customer outlays. In other words, when electric power went out, even if cable television services were still available for example, most customers were unable to enjoy the service, but still had to pay for the full month of cable television.

Bridge crossing data for the two toll bridges in the area, the Bob Sikes Bridge connecting Gulf Breeze to Pensacola Beach, and the Navarre Bridge, connecting to Navarre Beach show a drop in traffic in 1995 around Erin and Opal's landfalls. Figures for the Bob Sikes Bridge reveal a steep decline in traffic beginning with Hurricane Erin, falling by 9 percent in August of 1995, with bridge crossings dropping off by 44 percent by January of 1996. They began to return to normal as of February as beach reconstruction was being completed. Traffic on the Navarre Bridge did reveal a drop in traffic by 19 percent over the preceding year in August when Erin hit, but returned to normal crossings by the following month.

Table 3

	Erin		Opal		Danny		Georges
8/3/95	$ 98,899	10/5/95	$241,850	7/19/97	$18,130	9/28/98	$107,350
8/4/95	$257,773	10/6/95	$319,608		all restored	9/29/98	$181,400
8/5/95	$316,470	10/7/95	$455,784			9/30/98	all restored
8/6/95	$509,915	10/8/95	all restored				
8/7/95	$213,538						
8/8/95	all restored						
Total	**$1,396,596**		**$1,5017,242**		**$18,130**		**$288,750**

Estimated loss in Consumer Surplus, $Q= (2511.2853)P^{-.5}$.

Table 4

	Erin		Opal		Danny		Georges
8/3/95	$ 65,678	10/5/95	$160,820	7/19/97	$12,040	9/28/98	$71,380
8/4/95	$171,829	10/6/95	$212,988		all restored	9/29/98	$120,800
8/5/95	$210,319	10/7/95	$302,891		9/30/98	all restored	
8/6/95	$338,818	10/8/95	all restored				
8/7/95	$141,814						
8/8/95	all restored						
Total	**$ 928,460**		**$ 676,699**		**$12,040**		**$192,180**

Estimated loss in Consumer Surplus, $Q= (1087.6021)P^{-.75}$.

The lack of data makes it difficult to measure losses in consumer welfare from many of the other disruptions. Additionally, some of these losses may end up being counted as increases in economic activity elsewhere. If, for example, a family was forced to eat out because they were unable to prepare their meal at home due to a power outage, this activity would be recorded as an increase in restaurant revenues and associated state and local taxes.

CONCLUSION

The welfare losses arising from natural disaster are as readily measured as property damages and lost output. Pre-disaster baseline estimates of regional demand, and data on non-market household activities are generally not available. Thus, many of these losses must be estimated through ad hoc back of the envelop procedures instead of theoretically correct empirical specifications and techniques. While the consumer welfare losses estimated in this paper do give an indication of a portion of the uncompensated costs of disaster, they are far from exhaustive. This analysis is a first step in deriving these costs.

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ACKNOWLEDGMENT

The author would like to acknowledge the State of New York/UUP Professional Development Committee for financial support