THE INCOME DISTRIBUTION EFFECT OF NATURAL DISASTERS: AN ANALYSIS OF HURRICANE KATRINA

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ABSTRACT
This paper combines the study of income distribution with that of natural disasters. The income distribution effects of Hurricane Katrina are examined using the gini ratio as a measure of income inequality. The nature of the population shifts caused by the hurricane is considered, and a statistical model is applied to determine whether any inferences can be made about the change in income distribution. A hypothetical example of what the underlying shifts will be in the Lorenz curve that describes the New Orleans area income distribution is considered.

Introduction
There has been a lot written on the topic of natural disasters, with recent emphasis on the effect of hurricanes; this writing has been largely outside the field of economics. However, the literature of economics does contain a lot of writing on the topic of income distribution.

The goal of this paper is to combine the study of income distribution with that of the study of natural disasters. The plan is to examine the income distribution effects of hurricane Katrina. Predicting the change in income distribution within the New Orleans metropolitan statistical area (MSA) requires predicting how the effects of Hurricane Katrina will affect the size and composition of the population within the MSA. Current predictions of population losses in the area range from thirty to fifty percent.

We will also apply a previously determined statistical model to these population shifts to determine what, if anything can be inferred about the change in income distribution. Lastly we
consider a hypothetical example of what the underlying shifts will be in the Lorenz curve that describes New Orleans area income distribution.

**Survey of the Literature**

One area of the literature that is of interest concerns the different ways to measure the income distribution. For those interested in a comprehensive look at the different ways to measure income distribution, we suggest the analysis by Fred Compano and Dominick Salvatore (see Compano and Salvatore, 2006). They consider methods complex enough to estimate a five parameter probability density function. Our approach is not that complex; we will use a simpler approach where a gini ratio is calculated from a distribution measured at quintiles.

Another part of the literature to consider is that concerned with modeling or explaining the existing income distribution. A very complete study is the one by Janice Madden (see Madden, 2000). This study includes every metropolitan area in the U.S., and analyzes changes in several variables over the period 1979 to 1989.

Previous work by the authors uses a simpler approach to modeling income distribution (see Brendler and Jones, 1994). In this study we considered just the metropolitan areas in Louisiana and Texas, with the variables measured across the metropolitan areas in a single year, 1990. It is this simpler approach that we will use to arrive at the conjectures developed in this paper.

For data useful in analyzing the effects of Katrina, we rely on two sources. The first is the set of estimates developed by the Greater New Orleans Community Data Center (see Greater New Orleans Community Data Center, August 8, 2006). The second source of data is that provided by the Brookings Institution (see Liu, Fellowes, and Mabanta, August 2006). These data sets are what we will use to make a projection of the population change in the New Orleans area. We acknowledge that both of these data sets are estimates only. However, a more definitive set of actual numbers will have to wait until the next general population census, unless the government conducts a special census prior to 2010.

Finally, for those interested in a very descriptive analysis of the physical dislocations and the resulting social dislocations, we suggest the one by Van Heerden and Bryan, entitled simply “The Storm” (see Van Heerden and Bryan, 2006). The lead author is the co-founder and deputy director of the LSU Hurricane Center. There of course have been many works published about Katrina, but this one has the value of being scientific.

**Methodology**

As a measure of income inequality we will use the gini ratio. The interpretation of this ratio can be explained with respect to the diagram shown below in Figure One.
Suppose all the households in a metro area were ranked from the lowest in household income to the highest. If we then measured the cumulative share of total household income at various cumulative shares of total households, we could generate a cumulative distribution function of household income, an example of which is shown in Figure One as G(n). So at a given percentage of total households, for example 20 percent, we could say that the “poorest 20 percent of the households have only x percent of total income.”

If all households had the same income, then the cumulative distribution function would be a line from the origin at a forty-five degree angle with both axes. This is shown above as the Line of Equality. For example, on this line the first fifty percent of the households would have exactly fifty percent of the income.

The degree of income inequality is measured as the extent of deviation from the Line of Equality. This measure is called the gini ratio and it is defined as:

\[ g = \frac{A}{A+B} \]  

(1)
In this equation, A and B refer to areas A and B in Figure One. As income distribution becomes more unequal, the relative size of area A grows, so that a higher gini ratio means greater income inequality.

**The Model**

Previous work by the authors identified several variables as being significant determinants of the gini ratios for the metropolitan areas within the states of Texas and Louisiana. We shall retain the gini ratio as the measure of income inequality and use the same variables identified in that earlier study, with the exception of the dummy variable to differentiate between the two states. These variables, and the estimated direction of the relationship, are listed below in Table One:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Name</th>
<th>Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median Income</td>
<td>MEDIAN</td>
<td>+</td>
</tr>
<tr>
<td>Median Income Squared</td>
<td>MEDSQR</td>
<td>-</td>
</tr>
<tr>
<td>Percentage Of Population Considered Hispanic</td>
<td>HISPANIC</td>
<td>-</td>
</tr>
<tr>
<td>Share Of Earnings From Government Employment</td>
<td>GOVEARN</td>
<td>+</td>
</tr>
<tr>
<td>College Completion</td>
<td>SIXTEEN</td>
<td>+</td>
</tr>
<tr>
<td>Percentage Of Female Headed Households</td>
<td>FEMALE</td>
<td>+</td>
</tr>
<tr>
<td>High School Completion</td>
<td>TWELVE</td>
<td>-</td>
</tr>
</tbody>
</table>

Table One

Significant Variables

Table One does not include all the variables analyzed in the previous study; it includes only those that were found to be statistically significant. The column for ‘Sign’ indicates the sign of the estimated regression coefficient. For example, the median income variable was shown to have a positive sign. The inference is that areas with high median income should have higher gini ratios, everything else constant. Therefore areas with high median incomes will have more unequal income distribution, given the standard interpretation of the gini ratio.

**The Population Shift**

The prediction about the nature of the change in income distribution within the New Orleans MSA is based on prior predictions concerning how the effects of Hurricane Katrina will affect the size and composition of the population. Data provided by the Greater New Orleans Area Community Data Center and the Brookings Institution are used in making predictions about the population loss within the MSA. This data implied population losses ranging from thirty percent to fifty percent. Based on this information, we project a forty percent population loss for the city of New Orleans. This number was obtained simply by splitting the difference between the lowest of the estimates of thirty percent and the highest estimate of fifty percent.
Will this predicted loss of population for the city result in an equivalent loss for the metropolitan area? That probably will not happen for two basic reasons: relocation and building. There are three groups of households who have left New Orleans.

The first group of households is those who had insurance, other personal assets, and a good credit rating and who could relocate elsewhere within the metropolitan area. These households would be outside the city limits of New Orleans but still counted as being within the metropolitan area, even if they decide never to return to the city.

For the second group of households, any absence from New Orleans is only temporary. They will return to the city permanently once their rebuilding has been completed. This group, which is like the first in terms of economic resources, plans to rebuild in the same location, pending rulings on the elevation requirements due to a revised building code and the restoration of public utilities.

So some of the forty percent who have left the city of New Orleans will either relocate within that metropolitan area; others will eventually return after rebuilding. The remaining segment of households would be less likely to return to the city or the metro area. These households will have the principal lasting effect on the demographics of the metro area. It is this change in demographics that will produce the change in income distribution.

The households likely to remain absent for an extended period of time, and perhaps permanently, are those lacking the resources to rebuild or relocate within the New Orleans metro area. This group of households did not have the insurance or other financial resources that the other two groups of households had. Some households’ may have persons become unemployed because of the storm; they would not have the same access to credit. For them, relocating or rebuilding is not possible.

It is unknown at this time exactly how large this group of households is. However, it is possible to identify what type of households these are. They would be households at the lowest income levels, with many likely below the official poverty level. They would have all of the demographic characteristics associated with low household income.

The result would be that the set of households remaining in the New Orleans metro area would have the characteristics associated with higher income levels. We shall now apply the idea that the remaining households will have higher incomes to the model referred to in the previous section.

**Analysis**

Because the lowest income households will be least likely to return, the set of households remaining in the New Orleans metro area will have an overall higher level of incomes than before.

The two income variables, MEDIAN and MEDSQR should both increase directly. Because educational attainment is positively correlated with income level, both the level of college completion (SIXTEEN) and high school completion (TWELVE) should increase.
percentage of female-headed households (FEMALE), which is negatively correlated with income level, should decrease.

The importance of government employment should increase. Some of this increase could be due to the influx of government employees associated with the disaster recovery effort, such as those associated with FEMA. It is uncertain if this part of the effect will be lasting. Let us assume that the total absolute level of government employment will be unchanged; that is, there will be no lasting effects of the storm. If the total level of private sector employment is smaller, due to the permanent exodus of some employers, then the relative importance of government employment will be higher, so that GOVEARN increases.

That leaves the question of what will happen to the Hispanic population of the New Orleans metro area. There is some anecdotal evidence about a major influx of Hispanic laborers in the constructional industry because of the great need for construction labor. How much of this will be permanent? We simply cannot say. All we can state is that if the New Orleans metro area follows national trends, then the relative share of the Hispanic population should increase.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Name</th>
<th>Sign</th>
<th>Expected Change</th>
<th>Effect On Gini</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median Income</td>
<td>MEDIAN</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Median Income Squared</td>
<td>MEDSQR</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Percentage Of Population</td>
<td>HISPANIC</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Considered Hispanic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share Of Earnings From</td>
<td>GOVEARN</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Government Employment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College Completion</td>
<td>SIXTEEN</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Percentage Of Female</td>
<td>FEMALE</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Headed Households</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High School Completion</td>
<td>TWELVE</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

Table Two
Effect On Gini Ratio

Based on the information in Table Two, it is not clear exactly what the effect on the gini ratio will be. Three of the variables would contribute to a higher gini ratio, and four of the variables would contribute to a decrease of the gini ratio. It would appear that the exact change in the gini ratio, and therefore income distribution might have to be settled empirically.

An Alternative Approach

Because the variables included in the model do not give consistent predictions about the change in the gini ratio, let’s consider a “simulation” type approach. We propose to consider a hypothetical income distribution, with the relative shares measured at quintiles. Next we will consider what happens to that distribution if the entire lowest quintile is removed from the distribution. In essence, we want to imitate what has happened with the exodus of the poorest households from the New Orleans area.
In Table Three below, we show the hypothetical distribution, for both before and after Katrina.

<table>
<thead>
<tr>
<th>Quintile</th>
<th>Households</th>
<th>Quintile Mean Income</th>
<th>Quintile Total Income</th>
<th>Percent Share Total</th>
<th>Post Katrina Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>10,000</td>
<td>20,000</td>
<td>200,000,000</td>
<td>3.23</td>
<td></td>
</tr>
<tr>
<td>2nd</td>
<td>10,000</td>
<td>40,000</td>
<td>400,000,000</td>
<td>6.45</td>
<td>6.67</td>
</tr>
<tr>
<td>3rd</td>
<td>10,000</td>
<td>80,000</td>
<td>800,000,000</td>
<td>12.90</td>
<td>13.33</td>
</tr>
<tr>
<td>4th</td>
<td>10,000</td>
<td>160,000</td>
<td>1,600,000,000</td>
<td>25.81</td>
<td>26.67</td>
</tr>
<tr>
<td>5th</td>
<td>10,000</td>
<td>320,000</td>
<td>3,200,000,000</td>
<td>51.61</td>
<td>53.33</td>
</tr>
</tbody>
</table>

Table Three
Hypothetical House Income Distribution

For this distribution, we have assumed that there were 10,000 households in each quintile. We have also assumed the mean income numbers for each quintile. These numbers are totally arbitrary and chosen for demonstration purposes only.

The column ‘Percent Share Total’ is the share of that quintile of the total household income for all quintiles combined. The column ‘Post Katrina Share’ shows the share of total household income with the income from the first quintile removed.

If we now convert these numbers into cumulative distributions, we get what is shown in Table Four.

<table>
<thead>
<tr>
<th>Quintile</th>
<th>Pre-Katrina Share</th>
<th>Pre-Katrina Cumulative Share</th>
<th>Post Katrina Share</th>
<th>Post-Katrina Cumulative Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>6.67</td>
<td>6.67</td>
<td>14.29</td>
<td>14.29</td>
</tr>
<tr>
<td>2nd</td>
<td>13.33</td>
<td>20.00</td>
<td>21.43</td>
<td>35.71</td>
</tr>
<tr>
<td>3rd</td>
<td>20.00</td>
<td>40.00</td>
<td>28.57</td>
<td>64.29</td>
</tr>
<tr>
<td>4th</td>
<td>26.67</td>
<td>66.67</td>
<td>35.71</td>
<td>100.00</td>
</tr>
<tr>
<td>5th</td>
<td>33.33</td>
<td>100.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table Four
Cumulative Income Distributions

It is not immediately obvious if the distribution has become more or less equal, because one distribution uses quintiles, and one uses quartiles. However, if we graph these distributions, the nature of the shift becomes clearer.
Because the “After Katrina” Lorenz curve would be closer to the line of equality, the associated income distribution has become more equal, and the gini ratio would be smaller.

It would appear that if the effects of hurricane Katrina result in the permanent loss of many of the poorest households from the New Orleans metro area, there will be a change similar to what was shown in our hypothetical example. The implication is that the income distribution in New Orleans becomes more equal.

Concluding Remarks

The event that will hereafter simply be known as ‘Katrina” has aspects that make it both easy to analyze and also hard to analyze. The lasting effects of the storm appear to have been focused on a very narrow segment of the community, the poorest households. Contrast this to the Southeast Asian tsunami that wiped out entire communities. The fact that the effects of Katrina were so narrowly focused make it simpler to infer what the likely lasting impact is going to be. Katrina is also hard to analyze because the data needed to confirm or deny our hypothesis will not be known for some time.
Our conclusion is that the income distribution in New Orleans will become flatter or more equal. Because the storm has effectively removed many of the poorest households, the city will come to resemble a suburb, with less diversity in the economic status of the households there. Therefore any redevelopment efforts should consider what type of city it has become, and not what type of city New Orleans used to be.

REFERENCES


Greater New Orleans Community Data Center, as of August 8, 2006 located at: www.gnocdc.org

