Short-Run Economic Impacts of Hurricane Katrina (and Rita)

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A tropical depression formed over the southeastern Bahamas on 23 August 2005, moved toward the Gulf of Mexico, and strengthened to category 5 on the Saffir-Simpson Hurricane Scale over the central Gulf of Mexico (NCDC 2005). When hurricane Katrina made landfall on the Louisiana coast with category 3 intensity on 29 August 2005, 130mph of sustained winds breached the levees of New Orleans and caused substantial inundation. A flood following the storm, devastated the Crescent City, and the disaster was recorded as the costliest natural disaster ever in US history, resulting in an 80 percent flood in the City of New Orleans and over 1,800 casualties (Louisiana Geographic Information Center 2005).

The repercussions of hurricane Katrina (and hurricane Rita that happened soon after) continue until today and beyond into the future. However, most of the efforts now are focusing on housing provision, social reconstruction and community development. Of course, these have an economic impact, but this paper primarily focuses on the business interruption impacts, soon after the disaster.

Prior to hurricane Katrina, the three costliest natural disasters in terms of dollar magnitude of damages recorded in the United States were the drought in 1988 with estimated losses of over 39 billion US dollars, hurricane Andrew in 1992 which cost 30 billion US dollars and the Northridge earthquake in 1994 which resulted in over 44 billion US dollars (National Research Council 1999). 9/11, a manmade disaster, was of similar magnitude.

Covering the first year after the disaster, several studies on its economic impacts were completed. However, most of this research was from governmental reports mainly focusing on the direct losses or on speculations about future impacts on the area. Louisiana received federal reimbursements for losses of about 105 billion US dollars (Kent 2006). Nordhaus (2006) based an analysis on the economic impacts from US hurricanes since 1950 and came up with an estimate of 81 billion US dollars for hurricane Katrina.

However, the total (direct, indirect and induced) economic losses were higher than these estimates, in part because of the interdependence between economic sectoral activity and household consumption. Park *et al.* (2006a) estimated the direct and indirect economic losses because of the inoperability of the Port of New Orleans in the seven months after the hurricane as 62.1 billion US dollars. Of course, the sectors that rely heavily on waterborne commerce were more severely affected, although all major economic sectors were negatively impacted during the storm and recovery period.

It is useful to examine other economic losses in the region. Several oil and gas refineries were shut down for more than a week. 115 offshore oil platforms were missing, sunk, or went adrift. One-half of 1.3 million evacuees from the New Orleans metropolitan area were not able to return in the first month after the storm, and many key workers were away for much longer (Katz *et al.* 2006).

The Energy Information Administration (EIA 2006a) released a report analyzing historical impacts of tropical cyclones on Gulf of Mexico crude oil and natural gas production over the period 1960 through 2005, and refinery operations over the past 20 years. The analysis showed that tropical storms and hurricanes in the Gulf area typically cause seasonal disruption of shut-in production of 1.4 percent for crude oil and 1.3 percent for natural gas compared to

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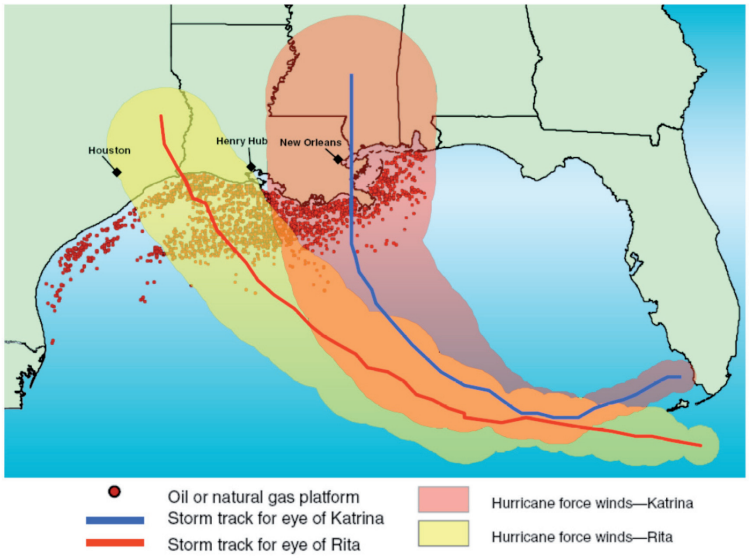
normal annual production from wells on the Outer Continental Shelf (OCS). However, these averages are skewed upwards by the 19 percent of oil production and 18 percent of natural gas production that was shut in during 2005. Also, the Government Accountability Office (GAO 2006) released a report addressing the factors causing natural gas price increases, influences on consumers according to the higher prices, and the adequacy of roles of federal government agencies played in ensuring natural gas prices competitive. In September 2005, natural gas spot prices increased to over 15 US dollars per million BTUs, which is roughly twice as high as the average price in July of that year. The skyrocketed price resulted from a substantial portion of domestic supply disruption and excessive demand because of colder weather than expected *(ibid)*. In research of economic losses because of the employment changes, a report of Bureau of Labor Statistics (BLS 2006) presented the impacts of Katrina on employment in the Gulf coast area by examining over-the-year changes. Employment in the most severely affected parish in Louisiana was down by nearly 40 percent in September 2005 compared to a year before. Colgan and Adkins (2006) discussed the proportion of employment and wages of the affected industries defining them as 'ocean industries'. Including oil and gas exploration as well as marine transportation and related goods and services, the ocean economy of the region encompassing Florida, Alabama, Mississippi, Louisiana and Texas employed 291,830 people in wage and salary jobs paying nearly 7.7 billion US dollars for the wages in 2004.

Figure 1 shows the severe impacts of two hurricanes (Katrina and Rita) on oil and gas production platforms on the coast of the Gulf of Mexico, where the inoperability of gas and oil industries severely affected the US national market because crude oil production as well as petroleum products in the area accounted for nearly three-fifths of the total US output in this sector in 2004 (EIA 2006b).

Not surprisingly, the Gulf of Mexico offshore installations have a significant place in the US oil and gas industries such that the domestic gasoline price escalated significantly right after the two storms. Figure 2 indicates the fact that the effects of the hurricanes were not confined to the area. The total volume of production for the entire US shows an abrupt drop in September 2005. The flow parallels the Gulf coast flow while the rest of the US shows a relatively

Figure 1

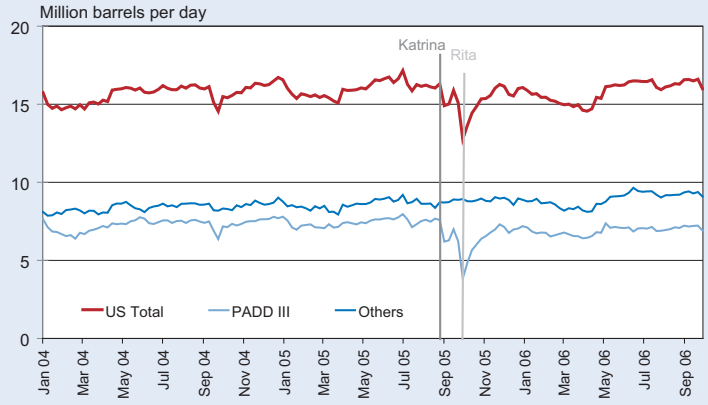
PATHS OF HURRICANES KATRINA AND RITA RELATIVE TO OIL AND GAS PRODUCTION PLATFORMS ON THE US COAST OF THE GULF OF MEXICO



Source: Government Accountability Office (2006).

Figure 2

PETROLEUM PRODUCTION PRE- AND POST-KATRINA AND RITA



Sources: EIA; authors' calculation.

steady trend. In other words, the rapid decrease in petroleum production of the United States from September 2005 mainly resulted from reduced production in the Gulf coast.

Crude oil industries in the Gulf region are closely related to port activity. The analysis conducted by Park *et al.* (2006a) addressed disruptions of port activity, including oil industries. This study, however, focuses on the oil-refinery industries of the Gulf of Mexico by subtracting foreign and domestic exports from the total output of oil refineries.

The Gulf of Mexico region is defined as PADD III (Texas Inland, Texas Gulf Coast, Louisiana Gulf Coast, North Louisiana-Arkansas and New Mexico) shown in Figure 3. This requires spatial aggregation by modifying our National Interstate Economic Output Model (NIEMO), to 47 regions from the original 52 (including the rest-of-the-world) regions. The next section illustrates our approach to estimating direct impacts required as input data for the 47-region NIEMO, and applying what we call the Flexible National Interstate Economic Model (FlexNIEMO).

Input-output models have been applied to the problem of economic impact estimation for many years. In recent years, our group has developed and applied IO models that include substantial spatial disaggregation. Most decision makers are interested in local effects and our models can estimate these. Our National Interstate Economic Model (NIEMO) is a multi-regional input-output model for the 50 states and the District of Columbia. Both models provide results for 47 industrial sectors (labeled the USC Sectors). NIEMO has a supply-side as well as a demand-side capability. In applications to hypothetical or actual port closures, for example, the loss of exports is best modeled via the demand-side NIEMO, whereas the loss of imports is modeled via the supply-side NIEMO.

This type of model is most useful for short-term impact analysis because buyers and sellers can be expected to eventually make substitutions in light of the price changes that follow longer-term major disruptions. Omitting these effects is a well-known limitation of the IO approach. Here, we describe how to use post-event information on concurrent demand and value-added changes to identify the technological (production function) changes that occur after a major disruption. We compare these results to the estimates from the baseline NIEMO to show the detailed impacts of substitutions and adaptations.

As seen in Table 1, Louisiana experienced an economic decline (by 1.5 percent) in the years 2004 to 2005. According to BEA's data, except for Louisiana and Alaska, all the other states grew in terms of Gross State Product. Also, the mining sector including oil and gas production was the most negatively impacted component of GDP.

Methodologies

Figure 3

Petroleum Administration for Defense District Maps

Source: Energy Information Administration (2006), District Description and Maps.

The Holt-Winters time-series approach was used to estimate normal economic trends, if the hurricanes had not occurred. These estimates provided the direct impacts necessary for input data into the demand-side NIEMO. We then used the FlexNIEMO to construct month-to-month supply-side versions of NIEMO.

The Holt-Winters approach to estimating the normal economic status using times-series methodology is described in several recent articles (Park *et al.* 2006a; Park *et al.* 2006b; Richardson *et al.* 2007; Gordon *et al.* 2007). The

Table 1

Contributions to Percent Change in Real GSP, 2004–2005

State and region	US	Southeast	Louisiana
Agriculture, forestry, fishing and hunting	– 0.05	– 0.01	– 0.05
Mining	– 0.04	– 0.12	– 1.66
Utilities	0.01	0.00	– 0.07
Construction	0.13	0.27	– 0.07
Durable goods manufacturing	0.40	0.37	– 0.04
Non-durable goods manufacturing	0.08	0.08	0.48
Wholesale trade	0.07	0.13	– 0.04
Retail trade	0.20	0.32	0.03
Transportation and ware-housing	0.11	0.11	0.02
Information	0.34	0.40	0.14
Finance and insurance	0.54	0.54	0.22
Real estate, rental and leasing	0.32	0.67	– 0.41
Professional and technical services	0.48	0.47	– 0.13
Management of companies	0.01	0.04	0.05
Administrative and waste services	0.21	0.32	0.19
Educational services	0.01	0.01	– 0.02
Health care and social assistance	0.33	0.34	– 0.08
Arts, entertainment, and recreation	0.02	0.03	– 0.05
Accommodations and food services	0.13	0.17	0.00
Other services	0.06	0.06	– 0.06
Government	0.18	0.41	0.07
Total	3.60	4.60	– 1.50

Notes: Real GSP is adjusted based on 2000 dollars. The Southeast region includes Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and West Virginia.

Source: US Bureau of Economic Analysis.

approach allows the estimated coefficients to change gradually over time, based on data for previous periods and exponentially declining weights. Based on the estimated coefficients, the forecast oil-refinery industry values are obtained at the end of 2005 (August to December) and for first three quarters of 2006. Direct impacts are calculated from the difference between the actual and predicted production of oil-refinery activities.

Second, FlexNIEMO was used to construct monthly versions of the supply-side NIEMO. The approach developed by Park *et al.* (2007b) allows the fixed coefficients in the input-output world to be continuously modified, reflecting previous economic events and interindustry substitutions. Because oil-refinery products are important to supporting the economy in the Gulf of Mexico and the United States, the supply-side NIEMO approach is helpful. One problem is how to adjust the supply-side model to reflect demand-side adjustments during the recovery period. The analysis combines the demand-driven NIEMO described in Park *et al.* (2007a) with the supply-side NIEMO in Park (2006). This solution overcomes some of the major shortcomings inherent in the IO model. The model aggregated 52 regions to 47 regions, because the Gulf of Mexico corresponds to six states, and treated the Gulf of Mexico as one region. Therefore, the newly defined NIEMO has (47x47)x(47x47) different coefficients for each month (August 2005 to September 2006) after hurricane Katrina for 47 regions and 47 sectors.

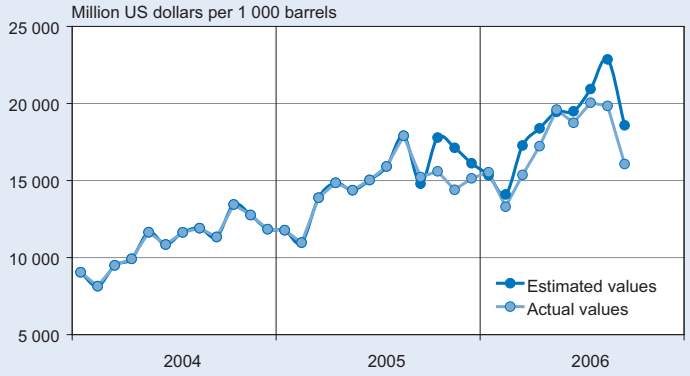
Results

Figure 4 shows the 13 months of forecasts using the Holt-Winters method, which is adjusted monthly. The R-Square is 87 percent and Theil's U statistic which summarizes the forecasting accuracy show 0.071. Because the U statistic is close to 0 and the U of no predictive power is 1 (Theil 1966; Maddala 1977), the forecasts are statistically acceptable.

The analysis here has concentrated on the total business interruption impacts of the hurricanes on the dominant sector (oil refining) by using a multiregional input-output model (NIEMO). These amounted to 8.28 billion US dollars in the first year after the hurricanes; even in September 2006 actual

Figure 4

CHANGES OF ACTUAL AND ESTIMATED OIL-REFINERY VALUES: PADD III



Sources: EIA; authors' calculation.

output remained below estimated output from a forecasting model. Using the other variant of the model (FlexNIEMO) which allows for input substitutions in response to changes in relative prices, the total impacts fall to 4.85 billion US dollars. As for the state-by-state impacts, not surprisingly, most occurred in the Gulf states – more than 92 percent. Similarly, because oil refining has few interrelationships with other sectors, almost all the sectoral impacts (98.04 percent) are restricted to the oil sector. The primary policy implication from the analysis is that the business interruption costs from the hurricanes (and from the more recent Gulf oil spill) provide an upper threshold on how much policymakers might pay to prevent and/or mitigate similar events. The difference in the results from an application of NIEMO and an application of FlexNIEMO are dramatic. The original model estimates an overall multiplier of 1.83 while the new results indicate a much smaller multiplier, 1.07.

Impact modeling using widely available input-output approaches routinely includes the caveat about the fixed technologies assumption and how that overstates the estimated results. We have adapted a new and operational multiregional input-output model of the US NIEMO, to analyze substitutions and have considered their scale and scope for the case of oil and gas refinery losses in the Gulf of Mexico following hurricanes Katrina and Rita in late 2005. The results suggest that a detailed study of substitutability is useful because overstated impacts from the application of conventional IO are substantial. NIEMO generates millions of multipliers that remain to be explored at the individual sector level, by month, sector and region. This is in the tradition of input-output structural decomposition analysis (see Rose and Casler 1996).

Recent developments

Prior to the Gulf oil spill of April 2010, New Orleans was finally beginning to recover. This paper does not deal with the most recent events, but this *New York Times* quotation (7 May 2010) offers a good summary: "since the Saints won the upon the backdrop of Mardi Gras, followed by the landslide election of a popular new mayor, New Orleans had been, by all accounts, getting its groove back. Five years removed from hurricane Katrina, the tangible signs of a real recovery are everywhere: in rebuilt homes and refurbished parks, in old restaurants come back to life and in new businesses thriving". The consequences of the oil spill are still unclear, especially in terms of its impact on seafood and tourism, but appear to get worse day by day. Only 20 percent of the seafood Americans eat is domestic, but most of it comes from either Alaska or Louisiana. The shrimp industry alone, which produced 90 million pounds in 2008, brings in 1.3 billion US dollars a year.

Other issues

Although this paper primarily focuses on the short-term (typically 2005–2006) economic impacts of the hurricanes, especially as they affected the dominant industry of oil refining, there are some other policy issues that merit attention, even if briefly.

One important item is the reconstruction of the levees in New Orleans by the US Army Corps of Engineers. Presumably because of budget constraints, they are rebuilding only to category 3 hurricane standards. This makes little sense because a category 5 hurricane is possible, even likely at some time. A related problem is the lack of back-up electricity generators for the pumping stations. The failure of these was a primary factor in the severity of the flooding.

Yet another problem is the defects in the insurance system (Kunreuther and Michel-Kerjan, 2008). The

scale of hurricane Katrina made the defects in catastrophe insurance obvious. There needs to be a major shift to risk-based premiums, an incentives scheme to encourage firms and households to invest in mitigation measures, and to deal with equity issues via some kind of subsidy program but not by subsidizing insurance premiums.

The housing issue which has still not been resolved is critical because it has affected the lives of so many people. More than 200,000 structures were damaged, most of them because of severe flooding resulting from the levees. Of these structures, well more than one-half were housing units, about evenly split between owner-occupied rental housing (approximately 67,000 of each). According to the US Department of Housing and Urban Development (HUD), 71.5 percent of the occupied units in Orleans Parish (the city) were damaged and 41.9 percent were severely damaged or destroyed. In the five most impacted counties 305,000 units were damaged, i.e. 65.1 percent of the occupied housing stock, and 22 percent were severely damaged or destroyed. In New Orleans itself only 3 high-lying neighborhoods out of 14 avoided severe damage to rental housing and not a single neighborhood (Bostic and Molaison 2008).

Housing damage was the primary factor explaining the population loss of the City of New Orleans from 458,000 prior to Katrina to a post-Katrina low of 137,000 four months later. After that, it began to recover but slowly and still remains below its peak. The population loss was not confined to the city alone. Population declined in other parishes outside the city, in one case – St. Bernard Parish – even more than in New Orleans itself (by 80 percent in the first six months compared with 60 percent in New Orleans itself – see Bostic and Molaison 2008). Not surprisingly, the situation stimulated a surge in repair, reconstruction and new construction and an inundation of workers, many of them Latino. The associated demand of non-resident workers for rental accommodation made the housing problem even worse.

As for tourism (the second most important sector), Mardi Gras made a partial recovery in 2006. Some of the parades were cancelled (six fewer parades in Orleans Parish, with an average of three fewer floats on each parade) and hotel occupancy rates were about 25 percent below the festival rates in 2005 (Deloughery 2008). In March 2006, hotel and restaurant employment was about 70 percent of the pre-Katrina level. Nevertheless, the comeback was quite surprising. The explanation was that the high-lying French Quarter escaped serious flood damage, although some hotels and restaurants were damaged by wind and activities were impeded in the short run by power outages and other inconveniences. Attendance in the last weekend of the 2006 Mardi Gras was 70 percent of the 2005 level (about 700,000). In 2007, it was about 100,000 more. By 2010, however, all three major festivals (Mardi Gras, the Essence and Jazz Festivals) achieved record attendances. As suggested above, it is unclear whether these performances will be repeated in 2011 because the short-term future of seafood production (that plays such an important role in New Orleans tourism) is in doubt as a result of the new disaster, the Gulf oil spill of April 2010.

Conclusions

This paper's primary focus has been the economic impacts of hurricane Katrina (and, to a lesser extent, Rita) in the first year aftermath. From then on, the emphasis was on social and economic reconstruction and recovery. Of course, these had economic impacts. A common argument in both natural and manmade disaster discussions is that such disasters are over time a 'wash' because the positive subsequent recovery impacts more or less balance out the negative initial disaster impacts. However, the problem with this approach is that it neglects the opportunity costs of the resources used in the recovery efforts. The implication is that including recovery activities among the favorable economic impacts associated with a disaster is misleading, if not downright wrong.

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