Measuring the Regional Economic Response to Hurricane Katrina

Bradley T. Ewing*,
Jamie B. Kruse** and
Mark A. Thompson*

Introduction

Catastrophic events such as natural disasters have an enormous impact on regional economies. In fact, a vast literature on the economic impact of hurricanes, tornadoes and other disasters exists (Ewing, Kruse and Sutter 2007). A strand of this research utilizes regional labor market and output measures as indicators of regional well-being and recovery. In particular, many time series econometric studies examine the economic impacts by comparing pre- and post-disaster periods, primarily using variations of event study techniques and intervention analysis. As such, previous researchers have generally focused on obtaining post-event periods that were as long as possible in order to increase the number of post-disaster data points. One drawback of the event study line of research is that it does not provide 'real time' assessments of the impact of major disasters. Another issue deals with the choice of the appropriate performance measure to capture the economic condition of the region. In this paper, we illustrate how the use of regional-level (i.e. US state) coincident indexes may be used to infer the extent and magnitude of a natural disaster on a local economy.

A number of time series studies have examined the impact of tornadoes and hurricanes using monthly labor market data (Ewing and Kruse 2001 and 2002; Ewing, Kruse and Thompson 2003, 2004, 2005a, 2005b and 2009). While employment-related data is timely and regionally defined, by definition it is a measure of the labor market and not of the overall economy, although the two are certainly related (Ewing, Kruse and Thompson 2003 and 2004; Skidmore and Toya 2002). Thus, one shortcoming to using employment or unemployment rate data to infer overall economic impact is that it does not account for payroll or wages, thus treating all jobs equally and inherently treating the consumption functions of various institutions and households as homogeneous. In this respect, the labor market approach, while informative, does not capture the typical multiplier effects that one might find estimated in input-output regional economic models.

On the other hand, gross domestic product (GDP) does measure the performance of the overall economy but is released on a quarterly basis at the national (US) level and only annually at state and regional levels (as defined by the US Bureau of Economic Analysis and the US Bureau of Labor Statistics). Quarterly and annual frequencies can be problematic when estimating the economic impact of disasters since differences in the immediate and longer-term effects have been found to exist (Ewing, Kruse and Thompson 2009). Furthermore, GDP metrics at the state and regional level often lag two to three years, further compounding the measurement problem. The lack of timely information could lead policymakers into making poor or suboptimal resource allocation decisions.

One approach to resolve these issues combines several regional economic indicators into a composite index that can be tracked through the business cycle. The composite index offers the potential of better and, possibly, more complete information on the condition of the economy than individual economic indicators and would be more current than GDP estimates. Consequently, a properly constructed composite index more closely captures elements of the overall economic well-being of a region than using a single labor market measure and, simultaneously, is timelier than using a single output measure such as gross product.

* Texas Tech University.
** National Oceanic and Atmospheric Administration, Silver Springs, Maryland.

Recently, Crone and Clayton-Matthews (2005) developed a consistent set of US state-level coincident indexes that are now produced by the Federal Reserve Bank of Philadelphia. Thompson (2009) provided an example of how such a state-level index could be used to measure the effect of a disaster and the subsequent regional economic response. In particular, Thompson (2009) focused on Louisiana's economy and hurricane Katrina, which made its first landfall in southern Florida as a category one storm, moved into the Gulf of Mexico where it intensified, and made its second landfall 29 August 2005 near the Louisiana-Mississippi border as a category four storm. This paper updates and expands the work of Thompson (2009) and examines what, if any, effect Katrina had on other states along the gulf coast.

Hurricane Katrina and the economy

The Federal Response to Hurricane Katrina: Lessons Learned (2006) reports that the economic cost of hurricane Katrina was nearly 100 billion US dollars making it the most costly US disaster in terms of economic losses. These losses resulted from a major disruption in economic activity and physical damage to infrastructure and homes. While previous studies provided information as to the economic impact on New Orleans (Guimaraes *et al.* 1993; West and Lenze 1994), the shear size and magnitude of Katrina on such a major city required policymakers to make immediate decisions with respect to recovery. For this type of situation, timely and relevant information is required.

Certainly, a number of factors help to determine the impact of a hurricane on a regional economy including the severity of the storm and its atmospheric characteristics, the built environment and the area's economic structure. Ewing, Kruse and Sutter (2007) provide a thorough review of the economic research on hurricanes and describe various approaches to modeling disasters. They conclude that valuable information can be derived from a variety of models; however, certain decisions must be made in a short time frame and thus sources of timely information is necessary for efficient resource allocation.

The short-term disruption from a hurricane may result in out-migration from the affected region to another area and the resulting loss in human capital may hinder future growth and recovery (Landry *et al.* 2007). Standard macroeconomic theory highlights how the losses in physical and human capital place a drag on long-term growth and potential output of the region. However, there is an inflow of financial assistance from insurance to federal, state and local aid. Additionally, following a disaster, the rebuilding of infrastructure, networks, and the installation and implementation of new technology may lead to higher growth over time. Moreover, the economic improvement may spread to connecting regions. Ewing, Kruse and Thompson (2005b) document this effect following the 1999 Oklahoma City tornado outbreak. They attribute much of this economic change to improvements to the supply chain.

The approach of this paper is to examine the behavior of the Louisiana state coincident index to determine the change in economic activity immediately following hurricane Katrina. The recovery process is followed through time to capture a sense of the longer-term or ongoing effects of the hurricane on the state. Additionally, the corresponding coincident indexes of the other Gulf Coast states are tracked to see the impact of Katrina and to document the extent to which the impacts, both immediate and ongoing, may have played out in the economic activities of those states.

Index composition

Regional policymakers need accurate and timely information on the current state of the economy for planning purposes. According to Crone (2006), state and regional markets may not follow national trends and cycles. Moreover, natural disasters are regionally-specific events placing even greater importance on accurate models of the regional economy for planning purposes. While hurricane Katrina was a major storm, its impact is still relatively regional to the gulf coast states of the United States. As previously mentioned, such comprehensive measures of the economy are often inadequate for timely regional information as to the impact of the storm. Due to these shortcomings, a composite index of several regional economic indicators may provide a better and timelier measure of the regional business cycle and its response to a disaster.

The approach that Crone and Clayton-Matthews take is based on the Stock and Watson (1989) dynamic single-factor model. The dynamic single-factor model is a variation of principal component or

factor analysis, where the resulting index represents the underlying state of the economy. The structure of the model is as follows:

$$(1) \quad \Delta x_t = \alpha + \beta(L)\Delta s_t + \mu_t$$

$$(2) \quad D(L)\mu_t = \varepsilon_t$$

$$(3) \quad \phi(L)\Delta s_t = \delta + \eta_t$$

where x_t is the logarithm of the observed variable in period t, s_t is the logarithm of the state variable to be estimated (i.e. the common factor), and L represents the lag operator.

The idiosyncratic components in the measurement equations from (1) follow an autoregressive process and are uncorrelated with one another. In particular to developing a consistent set of state-level indexes, Crone and Clayton-Matthews (2005) use employment, unemployment, hours worked in manufacturing, and real wages as the measurement variables in equation (1). The underlying state of the economy is represented by the state variable s_t and the final index sets the estimated state variable to 100 (for a given date). Crone and Clayton-Matthews (2005) retrend each index to the respective state GDP trend to allow for comparisons across states.

Each month, the Federal Reserve Bank of Philadelphia produces the 50 state coincident indexes. It is also worth noting that the indexes are re-estimated each month with the revised data. Below, we use the state coincident index to examine how Louisiana's economy responded before and after hurricane Katrina. In addition, we examine how other gulf coast states responded.

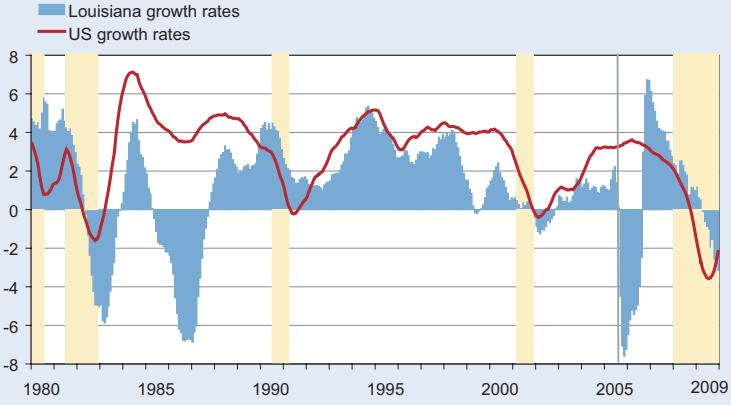
Louisiana's state coincident index and hurricane Katrina

Figure 1 illustrates the growth in economic activity for Louisiana and the United States using the index produced by the Federal Reserve Bank of Philadelphia. From the figure, it is clear that the state and national economy do not always move together further emphasizing the need to have regional-specific measures of the economy. The figure also highlights the severity of hurricane Katrina relative to past recessions.

Table 1 provides a comparison between Louisiana's economic activity and that of the United States during the past five national recessions as noted by the National Bureau of Economic Research (NBER). In addition, note that Louisiana's economy did not experience a decline in economic activity as the national economy entered two recessions (i.e. the 1980 and the 1990–91 recessions). With respect to the 1981 recession, Louisiana's economy lagged the national economy by seven months going into the recession and about six months coming out of the recession. While both the Louisiana and national economy entered the 2001 recession at the same time, the Louisiana economy lagged the US economy by six months in coming out of the recession. The NBER indicated that the latest recession started in December 2007; however, Louisiana peaked in January 2009 and has declined in economic activity every month thereafter (to the end of the sample period). Crone (2006) points outs that most states do not always follow the national business cycle – Louisiana does not simply mirror the behavior of the national economy.

Since states may not necessarily follow the national economy, their response to natural disasters may differ as well. Table 1 illustrates the timing of hurricane Katrina. The Louisiana economy declined for three months following the hurricane. Using the index, we can measure how long it took for the state economy to recover to its pre-hurricane level. Following hurricane Katrina, the Louisiana index dropped to

Figure 1



Notes: The grey vertical line shows the hurricane Katrina date. The yellow areas represent NBER recession dates.

Sources: Federal Reserve Bank of Philadelphia; NBER.

Table 1

Peak to trough dates for Louisiana state coincident index

	State coincident index	Official US recession	Hurricane
Peak to trough	–	1/1980 – 7/1980	
Peak to trough	2/1982 – 5/1983	7/1981 – 11/1982	
Peak to trough	–	7/1990 – 3/1991	
Peak to trough	3/2001 – 5/2002	3/2001 – 11/2001	
Peak to trough	1/2009 –	12/2007 –	
Katrina to trough	8/2005 – 11/2005		8/2005
Trough to pre-Katrina	11/2005 – 1/2007		

Sources: Federal Reserve Bank of Philadelphia; NBER.

120.91 in September from 126.36 in August 2005. The index continued to decline until its trough in November 2005. The magnitude of the decline equates to a 6.7 percent drop in overall economic activity or the equivalent of an index reading from June 1997 (November 2005 index = 117.84). Alternatively, Katrina destroyed approximately eight years of economic progress in Louisiana. Over the next 14 months, the index reverts back to its pre-Katrina level of 126.62. From trough to pre-hurricane level, it took 14 months to recover.

Hurricane Katrina and the other gulf coast state coincident indexes

Figure 2 shows the state-level coincident indexes for each of the gulf coast states: Florida, Alabama, Mississippi, Louisiana and Texas. Using the state coincident indexes to examine how the other gulf coast states responded to hurricane Katrina, it is seen that only Mississippi shows signs of having been impacted by the hurricane in terms of state economic activity. According to the state coincident index, Mississippi's economic activity dropped 1.11 percent following the hurricane. However, by the end of 2005, Mississippi was back to pre-hurricane index levels. None of the other gulf coast states experienced significant drops in economic activity following the hurricane.

With the exception of Mississippi, there does not appear to be a significant drop in economic activity for the other gulf coast states. However, Katrina may have altered the structure of the supply chain and/or economic landscape in other ways. If so, then the state coincident indexes may exhibit different behaviors following the hurricane, indicative of underlying structural changes in the economy. The monthly index values may be used to track how gulf coast states co-move before and after hurricane Katrina. One way to measure the co-movement between states is to compute the proportion of time that the two states spend in the same business cycle phase. The simple non-parametric statistic known as 'concordance' may be used for this exercise and is calculated as follows:

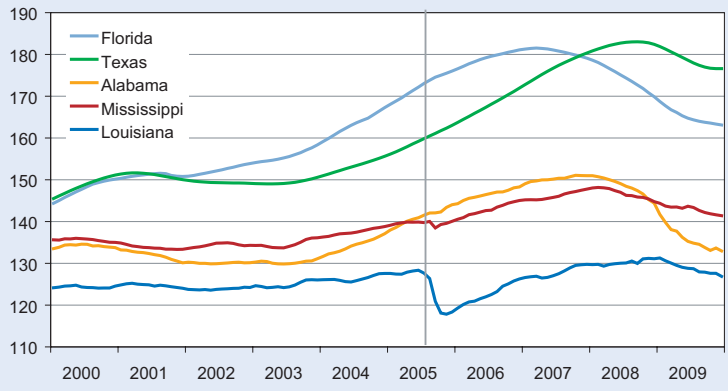
$$(4) \quad C_{i,j} = \frac{\sum_{t=1}^{T}\left(\left(S_{i,t}S_{j,t}\right) + \left(1-S_{i,t}\right)\left(1-S_{j,t}\right)\right)}{T}$$

where T is the sample size and $S_{i,t}$ $(S_{j,t})$ is a binary indicator series where the value is one when the respective i (j) state index is expanding and zero when contracting.

Table 2 reports the degree of concordance between Louisiana and the other gulf coast states before and after hurricane Katrina. Prior to Katrina, there was a relatively high degree of co-movement among

Figure 2

COINCIDENT INDEX FOR GULF COAST STATES



Note: The grey vertical line shows the hurricane Katrina date.

Source: Federal Reserve Bank of Philadelphia.

Table 2

Degree of concordance (C_{ij})

j-States	Pre-Katrina	Post-Katrina
Mississippi	0.76	0.59
Alabama	0.78	0.51
Florida	0.95	0.38
Texas	0.84	0.74

Note: The degree of concordance is the percentage of time that the two states, Louisiana and state j (i.e. j = Mississippi, Alabama, Florida and Texas), are in the same phase.

Source: Authors' calculation.

Louisiana and the other gulf coast states. Even though Florida is not a border state with Louisiana, they tended to move together most of the time (i.e. 95 percent of the time). However, the degree of co-movement among the gulf coast states (with Louisiana) has declined considerably following the hurricane. Most notably, Florida and Louisiana are in the same business cycle phase just 38 percent of the time.

The change in co-movements between Louisiana and the other gulf coast states is consistent with a major shift in economic relationships. In fact, the decline in co-movements ranges from 12 to 60 percent. In particular, this finding is in line with the earlier work on disasters altering supply chains. Thus, at least in the relatively short term, the destruction of the economic landscape resulting from hurricane Katrina appears to have isolated the state of Louisiana from the other gulf coast states. It remains to be seen if a re-building of the region will increase the linkages to pre-storm levels.

Concluding remarks

This paper examined the use of state level composite indexes for providing timely information as to the economic response of a region to natural disasters. It is shown how the state index can capture the economic condition of a region and subsequently be used to measure the extent and magnitude of a catastrophic event on economic activity. In particular, the economic activity of Louisiana and the gulf coast states were seen to have changed following hurricane Katrina. Moreover, the results are consistent with the devastation of Katrina altering the underlying structure and/or supply chain of the region.

Policymakers can make more informed decisions with objective or quantifiable data to facilitate a more efficient recovery process. One such example may be the media and news story about the increases in tax revenues during the recovery process in Louisiana (Eaton 2006). A state revenue forecaster and subsequent policymakers may be interested in knowing if this increase in tax revenues is a one-time windfall or a longer-term gain due to the implications on fiscal budgeting and planning. Use of regional/state coincident indexes may shed light on this question in a more timely fashion given the use of monthly vs. yearly data. In the case of Louisiana, the index rebounded to its pre-Katrina level and thus the observed surge in tax revenues were probably due to the purchase of replacement goods as opposed to a permanent increase in consumer spending.

Economic models for assessing the impact and response of a region to a catastrophic event should be both timely and able to capture the broad economic condition of the affected area. However, these two simple goals are not always met as broad measures of economic activity (e.g. GDP) are available only at annual frequencies whereas more timely (i.e. monthly) measures of economic performance are often narrowly defined (e.g. unemployment).

This research demonstrated the use of the Federal Reserve Bank of Philadelphia's state coincident indexes for modeling economic activity in the gulf coast states for the case of hurricane Katrina. The approach provides a broader and timelier estimate as to the overall economic disruption and subsequent response to a major hurricane than the use of state GDP or single-variable labor market indicators. The findings are encouraging and suggest that regional composite indexes may be used to complement standard measures of economic impact and recovery.

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