FOCUS ON REAL ESTATE ANALYSIS

How Major Hurricanes Impact Housing Prices and Transaction Volume

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WE SEEK TO INVESTIGATE THE EXTENT TO WHICH COASTAL impacts of major[1] hurricanes may affect short- and medium-term housing prices. Our investigation is largely motivated by the increased strength and frequency of storms threatening the eastern and southeastern United States. Namely, several major hurricanes have recently impacted the Gulf of Mexico region and the Eastern Seaboard causing billions of dollars in damages. Escalating worldwide focus on global warming and other potential causes of this increased meteorological activity has not altered the contention by meteorologists that this is not an aberration. On the contrary, widespread expectation of future storm seasons characterized by above-average frequency, strength and duration of hurricane-level storms remains the consensus. It follows then that a better understanding of the economic impact of these storms is a beneficial contribution to real estate literature.

CONVENTIONAL WISDOM AND THE POPULAR PRESS

Conventional wisdom and the popular press suggest that a noticeable shock to the housing industry is to be expected after a major hurricane. How that shock plays out, however, is not so clear. Following the recent sequence of highly active storm seasons, the popular press published mixed opinions regarding the repercussions these storms might have on real estate markets sustaining substantial damage. Generally speaking, press articles imply the reaction in residential real estate to major storms takes the form of a bubble. That is, markets surge from a housing shortage immediately following a storm, and then correct in the medium term as supply gradually returns to prior

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levels. For example, Katrina, the most notorious of these recent storms hit New Orleans in August 2005. Rich (2005) suggests that storms like Katrina are a stimulus to local real estate. Pointing to frenzied buying activity as people left homeless scramble to secure a residence, the shortage of building supplies driving up housing costs, and out-of-state investors buying in droves, Rich paints a rosy picture of real estate markets impacted by a major storm.

Roney (2007) also points to an initial surge in residential real estate, quoting the National Association of REALTORS® (NAR) as her source for median home sale prices jumping more than 8.7 percent in the New Orleans area immediately following Katrina. Roney then backtracks, however, suggesting that home prices rose only as a direct result of federal and state aid for the multi-billion dollar damage left in the wake of the storm. She cites a subsequent price correction of 6.7 percent as evidence of the unpredictability of home values. Bajaj (2007) explains this drop by quoting Jan Hatzius, a Goldman Sachs economist, as saying that prices have fallen in the past year to correct for a surge immediately after Katrina, again suggestive of a bubble pattern.

Not all press articles project a bubble reaction, however. Keegan (2005) points to his personal experience with Hugo in 1989 and its impact on the Charleston, S.C. region, observing a massive and lengthy recovery effort after substantial devastation in the region. He also points to panhandle and central communities in Florida "still reeling" a year after storms ravaged these areas. Nonetheless, even if it belies conventional wisdom, practitioners and academics alike might be interested to know what the data collected surrounding these events do suggest.

PRIOR ACADEMIC RESEARCH

Conventional wisdom and popular press articles aside, existing academic research on this subject is sparse. In fact, very little in academic or practitioner real estate journals has addressed natural disasters and their impact on residential prices.

Hallstrom and Smith (2005) hypothesize that housing values respond to information about new hurricanes. Using a difference-in-differences framework based on the 1992 storm, Andrew (one of the strongest storms to ever hit the U.S.), they find a proximity effect where homeowners respond to information conveyed by storms passing nearby and subsequently observe prices dip as much as 19 percent, in spite of missing that residential area. Bin and Polasky (2004) conduct a highly regionalized study examining the home price differential for Pitt County, N.C. homes located in flood zones ex-ante and ex-post hurricane Floyd. They find the discount of residential property values for homes located in floodplains significantly increased after the 1999 major storm and its associated flood damage to those homes.

Counter to Bin and Polasky, however, Speyrer and Ragas (1991) find repeated flooding does not continue to reduce prices, suggesting the market is relatively efficient in discounting the risk of repeat floods. Consistent with prior studies, Speyrer and Ragas find homes located in floodplains do experience lower property values than comparable homes not located in floodplains. New to their study, however, they determine that a large part of the price reduction is a direct result of mandated flood insurance as required by The Flood Disaster Protection Act of 1973. This Act requires Federal Standard Flood Insurance coverage for homes in certain zones. Accordingly, real estate pricing in our study should not be sensitive to zones, as this information should already be incorporated in price data.

A DIFFERENT APPROACH

Our contribution to this area of research is unique, first, because of our ability to look at Zip Code-level data. Most prior studies employ MSA-level (Metropolitan Statistical Area) or state-level data, neither of which allows for the precision obtained by a Zip Code-level analysis. Second, by examining the impact from several major hurricanes in a relatively constrained time period, we eliminate some of the variability of macroeconomic factors over time that could potentially affect results. Conversely, where some studies have considered only data from one or two storms during a brief interval (or even two unrelated intervals) taking our data from several hurricanes over a continual, but longer period generates less bias in the data. Finally, by considering several measures (price per square foot and transaction volume, in addition to raw price change differences), we aim to generate more comprehensive and definitive results.

In sum, we explore the sensitivity of median U.S. home prices and volume to the impact of major hurricanes, at the Zip Code level. Specifically, we examine quarterly changes in residential real estate price and volume following a major hurricane impact, and we test whether these particular Zip Code quarterly changes differ significantly from changes occurring in the rest of the state over the same time periods. In this way, we account for the rapid growth in population and associated increasing price trend occurring over this timeframe in the coastal states we examine.

We find some evidence from our three measures suggesting that during the first two quarters following a major hurricane, changes in home prices and transaction volume in the affected Zip Codes experience a temporary relative decline, followed by a positive correction. This temporary dip and bounce-back pattern exhibits characteristics resembling a short-term reversal consistent with the overreaction hypothesis, as often applied to financial market events. When looking at one full year following a hurricane, however, we see some evidence that areas hit by hurricanes outperform comparable areas not affected by the storm, a counterintuitive result.

DATA COLLECTION

To glean impacts on pricing and volume, we utilize quarterly median sales prices for single-family homes reported by U.S. postal Zip Code. Our Zip Code level data set was purchased from American Real Estate Solutions and includes over 3,000 Zip Codes. For each Zip Code, at least 20 quarterly median home price observations are available between the fourth quarter of 2000 and the fourth quarter of 2006, or a total of over 60,000 individual quarterly observations. Such a powerful data set permits greater precision than many prior real estate studies which are often limited to the use of MSA-level or state-level data. Further, the frequent observations allow a better time-lapse reflection of what actually happens with prices over time as opposed to yearly observations as is typically seen in real estate research.

Our use of quarterly data also imposes some burdens, however, in terms of the data's time series properties and resulting implications for estimation. First, our dependent variable is likely to display significant autocorrelation. Observed autocorrelation can be due to both fundamental factors and measurement biases. Fundamental factors include the tendency for some housing markets to display short-term momentum in home price movements, while others show fundamental mean reversion.

In addition to fundamental autocorrelation in "true" home price movements or in home price index changes measured by carefully constructed repeat-sales methods, autocorrelation in changes in observed median home prices could be induced by changes in the characteristics of home sales and their cross-sectional composition within a Zip Code. Specifically, if the distribution of homes sold within a Zip Code for a particular calendar quarter were skewed positively in terms of unobserved quality dimensions (e.g., date and quality of construction) relative to all homes within the Zip Code, the current quarter's observed median home price and price change relative to the prior quarter would be biased upwardly, and the subsequent period's observed price change would be biased downwardly. The opposite would occur if a quarter's sample of home sales were skewed negatively relative to average quality of all homes within a Zip Code. This kind of measurement-error induced autocorrelation, similar to so-called bid-ask price bounce errors in observed stock prices, would tend to induce negative autocorrelation in home price changes across calendar quarters.[2]

A further limitation of using quarterly home price data is that homes are sold throughout a calendar quarter with identification of the median price of all home sales based on all such sales within a quarter. The six major hurricanes we examine impact the coastline at different times during the quarter. Consequently, our Zip Code level median home prices for the quarter in which the natural event occurs are likely to be inclusive of home price changes surrounding the date of the hurricane impact. We define impacted Zip Codes as those where the eye of the major storm crossed directly through the region, retaining sustained winds measuring at least 55 knots.[3]

We identify major hurricanes impacting the U.S. coastline during the period for which we have Zip Code-level data using National Oceanic and Atmospheric Administration (NOAA) hurricane data, available on its website. As a part of NOAA, the National Hurricane Center is the central authority in predicting, monitoring and tracking tropical depressions, storms, and hurricanes in the North Atlantic basin. Of all the Atlantic-based storms originating between 2001 and 2005, only six storms qualify for our study due to Zip Code data limitations. In chronological order, these are Charley, Frances, Jeanne, Dennis, Katrina, and Wilma, all of which struck between August 2004 and October 2005. Damage from these hurricanes ranged from just over $2 billion (Dennis) to over $80 billion

(Katrina). Geographically, these storms limit our study to Florida impacts in 2004 (Charley[4], Frances and Jeanne) and 2005 (Dennis and Wilma), and the one big gulf-coast storm, Katrina, in 2005.

To maximize accuracy in identifying affected Zip Codes, we recreate unique detailed storm tracks and overlay these on Google Earth images of the impact zones. To recreate these tracks and gauge intensity levels with precision, we use the exact geographical coordinates of these storms as tracked and measured by NOAA at fixed time intervals, as well as multiple records of sustained wind speeds detected at various weather stations. The Google Earth images from U.S. military satellite imaging also show Zip Code border outlines. Thus, with geographically precise storm tracks and associated sustained wind speeds, we can then employ a duplicate-matching method to locate and confirm those Zip Codes directly under the path of the eye of the storm. The result is a unique set of hand-compiled data which, although limited in scope, makes a detailed examination possible for several natural and unpredictable events. After imposing the 55-knot minimum sustained wind-speed condition on available matching data, the final set includes 52 Zip Codes from our Zip Code-level data set.

Table I displays some descriptive statistics on this sample of Zip Codes. The six major hurricanes in our sample are distributed across 52 Zip Codes encompassing nearly 11,000 transactions over our study period. Of the 52 Zip Codes, four were impacted twice as a result of Frances and Jeanne in 2004. We matched each of these Zip Codes with their respective states using the www.zip-code.com website.

METHODOLOGY

To gauge the effect that hurricanes included in our study have on the housing market, we employ three core variables taken from our Zip Code-level data set. These variables are median sales price (PRICE), median sales price per square foot (PPSF) and transaction volume (VOL), as measured on a quarterly basis. Changes in these variables around the natural event should indicate any significant positive or negative deviations over time, when the changes for Zip Codes affected by the hurricanes are compared to changes for a control group.

Specifically, we adjust the quarterly changes in these three variables to control for seasonality effects as well as the overall housing trend in the surrounding areas during a given time period. Our adjustments are made by first pairing each hurricane-affected Zip Code with its particular state. Then, we find the difference between the variable change (percentage change from the previous quarter) in each affected Zip Code and the variable change in its paired state data. We refer to this difference in quarterly changes as the *adjusted difference* (denoted) for each of our three price and transaction volume variables.

Table I

Descriptive Statistics

Number of affected Zip Codes	**52 (4 were hit twice)**
Total number of transactions *	**10,759**
Number of hurricanes	**6**
Average median home price across Zip Codes *	**$239,016 ($148,982)**
Range of median home price *	**$60,750 – $889,450**
Average median price per square foot across Zip Codes *	**$123.68 (69.10)**
Range of median price per square foot *	**$59.37 – $432.43**
Average number of sales per Zip Code *	**206.90 (176.62)**
Range of number of sales per Zip Code *	**14 – 779**
Hurricanes time span	**August 2004 to October 2005**

Note: This table shows descriptive statistics of the major data items we use in this study. The notation * next to a variable indicates that the statistics is for the quarter in which the hurricane occurred. Figures in parenthesis are the standard deviations of the variable.

Finally, to derive the adjusted difference for each variable, we average these adjusted differences across all Zip Codes. These state-adjusted values draw a direct comparison of quarterly sales price and transaction volume changes in the affected Zip Codes with quarterly changes in Zip Codes statewide. More formally, we measure:

$$ADJ\Delta PRICE_{t,i} = \Delta PRICE_{t,i} - \Delta ST\_PRICE_{t,i} \quad (1)$$
$$ADJ\Delta PPSF_{t,i} = \Delta PPSF_{t,i} - \Delta ST\_PPSF_{t,i} \quad (2)$$
$$ADJ\Delta VOL_{t,i} = \Delta VOL_{t,i} - \Delta ST\_VOL_{t,i} \quad (3)$$

where $ADJ\Delta PRICE_{t,i}$, $\Delta PPSF_{t,i}$, and $\Delta VOL_{t,i}$ are the quarterly changes in median sales price, median sales price per square foot and transaction volume, respectively, for Zip Code i, from time t-1 to t-0. Similarly, $\Delta PRICE_{t,i}$, $\Delta ST\_PPSF_{t,i}$, and $\Delta ST\_VOL_{t,i}$ are the quarterly changes in median sales price, median sales price per square foot and transaction volume, respectively, for the state including Zip Code i, from time t-1 to t-0. Time t-0 is defined as the quarter in which the hurricane occurred. Thus, a $\Delta PRICE_{t,i}$ value measures from the prior quarter to the current quarter, t. Using the adjusted differences for each of these variables found with equations (1), (2) and (3), we evaluate five subsequent quarters beginning with the quarter in which the major hurricane hit (t-0) and ending four quarters later (time t+4). In this way, we examine both short and medium term effects.

To capture the short-term impact of these major hurricanes on residential properties directly affected, we first compare the arithmetic average of all the adjusted differences generated by equations (1), (2) and (3) across time periods using a two-sample mean comparison test. This quickly allows us to observe any statistically significant increase or decrease in the average adjusted difference for each variable, around the event date.

To further assess short term impact on residential property markets, we also use linear regression analysis to observe adjusted differences for each of our three variables around the hurricane event. Linear regression analysis allows us to emphasize changes in differences for each of the affected Zip Codes rather than changes in differences across all 52 Zip Codes in our sample. Accordingly, for each variable, we regress percentage changes in adjusted differences during a given quarter (dependent variable) on the previous quarter's percentage changes in adjusted differences (independent variable) to identify significant differences over time. More formally, we define these regressions as:

$$ADJ\Delta PRICE_{t,+1,i} = a + \beta ADJ\Delta PRICE_{t,i} \quad (4)$$
$$ADJ\Delta PPSF_{t,+1,i} = a + \beta ADJ\Delta PPSF_{t,i} \quad (5)$$
$$ADJ\Delta VOL_{t,+1,i} = a + \beta ADJ\Delta VOL_{t,i} \quad (6)$$

where a statistically significant positive or negative beta coefficient in any of the equations (4), (5) or (6) may suggest a significant increase or decrease in the adjusted difference in median sales price, median sales price per square foot, or transaction volume from one period to the next, near the major hurricane event.

Finally, to capture the medium term effects of the hurricanes on residential real estate, we compare adjusted differences in median sales price and median sales price per square foot over the full year following the hurricane.[5]. We accomplish this in a manner similar to equations (1) and (2). Rather than quarterly, however, this time we calculate the *annual* post-event percentage change in median sales price and median sales price per square foot, for each Zip Code, as:

$$\Delta PRICE_{t\_t+4,i} = ((PRICE_{t+4,i} \ / \ PRICE_{t,i}) - 1) *100 \quad (7)$$
$$\Delta PPSF_{t\_t+4,i} = ((PPSF_{t+4,i} \ / \ PPSF_{t,i}) *100 \quad (8)$$

where $PRICE_{t,i}$ and $PPSF_{t,i}$ are the median sales price and median sales price per square foot, respectively, for Zip Code i, at time t. Correspondingly, for the state including Zip Code i, we define the one year change in median sales price ($\Delta ST\_PRICE_{t\_t+4,i}$) and median sales price per square foot ($\Delta ST\_PPSF_{t\_t+4,i}$) in a manner similar to equations (7) and (8). Again, we use the two-sample mean comparison test to contrast the arithmetic average of all values generated by equations (7) and (8) from the 52 Zip Codes with their associated states' average values, respectively. A statistically significant difference between the changes in the values for affected Zip Codes and those of their surrounding state would suggest some medium-term effect on the residential real estate within those Zip Codes struck by major hurricanes.

HYPOTHESES

While the colloquial concept of market overreaction as a manifestation of normal psychological behavior has been observed for generations, its formal documentation and analysis is a relatively modern development. DeBondt and Thaler (1985) define the overreaction hypothesis simply as a hyper-response to new information. The hypothesis suggests both that extreme movements in stock prices are followed by movements in the opposite direction to "correct" the initial overreaction and that greater magnitudes of the initial price change are generally offset by increasingly extreme reactions.

Evidence of overreaction has primarily been found in analysis of stock returns following large one-day stock price declines. Brown, Harlow and Tinic (1988) as well as Atkins and Dyl (1990) find significant reversals for stocks experiencing one-day price declines. Many differences between investments in marketable securities versus homes exist, however. Exposure to housing price risk is largely non-diversifiable for individual homeowners. Home prices and changes in home prices vary by location. Arbitrage is costly and largely infeasible. Further, real estate markets do not have the liquidity of financial markets. As a result, the residential real estate market is often characterized as relatively inefficient relative to markets for financial securities. Still, similarities remain.

Bremer and Sweeney (1991) examine common stock returns following one-day price declines of 10 percent or more over nearly a quarter century, finding significant positive abnormal returns extend three days immediately following the declines. They further note that this prolonged recovery period is inconsistent with prices fully and quickly reflecting relevant information and suggest that market illiquidity may partially explain their findings, as also supported by Capozza, Hendershott, and Mack, (2004). The real estate market, as one of the more illiquid asset markets, consequently provides a vehicle to help maintain the idea that prolonged recovery periods may indeed be associated with illiquid markets. The reaction in real estate may remain analogous, but the timeframe may also be extended as a result of a relatively slower and more illiquid marketplace.

Accordingly, as we are interested in how major hurricanes affect observed changes in median home prices, median price per residential square foot, and residential transaction volume across our sample of 52 affected Zip Codes, we expect to see reactions resembling some form of overreaction, as a hurricane clearly is viewed as a natural (unforeseen) event with negative implications. Consequently, we test hypotheses gauging any reaction to six natural events in these three variables. Specifically, we look first at quarterly movements, and then reaction over a one-year period.

We expect quarterly changes in our price and volume variables across the state will differ significantly from changes occurring in those Zip Codes impacted by a major hurricane. Our method tests consecutive null hypotheses that the state-adjusted difference for each volume and price variable at times t-1, t-0, t+1, t+2 and t+3 is not significantly different than the adjusted difference for each variable at time t-0, t+1, t+2, t+3 and t+4, respectively.

Further, when looking specifically at how these differ, we expect to see some evidence of a decline in the quarter or quarters immediately following the hurricane event, and then we anticipate some form of rebound as a correction to the initial negative impact. Should there be these results, this should also break out as evident in basic regressions, showing as negative correlation between periods. That is, if the initial reaction is lower, then subsequent results should be higher. Conversely, if higher initially, then lower subsequently.

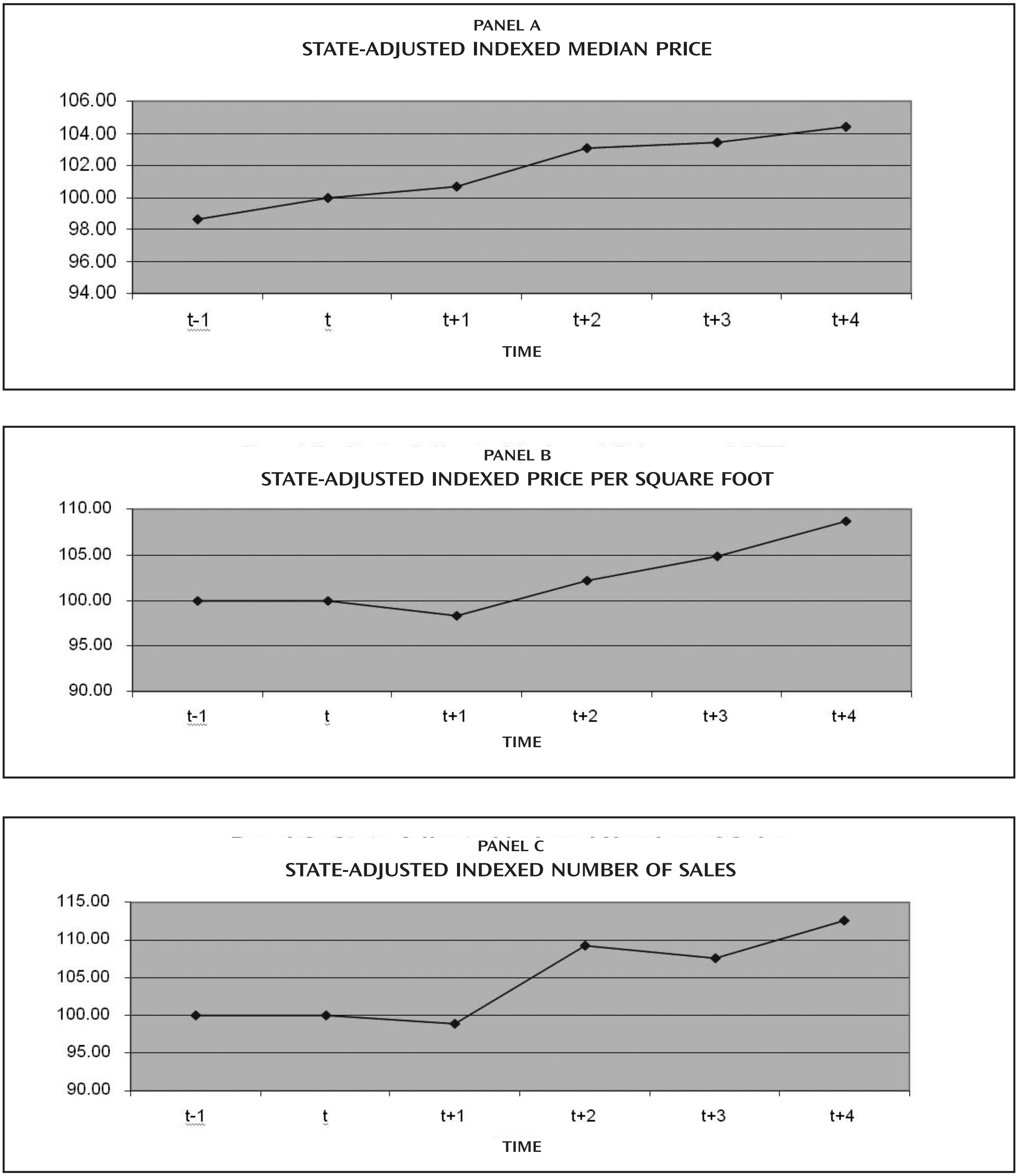
While Rich (2005) suggests post-storm growth "could come at the expense of building in other regions" in the state, we expect our findings to suggest otherwise. Substantial and rapidly occurring negative shocks to the market are likely to be associated with a substantial drop in demand, leading selling pressures to temporarily lower prices. As the public perception is that hurricanes spur growth and investment, any market drop should indeed be a temporary effect.

RESULTS

Benchmarking the adjusted differences at time t-0 as an index of 100, Figure 1 shows the adjusted differences for each of the three variables over the five sequential quarters, first from t-1 to t-0 (the quarter prior to that containing the hurricane) through t+3 to t+4 (the last quarterly change one year after the hurricane). The state adjusted median sales price, which is presented in panel A, does not initially decline (during t+1). It does increase slower than all other quarters, however, before sharply rising during quarter t+2. On the other hand, panels B and C clearly illustrate the adjusted difference in both median sales price per square foot and transaction volume decline during the quarter following the hurricane and increase sharply in the subsequent quarter. This is consistent with our hypothesized expectations.

Figure 1

Trend of State-Adjusted Housing Price and Sales Volume



Note: These figures present the trends of the indexed state-adjusted median price, median price per square foot, and sales volume. Time t is defined as the quarter in which the hurricane occurred. At time t we also define the index as 100. The state-adjusted variables are the difference between the average indexed value of the affected Zip Code variables and the average indexed value of their matched state.

To emphasize the changes in the adjusted differences, in Figure 2, we present the derivative of Figure 1. That is, Figure 2 shows the rate of change in differences from each time period to the next. All three panels illustrate a sharp decline from time t-0 to t+1 as well as a sharp increase from time t+1 to t+2. This is again consistent with our hypothesized expectations. Yet, while differences in changes across time are visible to the eye for both volume and prices, we do test the statistical significance of these differences in Table II.

Table II documents a quarter-to-quarter comparison of the change in adjusted difference for median price, median price per square foot, and transaction volume. Panel A presents the results of a two-sample mean comparison, in which we compare average adjusted differences in one quarter to the quarter that follows. The first row in this panel indicates a positive, but insignificant, statistical difference between variable changes during the quarter the hurricane hit and the subsequent quarter. The second row, however, indicates a negative and significant statistical difference between changes during the quarter that immediately followed the hurricane and its subsequent quarter. This significant difference is observed for all three variables with test-statistics of -1.96, -1.98 and -2.85 for median sales price, median sales price per square foot and transaction volume, respectively. The results of these two comparisons suggest that changes in prices and volume dip during the quarter following the hurricane, correcting soon thereafter, roughly during the second quarter that follows the hurricane (t+2). This supports the contention that illiquid markets lag the overreaction effect.

Table II

Panel A: Short and Medium Term Effects – A Two Sample Test Comparison

Null Hypothesis	X = PRICE Probability (t-stat)	X = PPSF Probability (t-stat)	X = VOL Probability (t-stat)
$ADJ\Delta X_{t,i} > ADJ\Delta X_{t+1,i}$	64.31% (0.37)	73.19% (0.62)	62.65% (0.32)
$ADJ\Delta X_{t+1,i} > ADJ\Delta X_{t+2,i}$	2.67% ** (-1.96)	2.56% ** (-1.98)	0.27% ** (-2.85)
$ADJ\Delta X_{t+2,i} > ADJ\Delta X_{t+3,i}$	93.12% ** (1.90)	62.31% ** (0.31)	99.55% ** (2.67)
$ADJ\Delta X_{t+3,i} > ADJ\Delta X_{t+4,i}$	34.37% ** (-0.40)	39.85% ** (-0.26)	7.35% ** (-1.46)

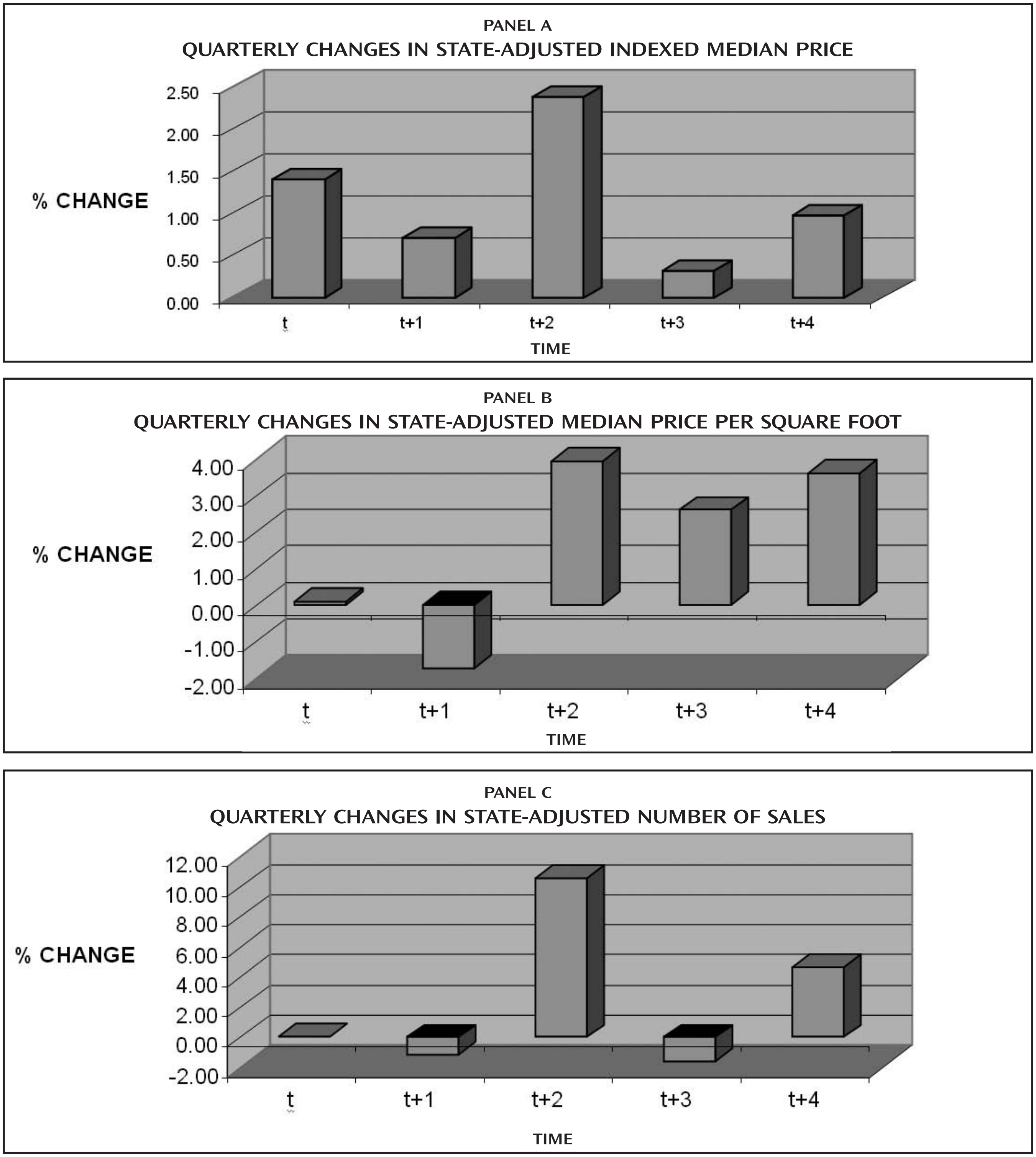
Panel B: Medium Term Effects

Null Hypothesis	X = PRICE Probability (t-stat)	X = PPSF Probability (t-stat)	X = VOL Probability (t-stat)
$\Delta X_{t\_t+4} > \Delta XST\_X_{t\_t+4}$	97.24%* (1.95)	92.45% (1.46)	NMF%

In panel B we measure the statistical significance of the difference between the change in median price and median price per sqft for the affected zip codes and their matched states during the full year following the hurricane. In both panels we use a two sample test comparison in order to measure the significance of the differences. We use ** and * to denote significance at the 5% and 10% level respectively.

Figure 2

Quarterly Changes in State-Adjusted Housing Price and Sales Volume



Note: These figures present the quarterly changes of the state-adjusted median price, median price per square foot, and sales volume. Time t is defined as the quarter in which the hurricane occurred. The changes in state-adjusted variables are defined as:

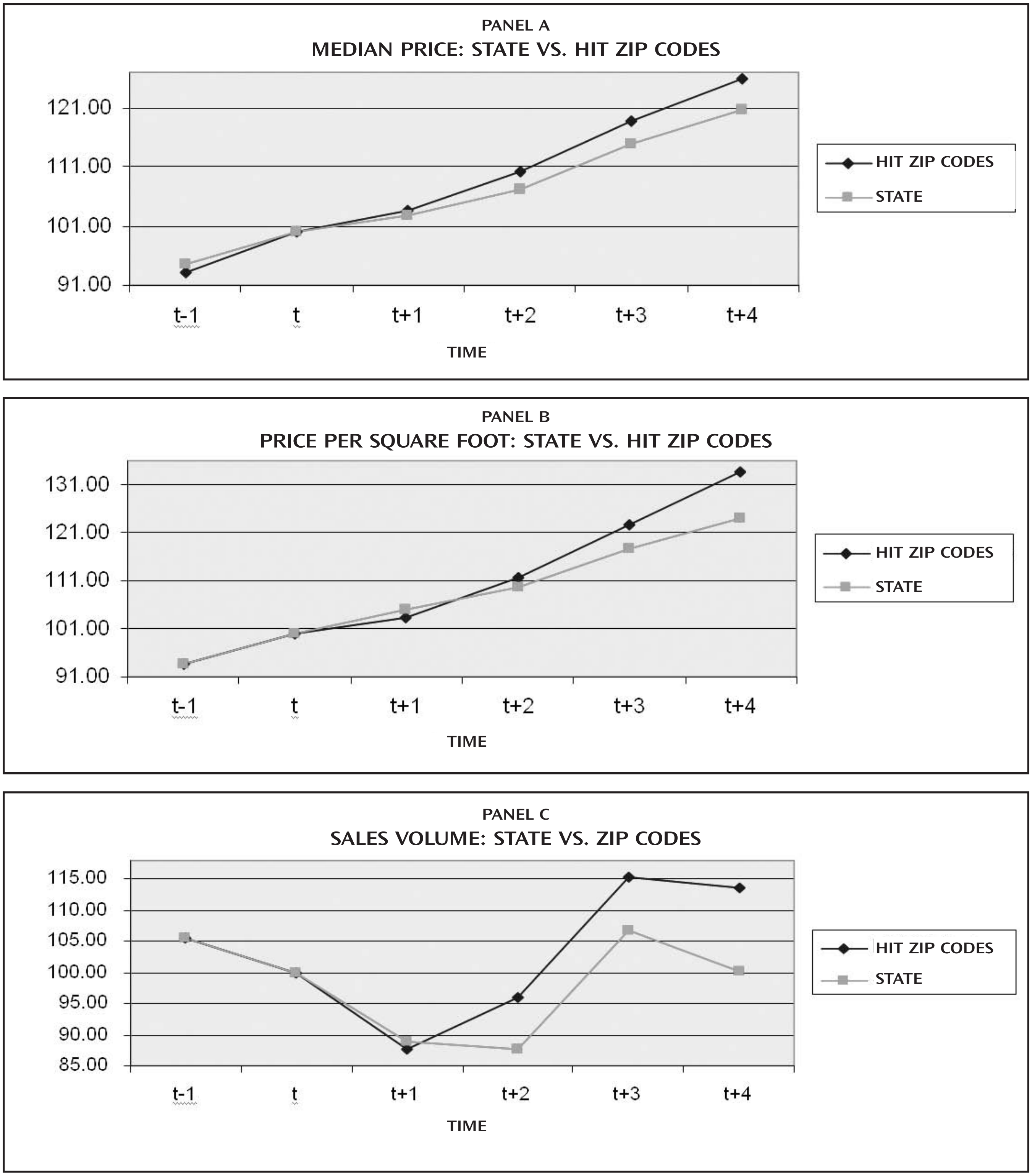
$$ADJ\Delta PRICE_{t,i} = \Delta PRICE_{t,i} - \Delta ST\_PRICE_{t,i} \quad (1)$$

$$ADJ\Delta PPSF_{t,i} = \Delta PPSF_{t,i} - \Delta ST\_PPSF_{t,i} \quad (2)$$

$$ADJ\Delta VOL_{t,i} = \Delta VOL_{t,i} - \Delta ST\_VOL_{t,i} \quad (3)$$

Figure 3

Housing Price and Sales Volume Trends of Hit Zip Codes Versus their Matched State



Note: These figures present the trends of the indexed median price, median price per square foot, and sales volume for the affected Zip Codes versus their matched state. Time t is defined as the quarter in which the hurricane occurred. At time t we also define the index as 100.

Figure 3 portrays results for prices and volume over the medium term, in the form of an indexed horse-race comparison between the affected Zip Codes and statewide Zip Codes. A visible difference between the changes in values for the affected Zip Codes and their statewide counterparts is counterintuitive. It suggests that over a course of one year, in spite of the direct and indirect negative effects brought to these Zip Codes by the hurricane, the prices of residential real estate in the affected Zip Codes rose faster than the median prices in the rest of the state (panel A and B). Similarly, panel C suggests that the relative number of transactions made in the affected areas increased over the course of the year more rapidly than at the rest of the state. This could explain the generalized conclusions drawn by the popular press in suggesting that housing markets experience a boom following hurricane impacts.

The second panel of Table II shows the statistical significance of the results presented in Figure 3. When comparing the change in median sales prices and median sales price per square foot between the affected Zip Codes and those statewide, we generate test-statistics of 1.95 and 1.46, respectively. Both of these values suggest price measures rose faster in the affected Zip Codes, with the median sales price measure bordering on statistical significance.

Finally, Table III presents the beta coefficient results for equations (4), (5) and (6). Negative and statistically significant beta coefficients appear in the first two rows, suggesting negative autocorrelation between changes in quarters t-0, t+1, and t+2. These results further support the results shown in panel A, but with stronger statistical significance. In summary then, our results for the short term suggest that a dip in changes for each of our three variables during quarter t+1 is statistically significant and is followed by a statistically significant upside correction

Table III

Short Term Effects – Regression Analysis

Regression Specification	X = PRICE Beta (t-stat)	X = PPSF Beta (t-stat)	X = VOL Beta (t-stat)
$ADJ\Delta X_{t+1,i} = a + \beta ADJ\Delta X_{t,i}$	-0.27 **	-0.43 **	-0.68 **
	(-2.50)	(-3.69)	(-5.22)
$ADJ\Delta X_{t+2,i} = a + \beta ADJ\Delta X_{t+1,i}$	-0.44 **	-0.75 **	-0.49 **
	(-4.61)	(-3.41)	(-3.53)
$ADJ\Delta X_{t+3,i} = a + \beta ADJ\Delta X_{t+2,i}$	0.03	0.02	-0.20
	(0.14)	(0.11)	(-1.29)
$ADJ\Delta X_{t+4,i} = a + \beta ADJ\Delta X_{t+3,i}$	-0.17	0.04	-0.14
	(-1.84)	(0.70)	(-1.31)

We use ** and * to denote significance at the 5% and 10% level respectively.
Note: This table presents the results of the â coefficient from the autoregression in which we regress the change in state-adjusted median price, median price per square foot, and sales volume on their value from the previous quarter. The changes in the state-adjusted variables are defined as per equations (1), (2), and (3):

$$ADJ\Delta PRICE_{t,i} = \Delta PRICE_{t,i} = \Delta PRICE_{t,i} - \Delta ST\_PRICE_{t,i} \quad (1)$$
$$ADJ\Delta PPSF_{t,i} = \Delta PPSF_{t,i} = \Delta ST\_PPSF_{t,i} \quad (2)$$
$$ADJ\Delta VOL_{t,i} = \Delta VOL_{t,i} - \Delta ST\_VOL_{t,i} \quad (3)$$

during quarter t+2, again consistent with our hypothesized market reaction.

CONCLUSION

We investigate subsequent changes in quarterly housing prices and volume for 52 U.S. Zip Codes impacted by six major hurricanes from 2004–2005, for one year following the natural event. We obtain results that are consistent with home price changes following an overreaction pattern, similar to that found in financial markets after an unforeseen negative shock to the market. During the first two quarters following a major hurricane, our data suggest that changes in home prices and transaction volume in the affected Zip Codes experience a temporary dip, followed by a positive correction. Thus, some evidence emerges that a transitory price decline presents a buying opportunity, providing some support for a short-term reversal. A time-extended form of a short-term reversal (a few months as opposed to a few days) as we find, is consistent with Bremer and Sweeney (1991) who suggest that illiquid markets may partially explain the inefficiency of a prolonged recovery period.

When examining changes in our measures one full year following a hurricane, little evidence emerges suggesting a lingering effect on residential real estate prices, as prices have generally corrected back to their prior trend-line. Still, a nominal positive difference is found. Although statistically insignificant, this presents some evidence that areas hit by hurricanes outperform comparable areas not affected by the storm, a counterintuitive result. This leaves the door open to further research in this area, something presently in development.

Our study is unique compared to prior work in this area. First, we look at Zip Code-level data where most prior studies employ MSA-level (Metropolitan Statistical Area) or state-level data, neither of which allows for the precision obtained by a Zip Code-level analysis. Second, by examining the impact from several major hurricanes in a relatively constrained time period, we have less bias in our data than data from only one or two hurricanes and we eliminate some of the variability of macroeconomic factors that could potentially affect results. Finally, we use several measures to generate more definitive results.

Contrary to popular opinion, our results do not present evidence of an immediate surge in prices from a housing supply reduction and capital infusions to drive demand as prior popular press articles have implied. Thus, the housing market reaction to a major hurricane impact does not seem to exhibit behavior indicative of a bubble. That is, while it may be possible that a housing shortage immediately follows major storms and later corrects as supply returns to prior levels, overshadowing this possible outcome seems to be a short-term precipitous drop in demand. This might be due to large quantities of people relocating after a major storm, but all such reasoning would be entirely speculative. We do not seek to explain our results, only to present them.

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NOTES:

1. Hurricanes rated at 3 or greater on the Saffir-Simpson scale are technically defined as Major Hurricanes. The Saffir-Simpson scale categorizes hurricane strength from 1 to 5, the strongest being 5. A category 3 storm has sustained winds of 111-130mph.

2. The problem would appear to be endemic in annual data, too, but to a lesser degree given more observations over longer time horizons.

3. While each hurricane in our study is categorized at 3 or greater, this categorization stems from *maximum* sustained wind speed. It is understood that storms will weaken over land. Although a 55 knot threshold, or nearly 64 mph, falls about 8 knots short of hurricane-status sustained winds, this level still ranks in the upper quartile of tropical storm strength and is a minimum speed, exclusive of gusts. Accordingly, with continual data unavailable, measurements of sustained winds exceeding 55 knots maintain enough power in the storm area for continued property damage, fatalities, and extensive flooding from the storm surge.

4. Charley hit Port Charlotte, FL with 150mph winds (category 4) and then crossed the state to re-emerge in the Atlantic before looping back into Myrtle Beach, SC where it only briefly sustained winds over 55 knots.

5. Transaction volume difference would have no meaning at this stage because it is not a continuous variable; accordingly, we omit this measure here.

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