

# Leading Indicators, Storm Data Guide Houston Economic Forecast

By Jesse Thompson

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**ABSTRACT:** A forecasting model for Houston that incorporates storm damage data and leading economic indicators can help project post-Hurricane Harvey employment growth. The forecast indicates that Houston's economy will grow near its 2 percent historical average in 2018.

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**A** surging energy sector helped Houston metropolitan employment expand at an annual rate of nearly 4 percent from 2011 through 2014—the equivalent of 325,000 jobs over the period. But in the subsequent two years, job growth stalled as rising crude production drove down oil prices.

A recovering energy industry helped propel Houston to above-trend growth in the first half of 2017 before Hurricane Harvey walloped the region in late August. The destructive storm disrupted economic activity, bringing with it a challenge for economic forecasters.

Businesses rely on job growth projections to plan for capital expenditures as well as more basic requirements such as office space, staffing and vehicle demand. Four economic models have been developed that rely on past job growth and leading indicators to forecast Houston employment growth, including a new experimental leading index.

Incorporating the dollar cost of direct storm damage improves model accuracy, and averaging the independent model forecasts tends to produce more accurate longer-term predictions. These models taken together anticipate that after three months of rapid recovery from Hurricane Harvey, Houston will grow near its historical average rate of 2 percent in 2018.

## High Growth, Volatility

The Houston metro area was the second-fastest growing of the nation's 20 largest metros from 1990 to 2016, adding jobs at an annual rate of 2.2 percent, just behind Dallas–Fort Worth at 2.3 percent. That compared with a national average growth rate of 1 percent during the period.

Houston had more than 3 million jobs in 2016, accounting for 2 percent of all U.S. payroll jobs, and a gross domestic product of \$478.6 billion, amounting to 2.6 percent of U.S. output. Houston is home to about one-fourth of all Texas jobs, nearly a third of the state's output and almost a quarter of the state's population.

Despite the metro area's heft, Houston's high growth comes with volatility. The area experienced the most volatile job growth of the eight largest U.S. metros from 1990 to 2016. It was also the nation's fifth-most-populous metro area in 2016, with 6.8 million inhabitants (*Table 1*).

Oil prices are responsible for much of Houston's volatility. They affect oil producers' revenues and future drilling activity. The supply chains for most U.S. oil and gas operations have connections to Houston—an industry headquarters city—although little oil is being produced in the immediate area. Houston retains the title “energy capital of the world,” despite diversification and deepening connections to the broader U.S. economy over the past 30 years.<sup>1</sup>

Additionally, many local businesses and residents also own mineral rights and receive royalty payments from oil and gas production.<sup>2</sup> Industries not generally associated with the energy sector, such as business and professional services, have direct and indirect connections to energy. Thus, Houston's service sector employment (excluding government) is the second-most volatile among the largest U.S. metros.

Forecasts by their very nature assume that the behavior of data in the recent past will carry into the future. How can businesses plan ahead given recent volatility? Tools are needed that help capture the sources of that volatility and identify underlying trends.

## Data and Leading Indicators

The Bureau of Labor Statistics (BLS) produces the most commonly used measure of regional employment growth. The Current Employment Statistics (CES) jobs data are generated from a national survey of 634,000 work-sites, covering about one-third of total nonfarm civilian jobs. Smaller sample sizes at the metro level can result in significant changes when the BLS annually revises its estimates based on unemployment insurance data, which are comprehensive but have lagged availability.

The Federal Reserve Bank of Dallas works to improve the accuracy of recent employment data in Texas and its major metros through a quarterly early benchmarking process and a two-step seasonal adjustment.<sup>3</sup> These processes help make the Dallas Fed's local employment data more accurate in real time than unrevised CES estimates while taking into account seasonal variations (like more retail workers before Christmas) that can obscure trends.

Recent job growth numbers set the trend for most forecast models, so boosting the accuracy of those data should improve ensuing predictions. Leading economic indicators when combined with improved employment data presumably better capture the cyclical nature and volatility of future job growth.

Among the useful indicators that contain information about Houston's near-future job growth and likely business-cycle changes are the Houston Purchasing Managers Index (HPMI) produced by the Institute for Supply Management (ISM) and the Texas Leading Index (TLI) from the Dallas Fed. Both are powerful barometers of impending changes in the local economy.

The HPMI is a monthly diffusion index that is similar to the ISM's national purchasing managers index. Supply managers from a broad group of industries, including health, manufacturing, oil and gas, and services answer questions seeking to ascertain whether business conditions are improving, worsening or unchanged relative to the prior month. Responses

**Table 1** | Houston Job Growth Volatile Relative to Other Large Metros

	Total nonfarm jobs		Service-providing nonfarm jobs (ex. government)		Population in 2016
	Rank	Volatility	Rank	Volatility	Millions
<b>United States</b>		<b>0.96</b>		<b>1.03</b>	<b>323.1</b>
<b>Houston-The Woodlands-Sugar Land</b>	<b>1</b>	<b>1.45</b>	<b>2</b>	<b>1.43</b>	<b>6.8</b>
Miami-Fort Lauderdale-West Palm Beach	2	1.43	1	1.44	6.1
Los Angeles-Long Beach-Anaheim	3	1.31	5	1.14	13.3
Dallas-Fort Worth-Arlington	4	1.27	3	1.37	7.2
Washington-Arlington-Alexandria	5	1.05	4	1.24	6.1
New York-Newark-Jersey City	6	1.03	6	0.94	20.2
Chicago-Naperville-Elgin	7	1.02	7	0.92	9.5
Philadelphia-Camden-Wilmington	8	0.93	8	0.89	6.1

NOTES: Volatility is calculated as the standard deviation of the absolute 12-month log-change in employment from January 1991 through December 2016. A larger standard deviation means the 12-month growth rate is more variable.

SOURCES: Bureau of Labor Statistics; Census Bureau.

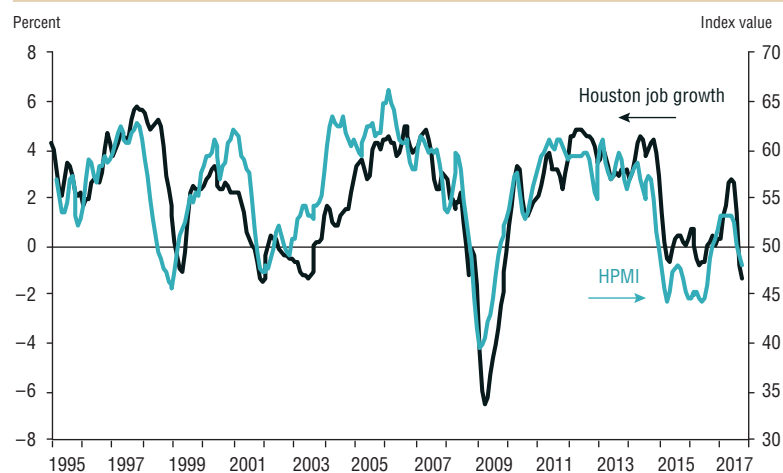
are compiled into eight component indexes—sales, production, employment, purchases, prices paid, lead times (from sellers), purchased inventory and finished goods in inventory. The responses are then combined into an index in which a value above 50 indicates an expanding economy and a value below 50 suggests contraction.

Since its inception in early 1995, the index has consistently provided an early

indication of changes in employment growth rates and turning points in the broader regional economy. It is also very timely, typically available on the 10th day following the measured month. Whenever the HPMI strengthens or weakens, job growth over the next few months most likely follows (*Chart 1*).

The Dallas Fed's TLI is a different kind of leading index. It combines eight separate indicators associated with

**Chart 1** | Job Growth Tracks the Houston Purchasing Managers Index



NOTES: Employment growth is the three-month percent change in the centered moving average. The Houston Purchasing Managers Index (HPMI) is depicted as a centered three-month moving average where values >50 indicate expansion.

SOURCES: Institute for Supply Management; Bureau of Labor Statistics; adjustments by the Federal Reserve Bank of Dallas.

future business activity that typically change direction three to nine months before the rest of the economy does.

For example, rising initial claims for unemployment insurance suggest firms believe they may be unable to support staffing levels; individuals losing their jobs will likely scale back consumption in the months ahead. When help-wanted advertisements rise, employers are more confident about their outlook and plan to hire more staff. As those positions are filled, new employees are likely to increase consumption in future months.

Both indicators are included in the TLI. Other items are the Texas value of the dollar, a trade-weighted index that accounts for inflation; the U.S. leading index from the Conference Board; the real (inflation-adjusted) price of West Texas Intermediate crude oil; oil and natural gas well permits; a Texas stock index representing the 100 largest publicly traded companies based in the state, and average weekly hours worked in manufacturing.<sup>4</sup>

The TLI is the main component of the Dallas Fed's Texas forecasting model, which has consistently outperformed other state-level employment forecasts tracked by the Western Blue Chip Economic Forecast.<sup>5</sup>

An index constructed to help forecast the Texas economy should have predictive power for Houston. Analysis suggests that the TLI is significantly correlated with Houston job growth one to six months into the future (*Chart 2*).

### Houston Leading Index

The TLI and the sales and production components of the Houston Purchasing Managers Index are subsequently combined with data covering additional metrics to produce an experimental index of leading indicators for Houston (HLI).

The additional data are: Help-Wanted OnLine advertising, single-family housing construction permits, existing-home sales, the American Chemistry Council's U.S. chemical production index, the Bloomberg Houston 150 stock market index, the average monthly price of West Texas intermediate crude oil, the U.S. rig count and the Conference Board's U.S. index of leading economic indicators.<sup>6,7</sup>

The new index's construction resembles the TLI and the U.S. leading index. Changes in each of the 11 components are divided by a measure of their own volatility to prevent the effects of inherently more noisy components—such as oil prices—from

overwhelming the effects of the others. These adjusted changes are then averaged to produce a Houston index of leading indicators.<sup>8</sup> Much like the TLI, the HLI is significantly correlated with Houston employment growth one to six months out (*Chart 3*).

### Improving Accuracy

Four different employment forecasting models—three of them based on measures of ongoing activity in Texas and Houston—were developed for Houston. The HLI, the HPMI and the TLI were each incorporated in models using two simultaneous equations, where the first equation forecasts employment growth based on past changes in employment and the leading indexes, and the second equation forecasts growth in the leading index based largely on lagged values of itself.<sup>9</sup>

A fourth model produced a forecast by averaging the predictions of many ARIMA (autoregressive integrated moving average) forecasts. These ARIMA forecasts use only combinations of past job growth to predict future job growth.<sup>10</sup> The HLI-based model tended to be more accurate at charting the course of employment growth over the year ahead.<sup>11</sup> It did particularly well at forecasting four to 11 months out.<sup>12</sup>

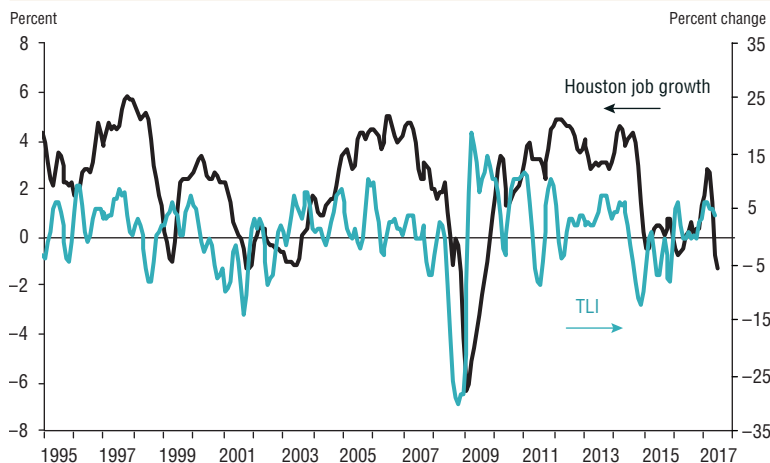
Frequently, averaging predictions from different models can provide better forecasts than the individual models. An average of all four of the models tested tended to be the most accurate when forecasting 12 months ahead, reducing forecast error—the extent to which predicted job growth differed from actual job growth—by 15.6 percent relative to the ARIMA model (*Table 2*).

Including estimates of the direct cost of damage from major storms over the past 26 years in the forecast models improved the accuracy of the forecast predictions and, in the most recent instance, provided estimates of Hurricane Harvey's employment impact.<sup>13</sup>

### Resurgent Economy Anticipated

The average of the four forecast models predicted a net drop of 30,000 Houston jobs from August to Septem-

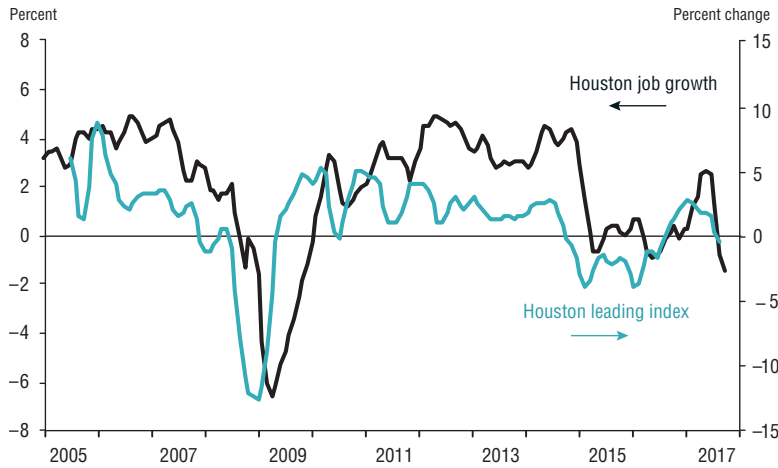
**Chart 2** Texas Leading Index Correlated with Houston Job Growth Up to Six Months into Future



NOTE: Employment growth and the Texas Leading Index (TLI) are the three-month percent change in a centered moving average.

SOURCES: Bureau of Labor Statistics; Federal Reserve Bank of Dallas.

**Chart 3** | Houston Leading Index, Future Job Growth Significantly Correlated



NOTES: The Houston leading index is experimental. Employment growth and the Houston leading index are depicted as three-month percent changes in a centered three-month moving average.  
SOURCES: Bureau of Labor Statistics; adjustments by the Federal Reserve Bank of Dallas; author's calculations.

ber, assuming that Harvey caused \$70 billion in direct damage. Initial estimates put the number at around 22,000 lost jobs. The impact was also likely to be short lived, corroborating an earlier Dallas Fed analysis that suggested the Texas Gulf Coast would recoup jobs lost due to the storm as recovery efforts boosted year-end growth.<sup>14</sup>

(See “On the Record,” a conversation with Harris County Judge Ed Emmett, page 8.)

In short, a host of leading indicators suggest that Hurricane Harvey, while devastating to many homeowners and small businesses, likely caused only one month of net job losses in Houston. Despite slower growth in the second half of 2017, the region’s long-run economic momentum is unlikely to be derailed.

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**Notes**

<sup>1</sup> “Diversified Houston Spared Recession ... So Far,” by Jesse Thompson, Federal Reserve Bank of Dallas, *Southwest Economy*, Third Quarter, 2015, [www.dallasfed.org/assets/documents/research/swe/2015/swe1503f.pdf](http://www.dallasfed.org/assets/documents/research/swe/2015/swe1503f.pdf).  
<sup>2</sup> “Asset Ownership, Windfalls, and Income: Evidence from Oil and Gas Royalties,” by Jason P. Brown, Timothy

Fitzgerald and Jeremy G. Weber, Federal Reserve Bank of Kansas City, Research Working Paper no. 16-12, November 2016, [www.kansascityfed.org/publications/research/rwp/articles/2016/asset-ownership-windfalls-income-oil-gas-royalties](http://www.kansascityfed.org/publications/research/rwp/articles/2016/asset-ownership-windfalls-income-oil-gas-royalties).

<sup>3</sup> See definitions of early benchmarking at [www.dallasfed.org/research/basics/benchmark.cfm](http://www.dallasfed.org/research/basics/benchmark.cfm) and two-step seasonal adjustment at [www.dallasfed.org/research/basics/twostep.aspx](http://www.dallasfed.org/research/basics/twostep.aspx).

<sup>4</sup> Texas Employment Forecast, Federal Reserve Bank of Dallas, Nov. 17, 2017, [www.dallasfed.org/research/forecast.aspx](http://www.dallasfed.org/research/forecast.aspx).

<sup>5</sup> “Revising the Texas Index of Leading Indicators,” by Keith Phillips and José Joaquín López, Federal Reserve Bank of Dallas, *Southwest Economy*, November/December, 2007, <http://dallasfed.org/assets/documents/research/swe/2007/swe0706b.pdf>.

<sup>6</sup> The Houston 150 stock index is produced by

Bloomberg. It is a price-weighted index composed of major companies based in Houston and significant employers in the area. The U.S. chemical production index is produced by the American Chemistry Council to track chemical production activity in the United States based on industrial production data from the Federal Reserve. Help-Wanted OnLine data are produced by the Conference Board on online job postings for employment in the Houston metropolitan area.

<sup>7</sup> Details of the Conference Board methodology can be found at [www.conference-board.org/data/bci/index.cfm?id=2161](http://www.conference-board.org/data/bci/index.cfm?id=2161).

<sup>8</sup> Component series are also seasonally adjusted where appropriate. Due to limitations in some of the component data, the Houston index begins in June 2005.

<sup>9</sup> Each system of two equations was estimated using seemingly unrelated regressions.

<sup>10</sup> The ARIMA forecast was a weighted average of many models automatically selected for each of the 84 iterations over the sample period and weighted based on goodness-of-fit measures.

<sup>11</sup> Each model was used to calculate 84 out-of-sample forecasts beginning in January 2010 and rolling forward to December 2016. The overall prediction error was tabulated for the 12-month forecasts, as well as the prediction error for each step-ahead.

<sup>12</sup> The HLI model was specified as follows:

$$\text{(Equation No. 1) } \Delta \ln(\text{emp}) = \beta_{11} \Delta \ln(\text{emp})_{t-3} + \beta_{12} \Delta \ln(\text{emp})_{t-4} + \beta_{13} \Delta \ln(\text{emp})_{t-6} + \beta_{14} \Delta \ln(\text{HLI})_{t-1} + \beta_{15} \Delta \ln(\text{HLI})_{t-3} + \beta_{16} \text{storms} + \beta_{17} \text{storms}_{t-1} + \beta_{18} \text{storms}_{t-2} + \beta_{19} \text{recessions} + \epsilon.$$

$$\text{(Equation No. 2) } \Delta \ln(\text{HLI}) = \beta_{21} \Delta \ln(\text{emp})_{t-1} + \beta_{22} \Delta \ln(\text{HLI})_{t-1} + \beta_{23} \Delta \ln(\text{HLI})_{t-2} + \beta_{24} \text{storms}_{t-1} + \beta_{25} \text{recessions} + \beta_{26} + \epsilon.$$

<sup>13</sup> Tropical Storm Allison in 2001 and the 1994 floods occurred before the HLI model sample period.

<sup>14</sup> See “Short-Term Job Growth Impacts of Hurricane Harvey on the Gulf Coast and Texas,” presentation by Keith Phillips and Christopher Slijk, Federal Reserve Bank of Dallas, San Antonio Branch, Sept. 5, 2017, <http://files.constantcontact.com/668faa28001/d7cdfcae-b861-4bb2-9cb7-a1f8e361a878.pdf?ver=1505446495000>.

**Table 2** | Forecast Averaging Produces Better Long-Term Predictions

	Percent improvement in accuracy over ARIMA
Average	15.6
Houston leading index	14.8
Houston Purchasing Managers Index	12.7
Texas Leading Index	6.7
ARIMA	—

NOTES: Data are the percent reduction in the 12-month-ahead root-mean-squared forecast error relative to the ARIMA (autoregressive integrated moving average) model.  
SOURCE: Author's calculations.