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Seasonal Variation in Traffic Congestion: A Study of Three U.S. Cities

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Most urban areas of the country face rising congestion levels as increasing volumes of vehicular traffic exceed the capacity of the transportation system. The Texas Transportation Institute (TTI) reported that, in 2005, "Traffic congestion continues to worsen in American cities of all sizes, creating a $78 billion annual drain on the U.S. economy in the form of 4.2 billion lost hours and 2.9 billion gallons of wasted fuel."[1]

At the national level, reducing congestion is one of the strategic goals of the U.S. Department of Transportation.[2] But to reduce congestion nationwide, it is often at the local level where congestion must be addressed.[3] Congestion patterns can vary depending on location and time of the year.

Congestion Costs in Perspective

The 2.9 billion gallons of petroleum wasted in 2005 would have fueled U.S. daily transportation needs for nearly a week that year—6.1 days. If spread evenly across the entire U.S. population of 295.5 million in 2005, the 4.2 billion hours lost to congestion that year would have cost every man, woman, and child in the country about 14.2 hours.

Source: FHWA, Highway Statistics, 2005

Drivers may notice seasonal changes in patterns of highway congestion in many urban areas of the country. These patterns, however, can be very different for individual cities. This report looks at congestion patterns over a 3-year period for three U.S. cities—Chicago, Los Angeles, and Houston (selected to illustrate geographic diversity)—by estimating the changes in monthly congestion during the year, the differences occurring in morning and evening congestion, and differences in weekend and weekday congestion.

These estimates are made using the monthly average number of congested hours per day (see box A for definition) for each of these cities.[4]

Findings from the analysis of the 3 years of data are:

- Chicago experiences an average of about 1 hour less congestion per weekday in the winter months of December and January compared to other months of the year. Weekends in January and June show the biggest variations, with about 1½ fewer congested hours per day in January and over 1½ hours more congested hours in June, compared to weekends in other months.

- The weekday congested hours in Los Angeles vary more during the year than they do in the other cities studied, with 7 months having at least ½ hour difference, either higher or lower, in congested hours compared to the yearly average. March and August show the biggest variations, with about 1 hour more congested hours in March and 1 hour fewer congested hours in August.

- Houston, in general, has less variation in congested hours; the exceptions are July and December morning weekday travel, with more than ½ hour less congestion per day compared to the rest of the year.

These data have the potential to provide a valuable source of detailed congested seasonal factors not previously available for the transportation sector. Different cities have different congestion patterns, and such information may prove helpful in developing future congestion reduction strategies.

[1] David Schrank and Tim Lomax. September 2007. *The 2006 Urban Mobility Report*, Texas Transportation Institute, College Station, TX; http://mobility.tamu.edu/ums/report/

[2] U.S. Department of Transportation, *Strategic Plan,* Fiscal Years 2006-2011; http://www.dot.gov/stratplan2011/index.htm

[3] See U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, *Compendium on Congestion: Issues and Analyses Across Modes*, May 2007, p. 16.

[4] These data are collected and compiled for use in the Federal Highway Administration's *Urban Congestion Report*, various months, using detailed traffic flow and speed information from the Intelligent Transportation System (ITS) installed on the major freeways most affected by congestion in each of the subject cities. The data are compiled by the Texas Transportation Institute and Noblis, Inc.

Congestion Measurement

Using traditional yearly average congestion estimates can obscure important variations:

- changes in congestion taking place during the year,
- considerable differences in travel between the morning and afternoon periods, and
- differences in congestion patterns for weekday and weekend travel.

An examination of monthly congestion data, in particular, could offer a view of the systematic intra-year movement or seasonal patterns of congestion.

The average monthly number of weekday congested hours per day for Chicago, Los Angeles, and Houston varied substantially among the three cities over the 3-year period from April 2004 to April 2007 (figure 1).[5] The total number of congested hours per day for each city should not be compared to the other cities because the data collection system coverage and free-flow speeds for each city vary dramatically.

However, it is useful to look at the trends and variations in those data. There are some similarities in the trends for the three cities; for example, a tendency for lower levels of congestion near the end of each year. Because seasonality is often driven by periodic fluctuations in weather, vacations, or holidays, the declining congestion around December is not surprising. But there are variations in these patterns, both over time and among the three cities.

Box A. Monthly Average Number of Congested Hours Per Day

The monthly average number of hours during the day when at least 20 percent of vehicle miles traveled (VMT) on the instrumented road network (road segments where detailed speed and traffic data are collected) are congested. For this measure, congestion is defined to occur when speeds on a particular highway segment are less than 50 miles per hour.

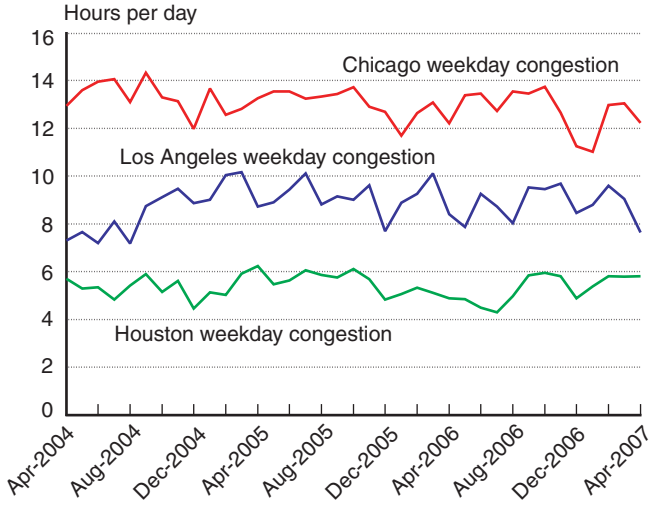
Source: Federal Highway Administration, Urban Congestion Reporting Measure Definitions.

Box B. Monthly Seasonal Factor

Seasonal factors reflect the variations that repeat every year to the same extent, e.g., holiday effects, weather fluctuations representative of the season, and so on. A monthly seasonal factor represents the impact that a particular month of the year has on a particular measure relative to what that measure would be if the seasonal influence were removed – or "deseasonalized."
In the case of congested hours, the seasonal factor represents how many more (a positive number) or fewer (a negative number) hours would be expected due to the month being observed. A seasonal factor near zero indicates little deviation from the underlying trend.

Source: Bureau of Transportation Statistics

Figure 1: Number of Congested Hours per Weekday: Monthly Average



NOTE: The number of congested hours per day are not directly comparable across different urban areas because data collection coverage on the freeway system in each urban area can vary dramatically. In this case, the data cover about 65 percent of all freeway lane-miles in Los Angeles, compared to about 22 percent in Chicago where data collection is focused on a smaller, more congested portion of the network. In addition, Chicago tends to have lower free-flow speeds on its monitored freeway network compared to Los Angeles.

SOURCE: Calculated from data used in preparation of Federal Highway Administration, *Urban Congestion Report*, April 2004–April 2007.

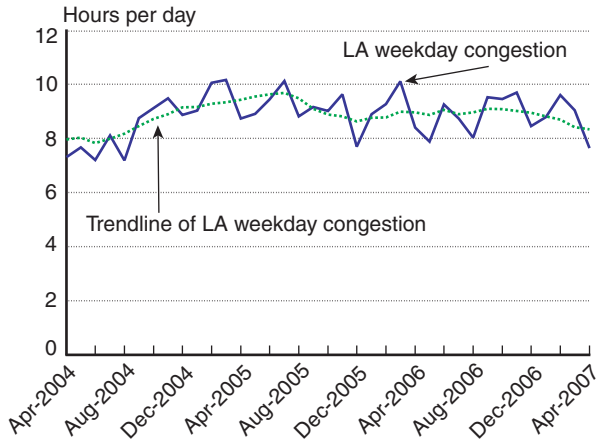
Measuring Seasonality

Seasonality is a pattern in time series data that repeats every year. This repetitive pattern in transportation can be attributed to a variety of causes. For example, the December pattern noted above is attributed to weather and holiday travel. To quantify the monthly seasonal factors (see box B), BTS uses a statistical procedure, called STAMP,[6] to separate the seasonality from the time series data. STAMP reduces the seasonality in 3 years of data to 12 monthly factors and shows how the average monthly congestion deviates from the overall trend for each city.

In addition to estimating the seasonal factors, STAMP can also calculate the underlying long-term trend, or trendline, for the congestion data. Figure 2 provides a graphical comparison of the monthly data against the trendline calculated in STAMP for Los Angeles' weekday congestion. The deviation of the monthly data from the trendline essentially represents the impact of seasonality, and these deviations can be averaged to create the monthly seasonal factors.

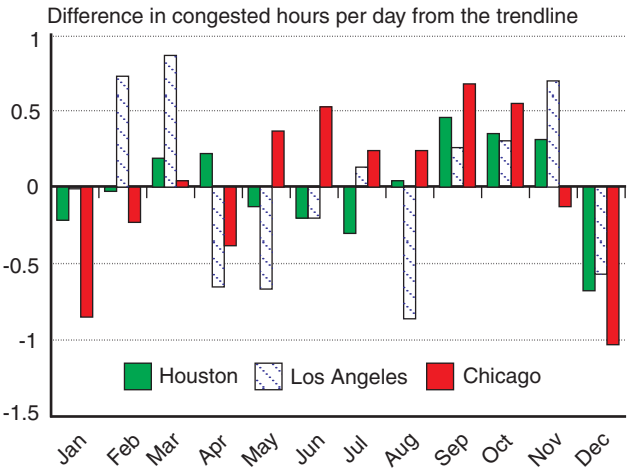
[5] This period represents the data available for those three cities at the time the analysis was conducted.
[6] Siem Jan Koopman, Andrew C. Harvey, Jurgen A. Doornik and Neil Shepard. 2006. *Structural Time Series Analyser, Modeller And Predictor, STAMP 7*, London: Timberlake Consulting Ltd.

Figure 2: Monthly Average of Congested Hours per Weekday in Los Angeles



SOURCE: Calculated from data used in preparation of Federal Highway Administration, *Urban Congestion Report*, April 2004–April 2007.

Figure 3: Monthly Variation in Weekday Congestion due to Seasonal Factors: Houston, Los Angeles, and Chicago



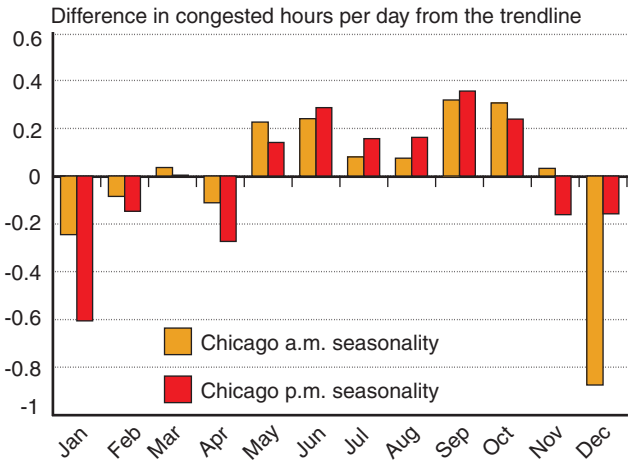
NOTE: Each bar represents the degree of departure from the underlying long-term trendline. For example, the December seasonal factor for Chicago of approximately -1 means that, in December in Chicago, the number of congested hours per weekday is approximately 1 hour less than the overall trend for the weekday congestion.

SOURCE: Calculated from data used in preparation of Federal Highway Administration, *Urban Congestion Report*, April 2004–April 2007.

The monthly weekday seasonal factors for the three cities are shown in figure 3. December congestion is lower for all three cities (between approximately ½ to 1 hour fewer congested hours per day). There are also some higher congestion levels for all three cities during September and October, months that may be affected by commuters returning to work after summer vacations and schools starting classes or by increased freight traffic transporting imports for the upcoming December holiday season. The other months show considerable differences among the cities. Los Angeles, in particular, has a unique pattern with much higher than normal congestion in February and March, and lower than normal congestion in April, May, and August. There are fewer congested hours in Chicago in both December and January, a time when adverse weather conditions occur frequently. Chicago has its highest level of congestion in September. Houston has the least variation over the year—December is the lowest congested month, with the most difference from the average, while September is the month with the most congestion.

The following provides an in-depth view of the congestion data for the three cities, including whether the monthly patterns for the overall weekday seasonal factors are replicated in the morning, evening, and weekend congestion patterns.

Figure 4: Monthly Variation in Chicago's a.m. and p.m. Congested Hours due to Seasonal Factors



SOURCE: Calculated from data used in preparation of Federal Highway Administration, *Urban Congestion Report*, April 2004–April 2007.

Seasonal Factors for Chicago

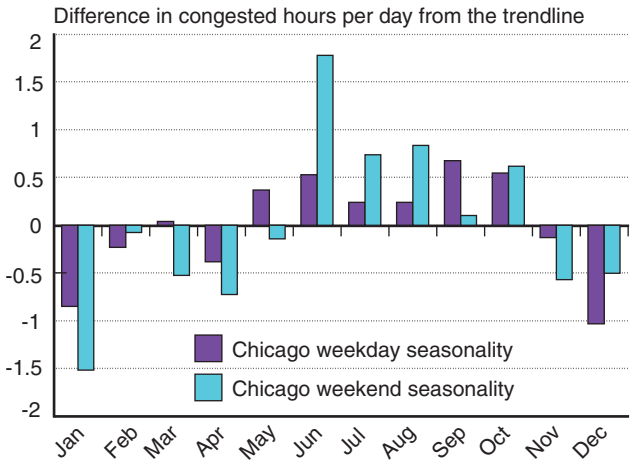
In Chicago, the largest seasonality factors are in December and January (figure 4). In December, the reduced congestion time is almost entirely due to a decrease in the a.m. period. In January, reduced congestion can be attributed to a drop during the p.m. period. During other months of the year, the a.m. and p.m. patterns are generally similar.

There are also differences between weekday and weekend travel in Chicago. For most months the weekday and weekend factors are similar in direction and magnitude, with the biggest differences in January and June. Weekend congested hours are much lower in January and higher in June (figure 5).

Seasonal Factors for Los Angeles

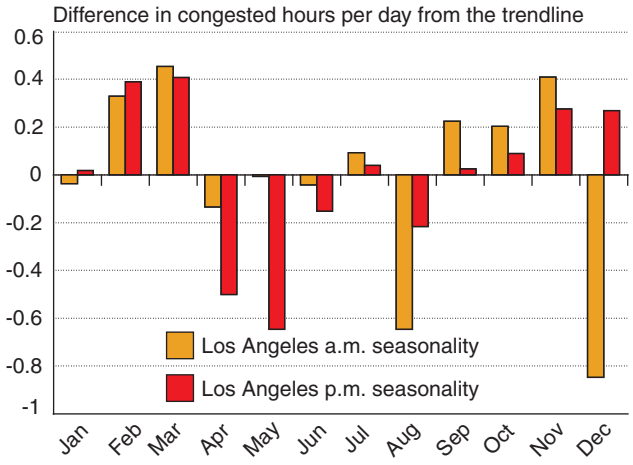
Los Angeles has a different seasonal pattern. The a.m. periods in August and December have lower than normal congestion levels. There is also a different pattern of congestion during December than in other months. In December, the p.m. period has somewhat higher congestion levels than normal, while the a.m. period is notably lower. In contrast, congestion during the p.m. periods in April and May is lower than normal, while congestion during the a.m. periods for those months is about normal (figure 6).

Figure 5: Monthly Variation in Chicago's Weekday and Weekend Congested Hours due to Seasonal Factors



SOURCE: Calculated from data used in preparation of Federal Highway Administration, *Urban Congestion Report*, April 2004 – April 2007.

Figure 6: Monthly Variation in Los Angeles' a.m. and p.m. Congested Hours due to Seasonal Factors



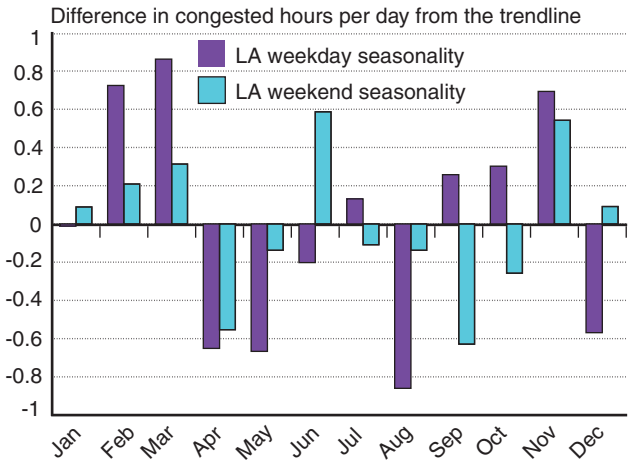
SOURCE: Calculated from data used in preparation of Federal Highway Administration, *Urban Congestion Report*, April 2004 – April 2007.

The weekday seasonality and weekend seasonality in Los Angeles, in contrast to Chicago, have several months with factors in opposite directions. In Los Angeles, the greatest variability is in the weekday periods, with the highest congestion levels in February and March, and the lowest in August. Weekend congestion is highest in June and lowest in September (figure 7).

Seasonal Factors for Houston

Congestion levels in Houston in the a.m. periods in July and December are lower than normal. But the estimated July seasonal factor may not be indicative of a seasonal effect because two of the three July values in the series were

Figure 7: Monthly Variation in Los Angeles' Weekday and Weekend Congested Hours due to Seasonal Factors



SOURCE: Calculated from data used in preparation of Federal Highway Administration, *Urban Congestion Report*, April 2004 – April 2007.

signaled as outliers – in opposite directions. In other months, there were only small variations in Houston congestion levels (figure 8).

Overall weekday congestion in Houston in December is lower than normal. Weekday congestion is highest during September. Weekends show very little variation during the year (figure 9).

Final Comments

For the three cities under study, key similarities and differences were found in the dataset on the monthly average number of congested hours per day from April 2004 through April 2007:

Weekday congestion (a.m. and p.m. combined):

- All three cities had low congestion in December (between approximately ½ to 1 hour fewer congested hours per day). The lowest level of congestion for Chicago and Houston was in December, but in August for Los Angeles.
- All three cities had higher than average levels of congestion in both September and October. Chicago and Houston had the highest levels of congestion in September, while Los Angeles had its highest congestion in March.

The weekday patterns are not always mirrored in the morning and afternoon periods. The two time periods do not always have the same degree of congestion for each month, possibly confounding the monthly weekday congestion estimates:

Morning (a.m.) congestion:

- The lowest average morning congestion for all three cities is in December.

- Weekday morning congestion is worst in Los Angeles in March, and in Chicago and Houston in September.

Afternoon (p.m.) congestion:

- Both Chicago and Houston have the lowest afternoon congestion in January, while May is the lowest for Los Angeles.
- Los Angeles' afternoon congestion is worst in February and March, Chicago's is worst in September, and Houston is worst in July and November.

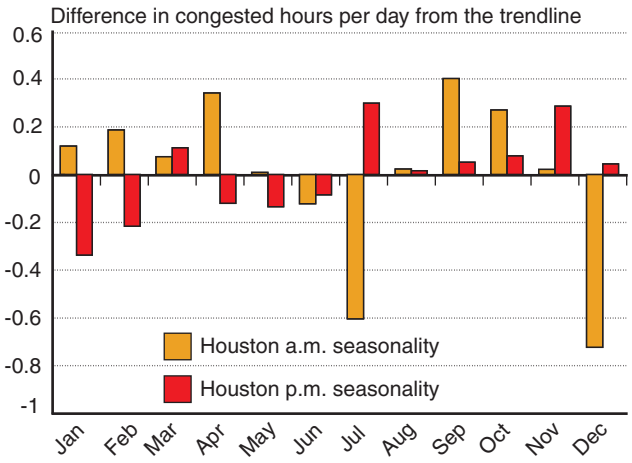
Congestion patterns change during the weekends, when fewer commuting trips are made. But there are still differences among the three cities.

Weekend congestion:

- Chicago has the most extreme differences of weekend congestion during the year, ranging from about 1¾ more congested hours per day in June to about 1½ hours less congestion per day in January.
- In Los Angeles, weekend congestion is highest in June and November, and lowest in April and September.
- In Houston, weekend congestion changes little throughout the year.

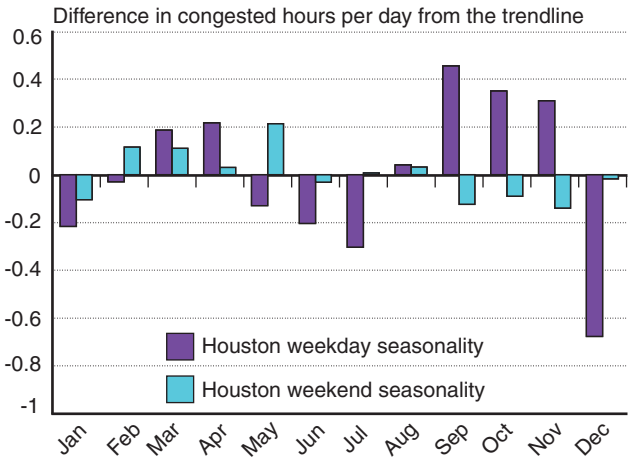
As more congestion data are gathered over the next few years, the estimates of these seasonal factors will improve, thereby allowing more in-depth statistical studies of the seasonality of congestion.

Figure 8: Monthly Variation in Houston's a.m. and p.m. Congested Hours due to seasonal Factors



SOURCE: Calculated from data used in preparation of Federal Highway Administration, *Urban Congestion Report*, April 2004 – April 2007.

Figure 9: Monthly Variation in Houston's Weekday and Weekend Congested Hours due to Seasonal Factors.



SOURCE: Calculated from data used in preparation of Federal Highway Administration, *Urban Congestion Report*, April 2004 – April 2007.

About this Report

This report was prepared by Jeffery Memmott and Peg Young, members of the Bureau of Transportation Statistics (BTS) Trending and Forecast Team. BTS is a component of DOT's Research and Innovative Technology Administration (RITA). The estimates in this report were developed from monthly Intelligent Transportation System congestion data collected and compiled for the Federal Highway Administration by the Texas Transportation Institute and Noblis, Inc.

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