HOTEL HORIZONS®

ASSESSING ACCURACY: *HOTEL HORIZONS®* FORECASTS

August 5, 2015

Executive Summary

The staff at PKF Hospitality Research, A CBRE Company proudly presents this report documenting the accuracy of our *Hotel Horizons®* forecasts of financial performance for U.S. lodging markets. This assessment is developed from comparisons between forecast changes in hotel market performance and actual changes during the period 2010 through 2014. We also compare our econometric forecasts to forecasts using an intuitive scenario. The analysis covers short-term accuracy defined as rolling one-year forecasts versus actual results for RevPAR, ADR, occupancy, supply, and demand. Long-term accuracy over the five-year interval also is reported. We provide evidence of annual forecasting accuracy for all U.S. hotels, hotel chain-scales, across locations, and for 50 U.S. markets. Various statistical measures, such as mean absolute error and Theil's U statistics, are relied on to assess accuracy.

The main findings from this self-assessment are as follows:

1. The *Hotel Horizons®* approach of combining econometric analysis and expert judgment is shown to be consistently more accurate than an intuitive approach based on common sense methods such as using a previous year's performance as a guide.
2. Forecast accuracy declines around turning points in the hotel cycle and improves as time moves further from the turning point, which is during the up-phases and down-phases of the cycle.
3. To some extent, the data we receive from other sources impacts the accuracy of our forecasts. This includes changes in historical data series, and the forecasting errors of data providers upon whom we rely.
4. Our forecasts largely proved to err on the side of caution as 41 of the 50 MSAs we cover had actual performance that exceeded our forecast.
5. Forecasts for the upper-priced chain scales tended to be more accurate over time than the lower-priced chains.

1. Introduction and Overview of U.S. Hotel Market Fundamentals Since 2010

This report contains an accuracy self-assessment of the PKF Hospitality Research, a CBRE Company (PKF-HR) *Hotel Horizons®* forecasts. This assessment is developed from comparisons between forecast changes in hotel market performance and actual changes during the period 2010 through 2014. We also compare our econometric forecasts to forecasts from an intuitive scenario. Previous analyses were conducted during 2005, 2010 and 2014. As part of the 2015 assessment, we examine outcomes from the slow economic recovery beginning in 2010 and the impact of events during the economic recovery on hotel market forecasting accuracy. Specifically, the study analyzes *Hotel Horizons®* forecasts released during the first quarter of each year from 2010 through 2014.

We analyze short-term accuracy defined as rolling one-year forecasts versus actual results for revenue per available room (RevPAR), average daily rate (ADR), occupancy (OCC), demand (*i.e.,* rooms sold), and supply (*i.e.*, rooms available). Long-term accuracy over the five-year interval also is reported. The exhibits contained herein display information about annual forecasting accuracy for all U.S. hotels, hotel chain scales, across locations, and for 50 of the 59 *Hotel Horizons®* Metropolitan Statistical Area (MSA) markets[1]. We rely on various statistical measures, such as mean absolute error and Theil's U statistics, to assess accuracy.[2]

The period covered in our self-assessment was characterized by a slow recovery and expansion from one of the most volatile periods in recent economic history. Cyclical phase changes in general economic conditions brought about coincidental, but not necessarily synchronous, movements in hotel market performance measures. This response is reflected in the performance history for U.S. hotels shown in Exhibit 1. Between 2009 and 2014, RevPAR growth for all U.S. hotels went from negative 16.7 percent to greater than eight percent. This roller coaster ride of financial performance was most pronounced for higher priced hotels relative to lower-priced hotels.

Exhibit 1: U.S. Hotel Performance, 2009-2014 (Y-O-Y % Change)

ALL HOTELS	2009	2010	2011	2012	2013	2014
Occupancy	-8.8	5.5	4.2	2.3	1.3	3.5
ADR	-8.6	-0.2	3.8	4.2	3.8	4.5
RevPAR	-16.7	5.4	8.1	6.6	5.2	8.2
UPPER-PRICED HOTELS						
Occupancy	-7.5	6.9	3.6	2.2	1.3	2.6
ADR	-11.8	-0.8	3.9	4.1	4.1	4.5
RevPAR	-18.4	6.0	7.6	6.4	5.5	7.2
LOWER-PRICED HOTELS						
Occupancy	-9.9	5.4	4.5	2.5	1.3	4.0
ADR	-5.9	-1.6	2.8	4.2	3.1	4.3
RevPAR	-15.2	3.6	7.4	6.8	4.4	8.5

Source: PKF-HR, STR, Inc.

The implications for forecasting in conditions such as these are twofold. First, entirely unexpected events, such as the 2012-2013 federal budget crises, cannot be woven into forecasts performed prior to such events. While the economy was in a steady recovery, not many experts predicted the political risks created by the U.S. Government flirting with financial default in 2012 and 2013. These political events are not easily forecast from economic data. Second, modern forecasting models perform best during prolonged cyclical up phases and down phases and perform their worst around turning points. Following turning

[1] Nine of the 59 *Hotel Horizons®* MSAs are not included in this assessment because they are new markets to the *Hotel Horizons®* universe. Therefore, these markets contain no previous forecasts to compare against their current forecasts.
[2] These measures are defined later in this report and in Appendix A.

points, forecasting models tend to 'reconnect' and do a better job of informing about future conditions. The realities of forecasting hotel market performance throughout this period appear quite clearly in this assessment report. Our accuracy was most impressive following 2010 once the economic recovery was well established.

The remainder of this report is organized as follows. Section II describes how PKF-HR approaches hotel market forecasting including discussions about the data used, the statistical techniques employed, and the potential sources of forecasting errors. In Section III we provide details about the measures introduced to assess the accuracy of *Hotel Horizons®* forecasts. The subsequent two sections (i.e., 4 and 5) present the results of our assessments for all U.S. hotels, chain scales, locations, and 50 of the 59 *Hotel Horizons®* MSAs we cover, respectively. The final section gives a summary of our forecasting effort during the period 2010-2014.

2. How *Hotel Horizons®* Forecasts Are Produced

PKF-HR prepares hotel market forecasts based on accepted econometric procedures and sound judgment. The two-stage process for producing the forecasts firstly involves econometric estimation of future hotel market activity and financial performance based on historical relationships between economic and hotel market variables, and secondly, a judgmental review of modeled outputs by experienced hotel market analysts. The hotel industry expertise of PKF dates back to the 1930s. PKF-HR and others believe that errors in forecasting are minimized by relying on both data analytics and judgment.

2.1 Econometric Models

The *Hotel Horizons®* econometric forecasting models fall into the category of multi-equation, demand and supply models. These models have the structure defined below, but vary in their construction for particular market applications (e.g., different cities and hotel market segments). The three estimated equations are:

1. Demand for hotel rooms is primarily driven by the general level of economic activity in the nation or city, as measured by income and employment. The equation recognizes the fundamental relationship between room purchasing behavior and either growth or decline in the relevant economy. Both economic theory and historical data relationships strongly support the inclusion of ADR in the demand equation because lower ADRs motivate increases in travel and leisure spending, while higher ADRs motivate decreases.
2. Supply change - In historical lodging data, a strong relationship exists between growth in the supply of new hotel rooms and prior-period lodging market conditions. In the equation, new hotel room growth in modeled as a function of past levels of new room growth, past ADR, and past occupancy levels.
3. ADR movements are correlated with room scarcity in the market. The equation which estimates ADR defines ADR as a function of past room rates and contemporaneous occupancy levels.

The parameters (*i.e.*, coefficients on each variable) then are used to forecast demand, supply change, and real ADR by multiplying the parameters by forecasts of the economic variables and relevant previously estimated values (lagged variables). Three additional calculations are made with these results, as follows:

1. Supply change is added to the previous-period number of available rooms to produce an available rooms level in future periods.
2. Number of rooms sold is divided by number of available rooms to obtain occupancy percent in each future period.
3. Expected inflation is added to real ADR to convert to nominal ADR

2.2 Judgmental Intervention

A committee of hotel experts from PKF-HR and CBRE Hotels performs a thorough review of each model prediction. These assessments are made by locally-based hotel experts working in the various CBRE offices around the U.S. The quarterly forecasts for the current and forecast period years are subject to review. The committee modifies the model's market prediction when there is compelling evidence that factors have come into play that the model could not possibly foresee. A Super Bowl-type event, as an extreme example, would cause the committee's forecast to differ noticeably from the model's prediction—not only in the city in which the event will occur, but also competing cities within the region. In most instances, however, the committee either defers to the model prediction or makes modest adjustments.

2.3 Data Sources and Issues

The forecasts utilize historical data from STR beginning in Q1 1987 and involve three performance measures – rooms available, rooms occupied, and rooms revenue. Using these measures we compute three additional measures – ADR, occupancy percent, and RevPAR. The STR universe, currently about five million rooms, represents a majority of the hotel rooms in the U.S. As they modify the census over time, analysts at STR alter the historical record. Hence in producing this accuracy assessment, we made certain that forecast results and histories are in synchronization.

The second important data source for *Hotel Horizons®* forecasts is Moody's Analytics[3]. The vast array of economic variables provided by this firm, both at the national and MSA geographic strata, provide a rich testing environment for the development of stable relationships between economic and hotel market experiences. We use the historical information from Moody's and STR to build regression equations.

[3] Starting with the March 2015 forecast, PKF-HR has switched to using CBRE Econometric Advisors forecasts of the main macroeconomic variables used in its econometric models.

Exhibit 2: Moody's Percent Change in Employment, 2014

MSA	FORECAST	ACTUAL	ERROR
Albuquerque	0.4	-0.6	-1.1
Anaheim	2.3	1.9	-0.4
Atlanta	2.4	2.3	0.0
Austin	3.1	3.7	0.5
Baltimore	2.4	1.5	-0.8
Boston	2.0	1.8	-0.2
Charlotte	3.3	2.3	-1.0
Chicago	1.8	0.8	-0.9
Cincinnati	0.5	1.6	1.1
Cleveland	0.2	0.8	0.6
Columbus	0.5	0.4	-0.1
Dallas	2.7	3.8	1.1
Denver	2.2	2.6	0.5
Detroit	1.7	0.3	-1.3
Fort Lauderdale	2.6	2.9	0.3
Fort Worth	2.7	2.7	0.0
Hartford	1.2	0.4	-0.8
Houston	2.3	3.6	1.3
Indianapolis	2.2	1.9	-0.2
Jacksonville	1.8	3.2	1.3
Kansas City	2.1	0.7	-1.3
Long Island	1.1	1.4	0.2
Los Angeles	1.9	2.1	0.3
Memphis	1.5	0.9	-0.7
Miami	2.1	2.9	0.8

MSA	FORECAST	ACTUAL	ERROR
Minneapolis	2.0	1.6	-0.3
Nashville	2.6	3.0	0.4
New Orleans	1.5	1.6	0.1
New York	1.6	1.7	0.2
Newark	2.1	0.9	-1.2
Oahu	1.7	1.0	-0.8
Oakland	1.6	2.1	0.5
Orlando	3.0	3.6	0.5
Philadelphia	1.4	0.7	-0.7
Phoenix	2.6	2.0	-0.6
Pittsburgh	1.7	0.5	-1.2
Portland	1.4	2.8	1.3
Raleigh-Durham	3.3	4.0	0.7
Richmond	1.3	1.6	0.3
Sacramento	1.8	2.1	0.2
Saint Louis	1.4	1.4	0.0
Salt Lake City	2.3	2.8	0.5
San Antonio	2.4	2.5	0.1
San Diego	2.1	2.5	0.4
San Francisco	2.7	3.2	0.5
Seattle	0.6	2.8	2.2
Tampa	2.3	2.0	-0.3
Tucson	1.7	1.5	-0.2
Washington DC	0.9	0.3	-0.5
West Palm Beach	2.8	2.7	0.0

Sources: Moody's, PKF-HR

An implication from using Moody's forecasts is that our forecasts pick up errors from their models along with errors from our models. Exhibit 2 presents errors from Moody's 2014 annual employment forecast of the 50 *Hotel Horizons®* MSAs included in this report. The impact of these errors on *Hotel Horizons®* forecasting accuracy is not measured here in a direct way and tests show almost zero correlation between errors. We also see that the forecast errors for Moody's MSAs are quite small. Moody's Analytics 2015 forecast review states, "With the continuing extension of economic recovery and the housing market making contributions to growth, the relative performance of states and metro areas was slightly easier to forecast than in previous years."[4] These minor errors had minimal impact on the *Hotel Horizons®* forecast error.

3. Accuracy Assessment Methodology

Assessing the accuracy of forecasts involves an analysis of errors, and often an examination of the sources of those errors. The 2015 version of PKF-HR's self-assessment of *Hotel Horizons®* forecasts involves both the investigations of absolute errors – those from taking differences between actual performances realized after forecasting and forecast performance made before realizations – and relative

[4] Nathan Kelley. *Regional Financial Review*. Moody's Analytics, April 2015, pg.43

errors – those from taking differences between *Hotel Horizons®* forecasts and forecasts from an intuitive approach.

3.1 Absolute Measures

The errors generated from *Hotel Horizons®* forecasts, *e*, may be defined as the differences between actual hotel market results, *A*, reported each year by STR and the PKF-HR forecast numbers, *F*, such that

$$e = A - F \qquad (1)$$

An appropriate way to represent these errors involves not allowing negative and positive 'misses' to cancel each other. The effect of the mathematical signs needs to be removed either by taking the absolute value of e ($|e|$) or by squaring e (e^2). Thus the mean absolute error (MAE) can be defined as

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|e_i| \qquad (2)$$

And, the mean square error (MSE) can be defined as

$$MSE = \frac{1}{n}\sum_{i=1}^{n} e^2 \qquad (3)$$

Another absolute accuracy assessment measure is Theil's U1 statistic. This statistic ranges between zero and one. The closer the statistic is to zero the better the forecast accuracy (see Appendix A for details).

3.2 Relative Measures

Forecasts are often evaluated in relative terms as well as absolute terms. Typically, the forecast results generated by the theoretically preferred model are evaluated against results from an alternative, very simply conceived set of assumptions about the future referred to as the intuitive model. For our intuitive approach, we used a simple six year moving average of performance for the each measure and location. This assumption follows the general practice of inferring that the next year's growth rate will be similar to what has happen in the near-term history and by taking a six year average, we can smooth out any large deviations caused by shocks to performance.

Theil's U2 statistic provides a measure of relative accuracy. This statistic is centered on 1.0. If the U2 statistic is less than 1.0, the preferred/sophisticated method results in the more accurate forecasts (see Appendix A for details).

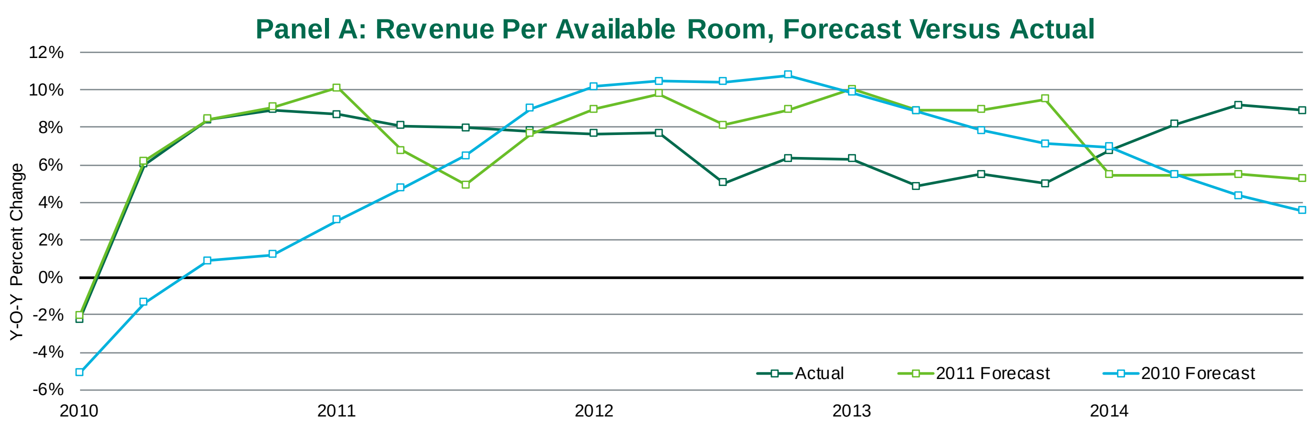
4. Accuracy of U.S. and Chain Scale, and Location Forecasts

The five panels in Exhibit 3 provide graphical presentations of the March 2010 and March 2011 Hotel Horizons® forecasts of the five hotel market performance metrics – RevPAR, ADR, occupancy, demand, and supply – for the U.S. along with the actual results. These graphs support the point made above as to the inherent inaccuracy of forecasts produced during cyclical turning points in the market. The graphs also show that our 2011 forecast more accurately fit the actual data than the 2010 forecast. As has been the case following previous recessions, there tends to be a pronounced bounce off the bottom of the cyclical trough during early recovery which shows up in our 2011 forecast but is absent from the 2010 forecast. By 2011, both sets of forecasts aligned closely with actual results for all market metrics.

Forecasting demand during a recession requires some insight as to where the economy is in the business cycle. The sharp drop in demand during the Great Recession recovered quite strongly by 2010. The 2010 forecast (*i.e.* 2009 year data) underestimated how quickly the recovery would take hold. This was corrected by the 2011 forecast, once the economy was returning to normal. Forecast and actual data show that both models closely track actual performance during the period of economic recovery from 2011-2014. The same story holds true for RevPAR and Occupancy. Panels A, C, and D in Exhibit 3 demonstrate this point.

Clearly, hotel supply change is a special case in recessions and recoveries relative to other market measures given the nature of hotels as durable assets.[5] Supply additions from construction, and reductions from removals, create patterns through time that ordinarily do not conform to the business cycle.[6] While supply is the most stable of market measures, constructing supply forecasting models is challenging. Panel E of Exhibit 3 demonstrates this point. Both forecasts of supply were slightly off with 2010 under forecasting supply and 2011 over forecasting through 2013. Following the Fiscal Cliff crisis in 2013, supply has remained below both model predictions reflecting a lack of access to financing for construction or caution on the part of hotel investors given the political risks in the economic climate of 2012-2013.

Exhibit 3: Comparisons of Actual and Forecast Performance of All U.S. Hotels from Two *Hotel Horizon*® Releases, March 2010 and March 2011

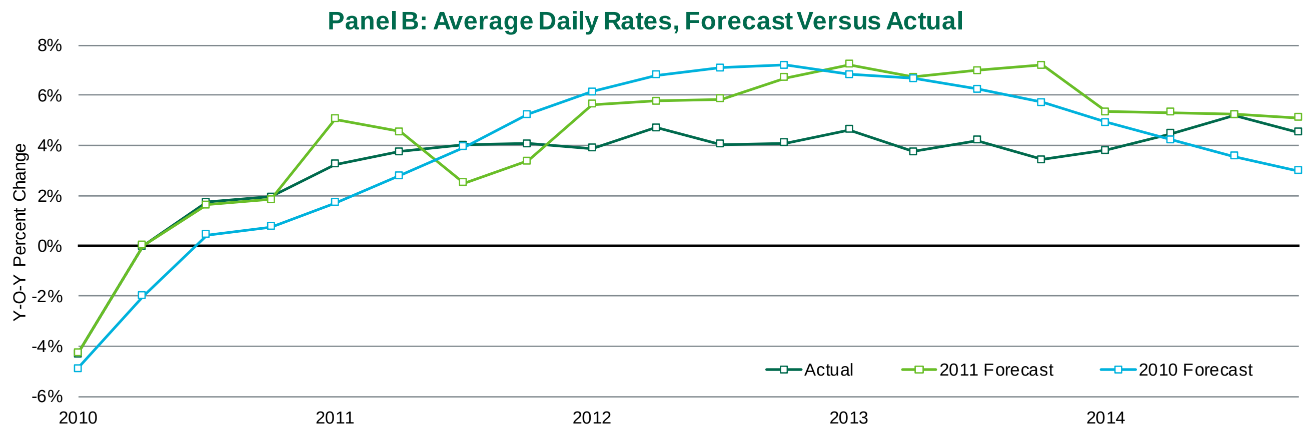


Note: This graph compares the five-year, quarterly forecast of RevPAR percent changes made in both March 2010 and March 2011 with actual percent changes.
Sources: PKF-HR and STR, Inc.

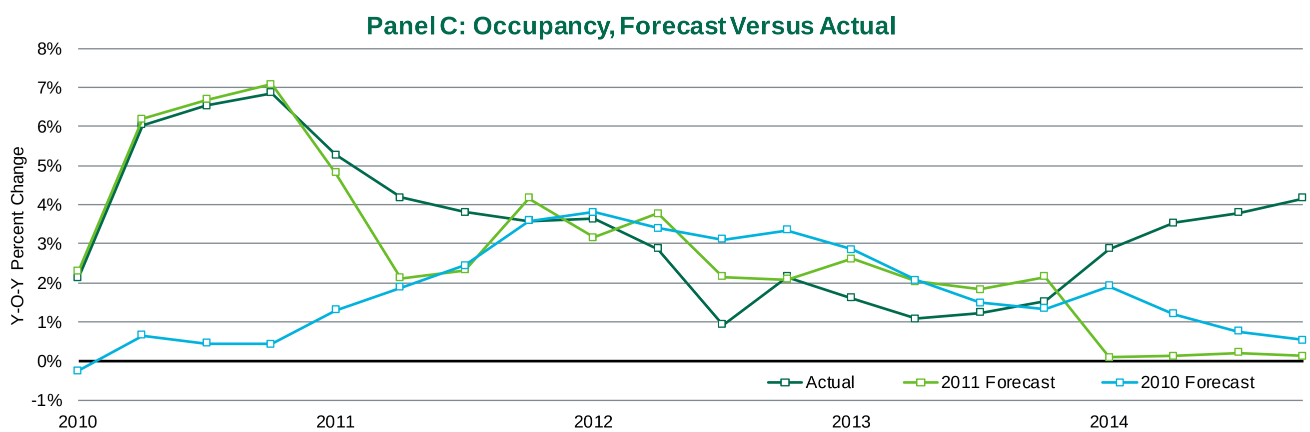
[5] Durable assets, especially operating real estate, cannot be immediately produced when demand increases (i.e., known as delivery lag) and are not immediately taken out of service when demand shrinks, particularly when a downturn is viewed as temporary.

[6] The supply cycles for hotels and some other property types appear to operate independent of the business cycle which determines demand. See William C. Wheaton, 'Real Estate "Cycles": Some Fundamentals.' Real Estate Economics, 1999, 27: 209-230.

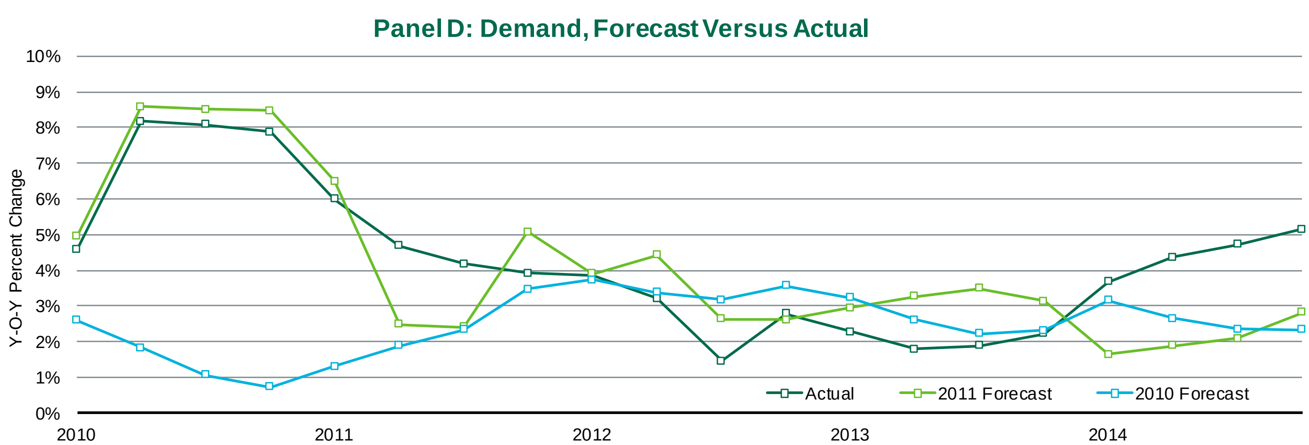
Exhibit 3 Continued



Note: This graph compares the five-year, quarterly forecast of ADR percent changes made in both March 2010 and March 2011 with actual percent changes.
Sources: PKF-HR and STR, Inc.

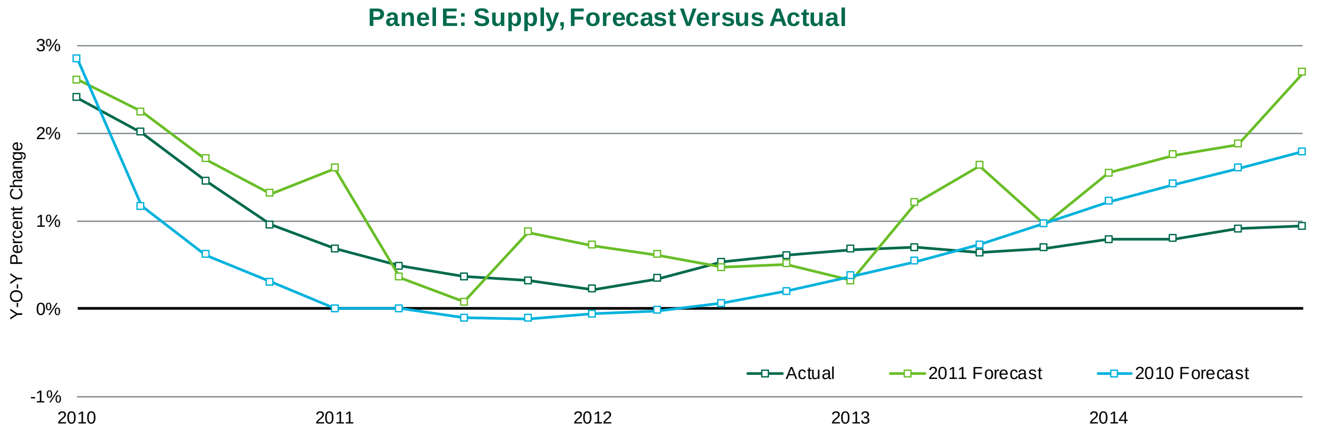


Note: This graph compares the five-year, quarterly forecast of occupancy percent changes made in both March 2010 and March 2011 with actual percent chang
Sources: PKF-HR and STR, Inc.



Note: This graph compares the five-year, quarterly forecast of percent changes in demand made in both March 2010 and March 2011 with actual percent change
Sources: PKF-HR and STR, Inc.

Exhibit 3 Continued



Note: This graph compares the five-year, quarterly forecast of percent changes in supply made in both March 2010 and March 2011 with actual percent changes.
Sources: PKF-HR and STR, Inc.

4.1 Chain Scales

The hotel inventory in the U.S. can be subdivided in many ways. Two common delineations are by market segment for chain-affiliated hotels and by property locations. Each quarter, *Hotel Horizons®* forecasts are prepared for these two types of categorizations. Exhibit 4 presents forecast accuracy in two panels – one for chain scales and the other by locations. The hotel populations differ between these two subdivisions in that the chain scale delineation does not include independent hotels and the location subdivision includes independents. The U.S. hotel industry is comprised of approximately 70 percent chain-affiliated hotels and 30 percent independents. Hence, the chain scale subset is somewhat smaller in the number of hotels and tends to include larger, higher quality properties than the location subset.

Exhibit 4: Absolute and Relative *Hotel Horizons®* RevPAR Forecasting Accuracy, 2010 – 2014

PANEL A: BY CHAIN SCALE REVPAR	2010	2011	2012	2013	2014	AVERAGE, 2010 - 2014
Mean Absolute Error (%)	5.76	1.00	0.93	0.17	2.33	2.04
THEIL'S U1 ANALYSIS OF CHAIN SCALE REVPAR						
Economy	1.00	0.03	0.12	0.14	0.15	0.29
Luxury	0.43	0.08	0.14	0.04	0.10	0.16
Midscale	0.97	0.42	0.30	0.03	0.20	0.39
Upper Midscale	1.00	0.23	0.16	0.12	0.31	0.37
Upper Upscale	1.00	0.04	0.01	0.05	0.17	0.25
Upscale	1.00	0.15	0.05	0.01	0.16	0.27
All Chainscales	1.00	0.07	0.07	0.02	0.16	0.26
THEIL'S U2 ANALYSIS OF CHAIN SCALE REVPAR						
Economy	0.65	0.06	0.22	0.17	0.11	0.24
Luxury	0.64	0.25	0.29	0.12	0.06	0.27
Midscale	1.89	0.69	0.60	0.03	0.13	0.67
Upper Midscale	0.53	0.69	0.66	0.17	0.21	0.45
Upper Upscale	1.32	0.09	0.03	0.08	0.09	0.32
Upscale	1.26	0.39	0.16	0.02	0.08	0.38
All Chainscales	0.92	0.19	0.22	0.02	0.10	0.29

Exhibit 4 Continued

PANEL B: BY LOCATION REVPAR	2010	2011	2012	2013	2014	Average, 2010 - 2014
Mean Absolute Error (%)	6.59	1.07	0.97	0.64	1.72	2.94
THEIL'S U1 ANALYSIS OF LOCATION REVPAR						
Urban	0.90	0.20	0.30	0.13	0.03	0.31
Suburban	1.00	0.04	0.06	0.09	0.15	0.27
Airport	1.00	0.09	0.20	0.12	0.16	0.31
Interstate	1.00	0.11	0.01	0.20	0.17	0.30
Resort	0.54	0.09	0.11	0.12	0.05	0.18
Small Metro/Town	1.00	0.11	0.04	0.02	0.27	0.29
All Locations	1.00	0.07	0.08	0.06	0.12	0.26
THEIL'S U2 ANALYSIS OF LOCATION REVPAR						
Urban	1.80	0.63	0.97	0.34	0.02	0.75
Suburban	1.04	0.10	0.19	0.12	0.09	0.31
Airport	0.96	0.20	0.44	0.17	0.12	0.38
Interstate	1.12	0.36	0.12	0.27	0.09	0.39
Resort	0.29	0.29	0.25	0.18	0.05	0.21
Small Metro/Town	1.76	0.39	0.21	0.03	0.11	0.50
All Locations	0.99	0.20	0.23	0.09	0.07	0.32

Note: The forecast accuracy assessed in this exhibit is for annual RevPAR growth rates at the end of each year from 2010-2014 published in March of that year. The mean absolute error portrays the percentage deviation of the actual RevPAR performance from the forecasts. Theil's U1 measures the forecast accuracy against actual numbers while Theil's U2 measures the quality of the forecast against a naïve forecast as explained in the text. The naive forecasting approach analyzed with the U2 statistic helps determine the advantage of using the technique. See Appendix A for details about Theil's U Statistics.

Sources: PKF-HR and STR, Inc.

The forecast accuracy assessed in Exhibit 4 is for annual RevPAR growth rates at the end of each year from 2010-2014 which were published in March of that year. Each panel includes results from forecast comparisons throughout the analysis period reported using three metrics. Mean absolute error, defined above in Equation (2), is a standard measure of absolute forecast accuracy (*i.e.*, direct comparison of forecast results to actual results). The remaining two measures reported in Exhibit 4, Theil's U1 and U2 statistics, are presented in the text above and formally defined in Appendix A.

For chain scales, the average MAE for the analysis period is quite good at 2.04 percent. This measure varies as expected by year from 2010 through 2014. The error is higher, albeit not alarmingly so, during 2010. The low MAE each year indicates a high level of accuracy during the expansion years of 2011-2014. From the U1 analysis of 2010-2014, the order of the greatest accuracy is: luxury, upper upscale, upscale, economy, upper midscale, and midscale. The relatively poorer performance of the models in 2010 and dramatically better results after each turning point, reinforces the statements made earlier in this report about the difficulty of forecasting at turning points, and also the ability of the models to reconnect in the aftermath. From 2011 to 2014 accuracy improved to a very high level for all chain scales.

From the U2 analysis (*i.e.,* comparing model forecasts to the non-econometric forecasts), the order of forecast accuracy is: economy, luxury, upper upscale, upscale, economy, upper midscale, and midscale. From 2010–2014, all *Hotel Horizons*® forecasts were superior to the non-econometric forecast for all chain scales. Similar to the U1 analysis, the 2010 turning point proved the most challenging for modeling future hotel performance. Nevertheless, the non-econometric forecasting approach tested here is not nearly as accurate as the econometric model and expert judgment underlying *Hotel Horizons*®. The U2 statistic exceeds 1.0 for no chain scales in 2010.

It is also important to note that STR, Inc. made major revisions to the makeup of the chain scales in January of 2011 and how they estimate non-participating hotels. These changes primarily affected the midscale and upper midscale chains and likely contributed to segments being our least accurate.

4.2 Locations

For locations, the average MAE for the truncated analysis period is quite good at 2.94 percent conforming to our chain scale findings. From the U1 analysis of 2010-2014, the order of the greatest accuracy is: resort, suburban, small metro/town, interstate, urban, and airport. The relatively poorer performance of the models in 2010 and dramatically better results thereafter, again reinforces the statements made earlier in this report about the difficulty of forecasting at turning points, and also the ability of the models to reconnect in the aftermath. From 2011 to 2014, accuracy improved to a very high level for all locations.

All *Hotel Horizons*® forecasts were superior to the intuitive forecast from 2011 through 2014 based on the U2 analysis. Over the three year period the order of relative (*i.e.*, to the intuitive approach) accuracy is: resort, suburban, airport, interstate, small metro/town, and urban. As in the case of the chain scale forecasts, the turning point proved the most challenging for modeling future hotel performance, and the *Hotel Horizons*® forecasts are more accurate than the intuitive forecasts.

5. Accuracy of MSA Forecasts

The *Hotel Horizons*® universe covers 59 of the largest Metropolitan Statistical Areas (MSA) in the U.S. in terms of size of the hotel market. These area-specific forecasts are generated each quarter and for each market for the aggregate categories of upper-priced and lower-priced hotels.[7] We evaluate the accuracy of 50 of our MSA forecasts along three dimensions – short-term (i.e., one year forward) during the 2010-2014 evaluation period, rolling forecasts starting with a five-year horizon and continuing in one year increments to a one-year horizon, and one-year forecasts for 2014 which corresponds to the a period of relative hotel market stability.

5.1 One-Year MSA Forecast Accuracy

In Exhibit 5 we present evidence of the accuracy of *Hotel Horizons*® forecasts of MSA RevPARs for one year periods beginning in 2010 and ending in 2014. Specifically, the evaluation covers forecasts made in March of each year for that calendar year. The Theil U statistics appearing in this exhibit are averages of Theil U statistics computed using the single year comparisons of (1) *Hotel Horizons*® forecasts vs. actual RevPAR (*i.e.,* U1) and, (2) *Hotel Horizons*® forecast vs. intuitive forecast (*i.e.*, U2).

[7] A list of these MSA markets can be found at www.pkfc.com. Upper-priced hotels include the chain scale divisions' luxury, upper- upscale and upscale; lower-priced hotels include economy, mid-price, and upper mid-price chain scales.

The column averages of U statistics shown at the bottom of the exhibit indicate that the one-year *Hotel Horizons®* forecasts over this period closely align with realized RevPARs across the 50 MSAs and that the intuitive forecasting idea we tested is not as accurate as the Horizon forecasts. These results are good given the volatile economic recovery experienced during the period. While most of the individual MSA U statistics resemble the 50 city averages, a few areas proved more problematic than others from a forecasting perspective. These are:

- New York – The U2 statistic of 2.28 for upper-priced hotels suggests that the intuitive approach performed as well as the *Hotel Horizons®* forecast. In hindsight, we know that Hurricane Sandy impacted the market and was an unforeseen event.
- Pittsburgh – The intuitive approach performed as well or better than the *Hotel Horizons®* forecast for upper-priced hotels segments. Notwithstanding, the U1 statistics show that our forecasts did a reasonably good job of forecasting actual RevPARs.
- Washington DC – The *Hotel Horizons®* model for all hotels struggled somewhat in this market as indicated by the U statistics. This is likely the results of the large impact the federal government has on the local economy. The city benefited from large federal economic stimulus funding from 2010-2011 and suffered during unexpected austerity measures associated with the 2012-2013 fiscal cliff negotiations.

5.2 Rolling Forecast Accuracy for MSAs

Another perspective on MSA accuracy involves an analysis of annual 2014 forecasts beginning with the publication of RevPAR percent change estimates made in March 2010 for year-end 2014 then rolling forward up to publication in December 2014 (*i.e.,* using data through 2014 Q3) to forecast year end 2014. This analysis serves two purposes. First, it allows readers to evaluate our long-term forecast accuracy (*i.e.,* up to five-year forecasts made in 2010 for 2014). Second, this rolling accuracy report indicates how consistent the forecasts were through the study period.

Exhibit 5: Average Theil U Statistics by MSA for One-Year Forecasts of U.S. Hotel RevPAR, 2010-2014

	ALL HOTELS		UPPER-PRICED HOTELS		LOWER-PRICED HOTELS	
MSA	THEIL'S U1	THEIL'S U2	THEIL'S U1	THEIL'S U2	THEIL'S U1	THEIL'S U2
Albuquerque	0.43	0.98	0.53	1.02	0.42	0.82
Anaheim	0.18	0.42	0.17	0.39	0.28	0.47
Atlanta	0.38	0.61	0.40	0.63	0.41	0.71
Austin	0.33	0.92	0.33	1.07	0.30	0.46
Baltimore	0.50	0.93	0.53	1.02	0.53	1.31
Boston	0.16	0.46	0.15	0.43	0.30	0.42
Charlotte	0.40	0.94	0.43	1.13	0.38	0.79
Chicago	0.21	0.47	0.21	0.46	0.30	0.64
Cincinnati	0.33	0.76	0.49	1.67	0.29	0.54
Cleveland	0.29	0.61	0.36	0.70	0.30	0.57
Columbus	0.40	0.81	0.42	0.79	0.41	0.72
Dallas	0.24	0.46	0.23	0.45	0.28	0.53
Denver	0.43	0.96	0.44	1.11	0.49	0.71
Detroit	0.29	0.48	0.29	0.46	0.35	0.81
Fort Lauderdale	0.33	0.67	0.38	0.79	0.25	0.46
Fort Worth	0.24	0.55	0.25	0.63	0.29	0.46
Hartford	0.38	0.66	0.25	0.51	0.58	1.00
Houston	0.22	0.43	0.16	0.40	0.30	0.47
Indianapolis	0.45	0.72	0.51	0.80	0.40	0.67
Jacksonville	0.30	0.44	0.36	0.50	0.31	0.60
Kansas City	0.25	0.45	0.26	0.49	0.30	0.38
Long Island	0.31	0.51	0.31	0.50	0.34	0.57
Los Angeles	0.21	0.52	0.22	0.55	0.27	0.50
Memphis	0.29	0.49	0.23	0.43	0.36	0.65
Miami	0.36	1.14	0.40	1.12	0.22	0.40
Minneapolis	0.22	0.46	0.23	0.48	0.33	0.93
Nashville	0.39	0.71	0.51	0.92	0.40	0.62
New Orleans	0.30	0.54	0.32	0.58	0.41	0.73
New York	0.60	2.08	0.62	2.28	0.51	0.99
Newark	0.19	0.46	0.19	0.50	0.25	0.92
Oahu	0.27	0.60	0.27	0.57	0.34	0.57
Oakland	0.28	0.55	0.25	0.52	0.33	0.63
Orlando	0.28	0.48	0.34	0.58	0.24	0.53
Philadelphia	0.57	0.99	0.73	1.21	0.40	0.62
Phoenix	0.42	0.56	0.46	0.57	0.38	0.66
Pittsburgh	0.46	1.49	0.55	2.39	0.32	0.43
Portland	0.21	0.59	0.21	0.60	0.27	0.88
Raleigh-Durham	0.32	0.60	0.43	0.74	0.25	0.64
Richmond	0.37	0.61	0.33	0.56	0.47	0.80
Sacramento	0.18	0.29	0.21	0.33	0.20	0.33
Saint Louis	0.30	0.55	0.37	0.69	0.27	0.35
Salt Lake City	0.21	0.72	0.20	0.56	0.29	0.74
San Antonio	0.36	0.85	0.30	0.61	0.44	1.25
San Diego	0.17	0.35	0.20	0.43	0.22	0.40
San Francisco	0.29	0.76	0.27	0.75	0.35	0.53
Seattle	0.19	0.45	0.20	0.46	0.21	0.92
Tampa	0.26	0.42	0.29	0.49	0.25	0.46
Tucson	0.54	0.95	0.43	0.69	0.56	1.21
Washington DC	0.87	1.71	0.90	2.06	0.84	0.84
West Palm Beach	0.30	0.43	0.33	0.47	0.33	0.50
Average of All 50 Markets	0.33	0.69	0.35	0.76	0.35	0.66

Note: This table shows average Theil U1 and U2 statistics for the one-year *Hotel Horizons* ® forecasts made each year from 2010-2014, for U.S. hotels in 50 major MSAs. Theil's U1 statistic ranges between 0 and 1; the closer U1 is to zero, the better the forecast. The benchmark/naive forecast for computing the Theil U2 statistic is described in the text. U2 takes a value less than one when the *Hotel Horizons* ® forecast outperforms the benchmark and a value greater than one when it does not.

Sources: PKF-HR, STR, Inc.

The top row of Exhibit 6 presents the MAEs for each 2014 forecast published at annual intervals from March 2010 through March 2014 and then at quarterly intervals during 2014. As expected, the size of the errors is directly related to the length of the forecast. The MSA forecasts made in March 2010 produced a MAE of 5.6 percent, and the shortest-term forecast for year-end 2014 made in December 2014 (*i.e.,* using data through 2014 Q3) generated an MAE of less than one percent.

The March 2010 MSA forecasts generated some large misses in certain MSAs, for example, Nashville (3.3% vs. 19.0% actual) and Oakland (1.8% vs. 15.3% actual). It also resulted in excellent predictions in some large markets, for example, Philadelphia (5.6% vs. 4.7% actual) and New Orleans (5.2 % vs. 4.7% actual). Economists at PKF-HR have reconfigured the models in MSA markets in which the forecasts produced less than acceptable results. Back testing indicates that the new models perform far better than those used for this assessment and should result in smaller errors in the future.

It should also be noted that by analyzing percent changes instead of levels, previous year's performance may be influencing actual percent changes in 2014.

Exhibit 6: MSA *Hotel Horizons*® 2014 Forecast Consistency - RevPAR % Change Forecast from 2010– 2014

	Forecast of 2014 Completed in:								
	Mar-10	Mar-11	Mar-12	Mar-13	Mar-14	Jun-14	Sep-14	Dec-14	Actual
MEAN ABSOLUTE	5.6	4.4	3.4	3.3	3.2	2.5	1.5	0.7	N/A
Albuquerque	3.9	5.3	8.2	5.0	6.1	5.9	5.3	5.7	6.2
Anaheim	2.2	5.8	6.9	8.1	6.1	7.6	7.8	7.6	9.5
Atlanta	5.9	5.8	7.2	6.9	6.3	8.7	10.5	12.7	13.1
Austin	6.3	6.0	7.2	5.4	7.4	8.4	7.9	7.6	8.0
Baltimore	6.4	8.0	7.8	8.9	5.2	4.8	7.3	7.8	8.0
Boston	2.0	3.0	7.9	7.8	8.0	8.5	9.9	11.5	10.8
Charlotte	5.1	5.7	6.0	10.0	6.6	7.0	10.2	11.7	11.9
Chicago	3.1	5.6	10.3	9.8	6.2	4.7	2.3	5.5	7.1
Cincinnati	4.0	6.3	8.3	5.1	5.5	5.9	7.6	7.7	7.4
Cleveland	3.5	5.4	7.3	8.5	6.3	4.3	4.5	4.5	3.8
Columbus	4.2	3.8	7.1	8.3	4.7	5.3	6.5	7.1	6.4
Dallas	2.3	5.6	9.3	7.7	7.4	9.0	10.0	10.1	9.0
Denver	4.2	3.2	8.8	8.9	6.2	9.6	12.5	15.5	16.2
Detroit	3.1	6.3	8.0	6.7	5.4	4.8	7.1	9.3	10.0
Fort Lauderdale	7.3	6.6	6.3	6.8	7.1	8.3	9.2	10.1	10.9
Fort Worth	5.1	7.1	8.1	7.1	6.4	6.3	6.6	6.5	6.4
Hartford	0.7	6.2	6.2	8.7	5.6	3.3	3.3	4.7	4.8
Houston	4.8	8.7	8.1	8.0	7.9	9.6	9.7	9.4	9.7
Indianapolis	5.4	3.5	5.7	6.9	5.9	7.1	9.2	10.3	9.8
Jacksonville	3.2	7.8	7.0	7.7	6.6	6.3	9.6	11.2	12.3
Kansas City	2.3	6.1	6.6	7.8	6.6	6.7	9.5	9.7	11.7
Long Island	5.4	7.2	6.1	7.0	1.4	-1.6	-0.5	1.5	0.7
Los Angeles	3.6	4.3	8.2	7.5	7.2	7.7	8.3	10.2	10.3
Memphis	2.6	6.6	8.0	6.6	5.9	8.6	13.6	13.9	12.7
Miami	3.8	4.1	4.4	6.0	6.3	6.3	7.4	7.0	7.0
Minneapolis	1.9	4.8	6.4	8.9	6.9	4.7	6.3	8.7	7.5
Nashville	3.3	3.9	5.3	5.8	8.7	13.2	18.2	17.9	19.0
New Orleans	5.2	4.5	3.1	3.1	4.0	2.4	2.9	5.6	4.5
New York	5.4	8.6	6.5	6.8	3.9	4.1	3.4	3.3	2.3
Newark	3.5	10.5	6.9	9.7	6.5	5.4	4.4	4.9	5.0
Oahu	1.4	5.8	6.2	7.6	6.6	6.1	4.0	6.1	6.5
Oakland	1.8	6.7	8.9	12.3	9.7	9.0	12.9	15.0	15.3
Orlando	2.6	3.5	6.6	7.4	8.0	8.8	9.0	9.5	10.7
Philadelphia	5.6	9.7	9.6	4.4	1.7	3.2	4.4	4.8	4.7
Phoenix	5.1	4.6	6.1	7.5	4.0	7.8	6.4	9.2	10.5
Pittsburgh	5.2	6.1	5.7	8.0	5.4	4.2	4.9	6.1	6.2
Portland	4.1	6.8	8.0	7.6	8.0	9.5	8.2	10.0	11.7
Raleigh-Durham	6.3	5.0	6.8	7.9	7.2	8.2	11.9	12.2	11.5
Richmond	2.1	6.8	7.8	6.4	5.5	5.3	9.6	11.5	11.2
Sacramento	6.0	3.7	9.7	8.3	7.2	5.9	7.2	8.1	9.0
Saint Louis	1.2	6.9	8.4	4.6	5.9	8.1	9.0	10.7	10.0
Salt Lake City	0.1	4.4	8.4	6.9	6.9	5.0	4.4	6.6	5.4
San Antonio	3.2	6.4	7.7	8.8	5.3	5.1	3.5	5.5	5.5
San Diego	1.5	2.8	6.3	8.8	5.4	7.5	9.4	9.7	9.4
San Francisco	3.5	4.7	6.0	9.2	11.4	12.3	12.8	12.7	12.6
Seattle	4.4	5.1	6.9	8.6	6.9	9.5	9.9	13.0	12.5
Tampa	3.5	5.8	6.8	9.0	6.2	7.0	9.8	11.8	12.0
Tucson	4.6	4.6	7.9	12.3	5.4	2.9	3.3	3.1	2.6
Washington DC	3.6	6.0	4.4	7.0	-0.6	-1.4	1.2	5.5	5.1
West Palm Beach	0.3	2.4	6.8	10.0	5.0	6.9	8.2	8.9	9.5

Note: This table shows the changes in the *Hotel Horizons* ® forecasts for 2014 from a five-year horizon (*i.e.,* 2010-2014) to a one quarter horizon (*i.e.,* 2014 Q3 - year end 2014) for 50 major MSAs. Mean Absolute Error is the average of the absolute values of the 2013 actual RevPAR minus the forecast RevPAR for the 50 MSAs.

Sources: PKF-HR and STR, Inc.

5.3 2014 MSA Forecast Accuracy

Finally, we report MSA forecast accuracy for the year-end RevPAR percent changes realized from the forecast produced in March of 2014 (*i.e.,* using 2013 year end data). As shown in Exhibit 7, both U1 and U2 statistics provide evidence of accurate forecasting. All of the U1 statistics are less than 0.50 across the 50 MSAs with the exception of Washington DC, and only six of the U2 statistics exceed 1.0. The *Hotel Horizons®* method was the least effective for this stable-year forecast, mainly in the same MSAs as we discovered when assessing the five-year forecasts, led by Baltimore and Nashville. To our credit, PKF-HR forecasted Nashville to have the second highest RevPAR growth among our 50 cities and it exceeded even our robust expectations. By contrast the simple difference between 2014 forecast and 2014 actual RevPAR change is less than one percent in the following MSAs: Albuquerque, Austin, Chicago, Fort Worth, Hartford, Long Island, Miami, Minneapolis, New Orleans, Oahu, Pittsburgh, and San Antonio. Our forecasts largely proved to err on the side of caution as 41 of the 50 MSAs we covered had actual performance that exceeded our forecast.

Exhibit 7: Actual Performance vs. *Hotel Horizons*® Outlook Published in March 2014- All Hotels

MSA	THEIL'S U1 STATISTIC	THEIL'S U2 STATISTIC	REVPAR, ANNUAL % CHANGE, 2014 FORECAST	ACTUAL	ERROR
Albuquerque	0.43	0.98	6.1	6.2	(0.1)
Anaheim	0.18	0.42	6.1	9.5	(3.4)
Atlanta	0.38	0.61	6.3	13.1	(6.8)
Austin	0.33	0.92	7.4	8.0	(0.6)
Baltimore	0.50	0.93	5.2	8.0	(2.8)
Boston	0.16	0.46	8.0	10.8	(2.8)
Charlotte	0.40	0.94	6.6	11.9	(5.4)
Chicago	0.21	0.47	6.2	7.1	(0.8)
Cincinnati	0.33	0.76	5.5	7.4	(1.9)
Cleveland	0.29	0.61	6.3	3.8	2.5
Columbus	0.40	0.81	4.7	6.4	(1.7)
Dallas	0.24	0.46	7.4	9.0	(1.6)
Denver	0.43	0.96	6.2	16.2	(10.0)
Detroit	0.29	0.48	5.4	10.0	(4.6)
Fort Lauderdale	0.33	0.67	7.1	10.9	(3.8)
Fort Worth	0.24	0.55	6.4	6.4	0.1
Hartford	0.38	0.66	5.6	4.8	0.9
Houston	0.22	0.43	7.9	9.7	(1.9)
Indianapolis	0.45	0.72	5.9	9.8	(3.9)
Jacksonville	0.30	0.44	6.6	12.3	(5.7)
Kansas City	0.25	0.45	6.6	11.7	(5.2)
Long Island	0.31	0.51	1.4	0.7	0.7
Los Angeles	0.21	0.52	7.2	10.3	(3.2)
Memphis	0.29	0.49	5.9	12.7	(6.8)
Miami	0.36	1.14	6.3	7.0	(0.7)
Minneapolis	0.22	0.46	6.9	7.5	(0.6)
Nashville	0.39	0.71	8.7	19.0	(10.4)
New Orleans	0.30	0.54	4.0	4.5	(0.5)
New York	0.60	2.08	3.9	2.3	1.6
Newark	0.19	0.46	6.5	5.0	1.4
Oahu	0.27	0.60	6.6	6.5	0.1
Oakland	0.28	0.55	9.7	15.3	(5.6)
Orlando	0.28	0.48	8.0	10.7	(2.7)
Philadelphia	0.57	0.99	1.7	4.7	(3.0)
Phoenix	0.42	0.56	4.0	10.5	(6.5)
Pittsburgh	0.46	1.49	5.4	6.2	(0.8)
Portland	0.21	0.59	8.0	11.7	(3.7)
Raleigh-Durham	0.32	0.60	7.2	11.5	(4.3)
Richmond	0.37	0.61	5.5	11.2	(5.7)
Sacramento	0.18	0.29	7.2	9.0	(1.8)
Saint Louis	0.30	0.55	5.9	10.0	(4.1)
Salt Lake City	0.21	0.72	6.9	5.4	1.5
San Antonio	0.36	0.85	5.3	5.5	(0.2)
San Diego	0.17	0.35	5.4	9.4	(4.0)
San Francisco	0.29	0.76	11.4	12.6	(1.2)
Seattle	0.19	0.45	6.9	12.5	(5.7)
Tampa	0.26	0.42	6.2	12.0	(5.7)
Tucson	0.54	0.95	5.4	2.6	2.8
Washington DC	0.87	1.71	(0.6)	5.1	(5.7)
West Palm Beach	0.30	0.43	5.0	9.5	(4.4)

Actual Greater Than Forecast	41
Actual Less Than Forecast	9

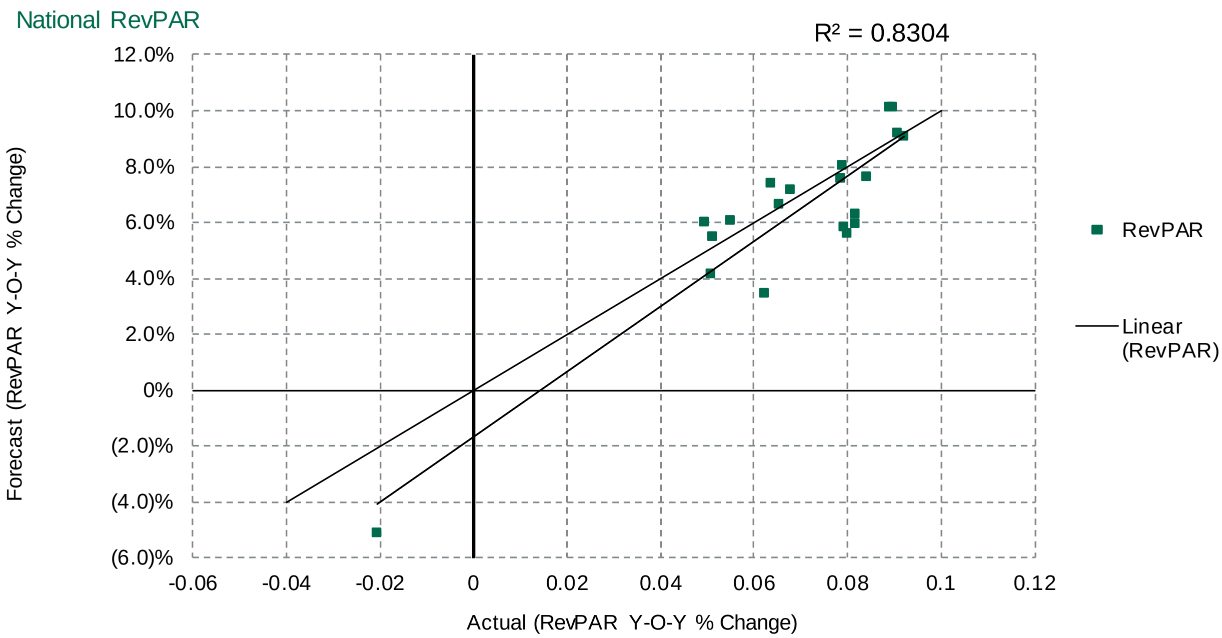
Note: This table compares the RevPAR forecast made in March 2014 to the actual RevPAR performance. It also shows Theil's U1 and U2 statistics for the one-year *Hotel Horizons* ® forecasts made for 2014, for each of the 50 major Metropolitan Statistical Areas. Theil's U1 statistic ranges between 0 and 1; the closer U1 is to zero, the better the forecast. U2 takes a value less than one when the *Hotel Horzions* ® forecast outperforms the benchmark and a value greater than one when it does not.

Source: PKF-HR and STR, Inc.

6. Our Forecast Accuracy

The method we use to prepare *Hotel Horizons*® forecasts produces accurate hotel performance forecasts across large geographic areas, market segments, and locations. The accuracy of our forecasts is quite good for the U.S. hotel market and for the sub-categories at the national level that the hotel industry uses to identify different hotel types – chain scales and locations. The chart presented in Exhibit 8 demonstrates *Hotel Horizons*® All U.S. Hotels forecast accuracy for RevPAR from one quarter out for the immediately following quarter. The 83 percent r^2 indicates that PKF's near term forecasts at the national level are very accurate throughout the entire period analyzed.

Exhibit 8: Actual Performance vs. *Hotel Horizons*® One Quarter Out Forecast Published in March 2014 - All Hotels



Note: This table shows forcast and actual RevPAR for the one-quarter out *Hotel Horizons*® forecasts made each year from 2010-2014, for all U.S. hotels. The line through the middle represents a 45 degree angle and shows where each dot would be if the forecast were 100 percent accurate. The r-squared shows correlation of our forecasts and actuals to that line.

Source: PKF-HR and STR, Inc.

Forecasting accuracy is shown in this report to be even over the 50 included MSAs, with little differences between forecast and actual results, and existing differences well within a tolerable range of error. Even though the errors in our quarterly forecasts are small, is it not perfectly accurate and work is continuously being done to improve accuracy of our near term forecasts.

Appendix A

Econometrician Henri Theil during the 1960s and 1970s developed two statistics for measuring the accuracy of forecasts – U1 and U2. Theil's coefficients are derived using changes rather than levels in order to avoid the inflated view of accuracy. For U1, the values are bounded between 0 and 1, with values closer to 0 representing greater accuracy. For U2, values less than 1 show that the forecasting technique used is better than the intuitive forecast and values greater than 1 show that the technique is worse than the intuitive forecast. When U2 equals 1, there is no difference between the techniques.

Equations for Theil's U1 and U2 statistic:

$$U1 = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(A_i - P_i)^2}}{\sqrt{\frac{1}{n}\sum_{i=1}^{n}{A_i}^2} + \sqrt{\frac{1}{n}\sum_{i=1}^{n}{P_i}^2}}$$

$$U2 = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(P_i - A_i)^2}}{\sqrt{\frac{1}{n}\sum_{i=1}^{n}{A_i}^2}}$$