Volatility of Hotel Market Fundamentals and the Determinants of Variations Between Markets

by

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Submitted to the Program in Real Estate Development in Conjunction with the Center for Real Estate in Partial Fulfillment of the Requirements for the Degree of Master of Science in Real Estate Development

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ABSTRACT

How can volatility as well as other dynamics and characteristics in hotel market fundamentals affecting risk be better understood?

This paper explores that fundamental question along with other more specific questions that naturally follow:

What are the markets and hotel sectors that exhibit the most volatility in RevPAR, and its various components: occupancy, ADR, absorption and completions? How can markets be characterized as more supply driven or demand driven? How can market revenue metrics be characterized as rate or occupancy driven? What determines the variations in these metrics? What markets behave similarly? What do these findings mean in terms of various risk management practices?

This paper develops a model for the systematic analysis of hotel markets based on observed trends in historical data. The paper first calculates measures of volatility. It then develops a model to characterize markets based on which fundamentals play a larger role in hotel market dynamics. It then provides a further comparison of markets based on which exhibit similar movements in RevPAR.

The findings then are analyzed for their meaning in terms of risk in hotel markets. Finally, the findings are interpreted to reach conclusions about the nature and determinants of volatility in hotel markets, and how to better mitigate these risks in portfolio selection.

Thesis Supervisor: Bill Wheaton

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Chapter 1: Introduction

Hotels are widely considered to be the most volatile and, hence, most risky of the major real estate asset classes. This largely results from the inherent relative sensitivity of hotel performance to fluctuations in demand and supply compared to other types of real estate. Hotels by their very nature have 100% turnover on a weekly basis in most cases. Hotel revenues are thus highly responsive to the forces affecting room demand given the absence, except in unusual circumstances, of long term leases. Further, hotel managers have the ability to adjust room rates on a continuous basis and fluctuations in room rates are often the result of a highly dynamic pricing environment. Relative to other asset types, the performance of a hotel property is also highly dependent upon supply shocks, again given the absence of long term leases which enable other real estate asset types to maintain their occupancies for a length of time following new supply additions to the market. It follows that hotel performance is considered highly volatile and highly sensitive to market forces.

Academic research has so far touched on a number of these various fundamentals at the national level, and, in limited instances, at the regional or individual market level. However, no academic research has yet measured volatility across various hotel market fundamentals and hotel sectors to the same extent as found in this paper. Further, no academic research has characterized hotel markets on the basis of what fundamentals predominantly drive their observed dynamics. In this way, and given the 20+ year time period considered when forming these measures and characterizations, this paper aims to contribute to the body of research surrounding hotel market risk by providing a more robust study in breadth and scope on the topic of hotel market volatility and specific observations across markets and sectors.

Various hotel sectors each have inherently different characteristics from the next. At the general level considered in this paper, hotels can be broken down into full service and limited service sectors. The former offers a variety of amenities and a more comprehensive array of services, including food and beverage. Hotel managers generally charge premiums for these additional services and amenities, though premiums and the relative level of room rates in either sector varies substantially across markets. Limited service hotels often occupy a lower price point on a relative basis across markets and have a scaled-down offering of services and amenities. While full and limited service hotels behave similarly in certain respects, this paper will show that they perform quite differently in many others.

Further, each hotel type may respond to different market forces. They also may respond to the same market force in varied ways. The methodologies introduced in this paper allow a greater depth and new insights into the understanding of hotel market volatility and its determinants across markets.

This paper then characterizes hotel markets on the basis of the results of these methodologies. It will go further to measure the volatility of various hotel market fundamentals. It will also characterize markets on the basis of the extent to which revenue changes in a market are driven by changes in ADR or changes in occupancy. The result will be a framework to analyze the relative portion of the various components of certain fundamentals most responsible for changes in those fundamentals and to what extent. Through this framework, this paper will seek to characterize full service and limited service hotel markets as supply driven or demand driven. Then the determinants of these characterizations and measures will be studied further. The data used for all studies conducted has been provided by Torto Wheaton Research and includes approximately twenty years of quarterly supply (available rooms), demand (occupied rooms), and revenue (Average Daily Rate) data across 53 markets and full service and limited service sectors within each of those markets.

After measurements of various hotel fundamentals and their volatilities are analyzed, the analysis will test various descriptive statistics and measures reflecting the inherent characteristics of the various markets and their significance to phenomena observed in hotel market dynamics. Once markets have been characterized, analysis will be conducted to see which markets exhibit similar RevPAR movements as a useful tool to manage the portfolio risk through diversification.

It will seek to answer the following questions:

How can volatility as well as other dynamics and characteristics in hotel market fundamentals affecting risk be better understood? What are the markets and hotel sectors that exhibit the most volatility in RevPAR, and its various components: occupancy, ADR, absorption and completions? How can markets be characterized as more supply driven or demand driven? How can market revenue metrics be characterized as rate or occupancy driven? What determines the variations in these metrics? What markets behave similarly? What do these findings mean in terms of various risk management practices?

A better understanding of hotel market fundamentals, their behavior, and its determinants are paramount to a thorough understanding of hotels as investments and their contributions to a portfolio of assets. Though this paper does not consider hotel performance against the performance of other real estate asset classes, it does seek to provide useful tools for quantifying risk in a hotel in either sector—limited service or full service—and in 53 different domestic markets compared to one another.

Though consideration of the various components of hotel performance mostly beyond room revenue is beyond the scope of this paper, it is important to note that other components may have a sizeable impact on hotel property fundamentals. Room revenue, typically the most important component of hotel performance, is only one part of the overall picture when analyzing hotel performance. Hotels (full service to a greater extent) generate revenue from various sources including food and beverage departments and other amenities and services. RevPAR is an imperfect proxy for overall hotel performance. Ultimately, Net Operating Income (NOI) is the most critical element in hotel performance. It is the bottom line operating profit or loss, and takes into consideration all forms of revenue, and expenses including those expenses from departmental hotel operations, overhead, taxes, insurance, and the physical upkeep of the property. However, an understanding of hotel performance begins with an understanding of room revenue. Therefore RevPAR, the largest single component of NOI, is considered the most important single component of overall hotel performance and therefore is an effective proxy, albeit a limited one.

This paper aims to provide a tool and a reference. The findings contained in this research offer a basis for understanding what drives hotel performance that can be used to assess the inherent riskiness of a particular hotel market. Then this paper provides methodologies and results helping to understand and quantify the relative risk between hotel investments in different markets. It also compares hotel markets to one another, analyzing which markets exhibit similarities and differences. Finally, these findings will be interpreted, providing useful lessons to promote understanding of market dynamics and possible applications in portfolio selection and risk management.

Chapter 2: Literature Review

Volatility and risk are the key concepts analyzed in this thesis. In order to better understand the research presented in this paper, it will be useful to review the body of academic literature surrounding these topics. Existing literature analyzes, using various methods, the behavior and risk of real estate markets and hotel markets within them. The relevant literature for this paper will focus on the following questions: What are the types of risk in hotel properties? What are the determinants of risk?

The research most relevant to that which is presented in this paper was conducted by Mark Gallagher and Aseih Mansour, in their 2000 paper entitled, "An Analysis of Hotel Real Estate Market Dynamics," measure the volatility in certain hotel market fundamentals. In their research, they analyze differences in supply and demand fundamentals across markets and provide a comparison of markets based on volatility metrics.

In their research, Gallagher and Mansour present a methodology that is similar in certain ways to the methodology used in this paper. The key similarity comes in that they measure supply and demand volatility and tie their findings to RevPAR movements, albeit only over one to two years. Also, Gallagher and Mansour base their findings on approximately 10 years of data covering only one recession and recovery. This paper will consider a longer time period including the ensuing 12 years, covering multiple full market cycles, thus creating a more robust characterization of the fundamentals in question. Further, Gallagher and Mansour consider hotel fundamentals at the aggregate market level, without further breakdown by sector or segment, and by default reflect characteristics of a more heterogeneous group of hotels than considered in this paper.

Gallagher and Mansour advance the discussion of the dynamics of hotel fundamentals in various relevant respects. Initially their paper compares hotel and office market dynamics. Among the conclusions was a strong relationship between the construction cycles of office and hotel markets[1]. Gallagher and Mansour also identify weakly and negatively correlated markets and suggest the application of their findings to active portfolio management strategies[2]. Gallagher and Mansour find numerous instances of strong negative correlations between markets, a finding that contradicts the

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[1] Gallagher and Mansour, 161.
[2] Gallagher and Mansour, 143.

correlation results presented later in this paper. However, Gallagher and Mansour's findings are based upon annual percentage changes in RevPAR over a ten year period. This paper measures quarterly percentage changes in RevPAR over a much longer period, distinctions that introduce the possibility of discrepancies in the results. In considering RevPAR changes over short periods of one or two years, Gallagher and Mansour stop short of robust market characterizations on the basis of RevPAR volatilities that would require the analysis of a data set covering multiple market cycles.

Joseph A. Ismail, Michael C. Dalbor, and Luline E. Mills, in their 2000 paper entitled, "Using RevPAR to Analyze Lodging-segment Variability," provide a study of RevPAR volatility over a longer period. Though they do not characterize individual markets, they do analyze variations in RevPAR across different hotel segments. Ismail, Dalbor, and Mills analyze RevPAR volatility across five price segments and five location segments over a period from January 1987 to November 2000, making comparisons between the characteristics of RevPAR in these different segments at the aggregate national level. The Change in RevPAR for these various segments is compared to the RevPAR change in the industry as a whole. Rather than adjusting for seasonality using a year-over-year change, the research applies the X-11 method, used by the department of commerce, to the data which adjusts for seasonality. The higher price segments are increasingly more volatile, as are urban properties.[3] A certain price segment will contain both full service and limited service properties, and therefore the findings cannot be compared to the findings of this paper on an apples-to-apples basis. Their research also found that locational attributes (urban, suburban, highway, etc) also have an impact on the degree of volatility and variability in hotel markets.[4]

The overall performance of lodging properties as an investment vehicle within the context of other investment opportunities is a requisite topic in any understanding of hotel market risk. Daniel C. Quan, Jie Li, and Ankur Sehgal in their paper, "The Performance of Lodging Properties in an Investment Portfolio," analyze the macro level performance of hotels, focusing on price indices, and also delve briefly into some determinants of variations between hotel segments. Their analysis does consider regional variations through regional indices, but for the most part, the analysis focuses on the difference between hotel market segments. Quan, Li, and Sehgal observe the strong performance of hotel properties in inflationary environments, reinforcing the conventional belief that hotels are effective inflation hedges because of their ability to pass along increases in operating costs through revenue

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[3] Ismail, Dalbor, and Mills, 78.
[4] Ismail, Dalbor, and Mills, 79.

management.[5] Also the authors determine that customers of economy hotels are more price sensitive than upscale and midscale customers based on their relative performance in inflationary environments.[6]

Though cyclical markets also exhibit volatility, the cyclicality of hotel markets is not directly analyzed in this thesis. However, the study of cyclicality has yielded research relevant to a better understanding of hotel market volatility and risk. The cyclic behavior of the lodging industry is analyzed in depth by William C. Wheaton and Lawrence Rossoff in their 1997 paper, "The Cyclic Behavior of the U.S. Lodging Industry." Within their study, Wheaton and Rossoff analyze the mechanics of the relationship between occupancy level and rents (ADR), determining the relative occupancy levels that drive rents upward or downward and how occupancy affects rent growth over time. Among their conclusions, occupancy must be 67% at the national level for rents to rise with CPI growing at 8% annually.[7] The relationship between occupancy and rents will be explored in this paper as well, though in terms of how the strength the relationship and elasticity of rents varies across markets.

Other research and journal articles looks at the various components of risk associated with a hotel investment from a variety of factors. Daniel Larkin and Carmelo Lam in their 2007 paper, "Hotels—The fifth food group?" discuss the perspectives of investors relating to hotel properties. These include the risks associated with the perceived impact of demand shocks on hotel performance, the inherent risks resulting from operating leverage, and the length of time required for development and stabilization of a hotel property and the challenges it poses to investors looking for a 5-7 year investment period.

Jane Hsu and Shawn Jang help round out the context of risk in hotel markets with their 2008 paper, "The Determinant of the Hospitality Industry's Unsystematic Risk: A comparison Between Hotel and Restaurant Firms." Hsu and Jang analyze the impact on capital structure and capital budgeting of hospitality firms on the volatility of their stock prices. This topic is outside the scope of the research presented in this paper but serves to identify other sources of risk in non-direct property investments in the lodging sector which represent an important part of overall investment in hotel properties.

The optimal strategies of diversification in real estate have evolved through research but generally point to elements of risk that can be mitigated through diversification. Though the merits of diversification are a matter of some debate, the literature generally agrees upon the ability and benefits of

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[5] Quan, Li, and Seghal, 87.
[6] Quan, Li, and Seghal, 89.
[7] Wheaton and Rossoff, 76.

diversification, even within a single asset type. Miles and McCue in their 1984 paper, "Diversification in the Real Estate Portfolio," discuss the merits of diversification within a real estate portfolio. Their research finds that "there are large potential gains to diversification even if the portfolio is limited to a single property type and a single region of the country."[8] Hartzell, Hekman and Miles contribute to the discussion of the benefits and techniques of real estate diversification in their 1986 paper, "Diversification Categories of Investment Real Estate." They analyze the benefits of portfolio diversification and the levels of systematic risk in portfolio real estate. They find systematic risk to be similar to that of common stocks.[9] However, Miles and McCue argue that systematic risk in real estate is substantially less. Hartzell, Shulman and Wurtzebach specifically discuss regional diversification strategies and techniques in their 1987 paper, "Refining the Analysis of Regional Diversification of Income-Producing Real Estate." They suggest that diversification be based on differences in the underlying economic fundamentals between regions, and hence markets, rather than simply diversifying through investments in properties in different regions.[10] This conclusion mirrors the some of the fundamental conclusions and basis for the research presented in this paper.

The discussion that surrounds the role of changes in occupancy or changes in rate in the overall changes in RevPAR is often informal in nature. Representative examples of that discussion can be seen in Jeff Higley's 2006 article, "Will full-service come full circle?" Mark Lomanno's 2007 article "Luxury hotel segment outperforms industry" and Stephanie Ricca's 2010 article, "Demand fuels luxury recovery." These articles look at RevPAR movements over relatively brief periods and analyze whether the movements were driven more by supply or demand. The logic and identification of the components of RevPAR change are concepts on which this paper bases its underlying methodology, and to which it develops an analytical framework for their characterization on an objective and systematic basis across markets. Existing literature does not provide a comprehensive study of the degree to which ADR and occupancy influence RevPAR over time across markets, nor does it generally seek to characterize markets on this basis.

This paper will seek to contribute to the discussion in breadth and scope. The data set covers a longer period, i.e. 20+ years, than any previously published study on the volatility of hotel market fundamentals. Moreover, it considers the dynamics of hotel market fundamentals not only across

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[8] Miles and McCue, 66.

[9] Hartzell, Hekman, and Miles, 248.

[10] Hartzell, Shulman and Wurtzebach, 85.

markets, but across full and limited service sectors within each market. It will contribute to the discussion of volatility and risk in hotel markets and provide new insights into risk management to mitigate observed volatility in hotel market fundamentals.

Chapter 3: Methodology

Data

The data set analyzed for this paper is comprised of supply, demand and room revenue data, measured quarterly over the period beginning first quarter 1987 and ending first quarter 2010, for 53 domestic markets and two hotel types—full and limited service—within each market. Therefore the data includes only metropolitan areas. Not considered are smaller markets, and hotels outside metropolitan areas. Also not considered is Las Vegas given that hotel-casinos do not report operating data, and therefore the available data on Las Vegas is too incomplete to yield meaningful conclusions about the market.

Hotel room demand is measured by total rooms occupied. Hotel room supply is measured by total rooms available. And revenue data is measured by Average Daily Rate (ADR). A description of the geographical composition of each market can be seen in Appendix 1. This shows that some markets under considerations are Metropolitan Statistical Areas (MSAs), whereas some are Metropolitan Divisions, e.g. Miami and Fort Lauderdale, of MSAs. Additional data includes the quarterly total employment by market and number and size of submarkets within each market.

Derived from this raw data are a variety of measures to be analyzed further. All measurements of rates of change in the various data are calculated in quarterly increments of year-over-year (YOY) change. Thus each year has four data points but each data point represents the YOY change from the corresponding quarter of the prior year divided by 4 so as to convert the change into a quarterly rate. Due to the seasonality present (but not uniform) across many hotel markets, measuring quarterly change in the data will include a significant seasonal component and any measures or analysis of volatility of the data will be inflated accordingly. To distinguish seasonal volatility from seasonally adjusted volatility would require complex and involved seasonal smoothing algorithms, which also would have to be customized to particular markets. The described measurement procedure "smoothes" the seasonality out of the data such that measures and trends can be observed using a quarterly frequency. The first quarter in the raw data set is Q1 1987. Therefore, the first data point allowing YOY calculations is 1988.1 and hence is the first data point used in calculations and analysis involving the full time series.

Derived measurements include the rate of completions, rate of net absorption and change in vacancy rate, as defined, respectively, by the formulas below:

$$Completion\ Rate_T\,(C) = \frac{AvailableRooms_T - AvailableRooms_{T-4}}{AvailableRooms_T} \times \frac{1}{4}$$

$$Absorption\ Rate_T\,(AB) = \frac{OccupiedRooms_T - OccupiedRooms_{T-4}}{AvailableRooms_T} \times \frac{1}{4}$$

$$\Delta VacancyRate(V)_T = C_T - AB_T$$

Additional measurements included the Change in Occupancy and Change in ADR defined by the formulas below:

$$\%\Delta OccupancyRate_T\,(Occ) = \frac{Occ_T - Occ_{T-4}}{Occ_{T-4}} \times \frac{1}{4}$$

$$\%\,\Delta AverageDailyRate_T\,(ADR) = \frac{ADR_T - ADR_{T-1}}{ADR_T} \times \frac{1}{4}$$

All revenue data and data measures i.e. ADR and RevPAR, have been converted to Q1 1987 dollars based upon the Consumer Price Index for All Urban Consumers : US City Average.

Measures of Hotel Market Fundamental Volatility

The following measures will form the basis for the analysis and describe all the main components affecting hotel room revenues:

Volatility of absorption, measured as the variance in the quarterly YOY percentage change in occupied rooms – This measures the volatility of demand.

Volatility of completions, measured as the variance in the quarterly YOY percentage change in available rooms – This measures the volatility of supply.

Volatility of change in vacancy (henceforth, “Change in Vacancy”), measured as the variance in the quarterly YOY change in vacancy rate – This measures vacancy fluctuations, which are a result of demand and supply relative to one another.

Volatility of the change in real ADR (henceforth, “Change in ADR”), measured as variance of the quarterly YOY change in ADR – This measures the volatility of the Change in ADR rather than the volatility of ADR. This distinction allows the accurate measurement of ADR volatility in a trending environment. As an illustration, a market in which ADR grows steadily at 3% per year will exhibit measured ADR volatility due to an ever-changing ADR. However, such a market would exhibit no volatility in the Change in ADR measure. Although the ADR is trending upward, it changes at a constant rate. Therefore, using the measure of Change in ADR adjusts for any linear trend in the data and measures volatility relative to any trend present in the data.

Volatility of the Change in Occupancy, measured as the variance of the quarterly YOY change in occupancy rate – Once again, this measure reflects volatility of occupancy rate adjusted for any linear trend in the data.

Volatility of the Change in real RevPAR (henceforth, "Change in RevPAR"), measured as the variance of quarterly YOY change in RevPAR – Once again, this measure reflects volatility of occupancy rate adjusted for any linear trend in the data.

Decomposition of Volatility of Change in Vacancy Rate

The Change in Vacancy is defined as the difference in occupied rooms between periods less the difference in available rooms between periods. As such, the variance of the Change in Vacancy can be decomposed into the variance of the completion rate and the variance of the absorption rate adjusted by the covariance between the completion and absorption rate according to the following formula:

$$\sigma^2 \Delta V = \sigma^2 C + \sigma^2 AB - 2 \times Cov(C, AB)$$

This formula yields an exact decomposition of the variance in the Change in Vacancy into its components without any error term. The third term, *Cov(C,AB)*, represents the covariance between completions and absorption. The term measures the degree to which the two components of the Change in Vacancy move in step with one another. This equation can be interpreted in several ways. First, covariance of completions and absorption is equal to the standard deviation of each multiplied by one another and by the correlation between the two. Thus in a market in which completions and absorption are perfectly correlated (correlation equals 1) and the variance of completions equals that of covariance, the second term of the equation will equal the sum of the first two and the variance of the Change in Vacancy will equal zero, i.e. it will exhibit no vacancy volatility. Intuitively, this results when changes in available rooms perfectly offset changes in rooms occupied completely and simultaneously, therefore leaving vacancy unchanged. And in a market where correlation is 1 but the volatility of each component is not equal, these different magnitudes will lead the covariance term to have an impact on vacancy. Conversely, a market in which the variances of each component are equal but are perfectly negatively correlated (correlation equals -1) will have a vacancy variance double that of the sum of the completions and absorption variances. Negatively correlated completions and absorption lead to a more volatile vacancy rate. Finally, a case where there is no correlation whatsoever (correlation equals 0) between completions and absorption will render the third term also equal to zero and the variance of vacancy will be equal to the sum of the variance of its two components. In such a market the degree to which completions and absorption move together has no impact on the volatility of the vacancy rate.

Further, the degree to which the variance in vacancy is the result of the variance in demand or supply, the “Demand Share” or “Supply Share”, respectively, can be defined by the following formulas:

$$Demand\,Share(DS) = \frac{\sigma^2 AB - Co\operatorname{var}(C, AB)}{\sigma^2 \Delta V}$$

$$Supply\,Share(SS) = \frac{\sigma^2 C - Co\operatorname{var}(C, AB)}{\sigma^2 \Delta V}$$

The numerator of each formula sums to equal the previous formula. In each case, half of the earlier covariance term has been subtracted from each the measures of supply volatility and demand volatility to produce the share of the overall volatility of Change in Vacancy attributable to either volatility in demand or volatility in supply. The Demand Share and Supply Share sum to equal 1 (and each equals one minus the other), and therefore each represents a percentage of total volatility of Change in Vacancy attributable to either supply or demand.

Decomposition of Volatility of Change in Revenue

A common revenue metric used in the hospitality industry is Revenue Per Available Room (RevPAR). RevPAR is the product of its two components, occupancy and ADR, as seen in the formula below:

$$REVPAR = Occ \times ADR$$

Derived from this formula is the following formula which states that the Change in RevPAR, expressed as a percent, is equal to the Change in Occupancy plus the Change in ADR, both expressed in percentage terms:

$$\%\Delta REVPAR_T = \%\Delta Occ_T + \%\Delta ADR_T + \delta$$

This formula does produce a small error term due to the non-continuous measurement of the terms i.e. each component is measured periodically and therefore the two sides of the equation do not perfectly balance. However, it serves as a useful approximation in the decomposition of changes in revenue into its various components. Based on this formula, the Percentage Change in RevPAR can be decomposed into its two components, or the Percentage Change in Occupancy and the Percentage Change in ADR based on the following formula:

$$\sigma^2 \%\Delta REVPAR = \sigma^2 \%\Delta Occ + \sigma^2 \%\Delta ADR + 2 \times Cov(\%\Delta Occ, \%\Delta ADR) + \delta$$

The formula states that the variance of the percentage Change in RevPAR is equal to the sum of the variance of the percentage Change in Occupancy and the percentage Change in ADR adjusted by the covariance between the two. Unlike in the prior decomposition, a positive change in both components has a doubling, rather than offsetting, effect. This is why the sign of the covariance term is positive.

In parallel fashion, the overall volatility of the Change in RevPAR can be decomposed into the degree to which it is caused by volatility of changes in occupancy or changes in ADR. The degree to which the variance in RevPAR is the result of the variance in occupancy or ADR, the “Occupancy Share” or “ADR Share”, respectively, can be seen by the following formulas:

$$Occupancy\ Share = \frac{\sigma^2 \%\Delta Occ + Co\,\text{var}(\%\Delta Occ, \%\Delta ADR)}{\sigma^2 \%\Delta REVPAR}$$

$$ADR\ Share = \frac{\sigma^2 \%\Delta ADR + Co\,\text{var}(\%\Delta Occ, \%\Delta ADR)}{\sigma^2 \%\Delta REVPAR}$$

Again, the two formulas are derived from the previous formula. In both cases, the covariance has been added to each the measures of Change in Occupancy volatility and Change in ADR volatility to produce the share of the overall volatility of Change in RevPAR attributable to either Change in Occupancy or Change in ADR. The Occupancy Share and ADR Share sum to equal 1, and therefore each represents a percentage of total volatility of Change in RevPAR attributable to either to movements in occupancy or ADR.

We will add one other measure to the discussion. The degree to which the volatility in RevPAR is affected by the co-occurrence its two components, the Covariance Share, can be seen by the following formula:

$$Co\,\mathrm{var}\,iance\,Share = \frac{2 \times Co\,\mathrm{var}(\%\Delta Occ, \%\Delta ADR)}{\sigma^2\,\%\Delta REVPAR}$$

This Covariance Share represents the portion of the volatility of Change in RevPAR, in percentage terms, that is the result of the co-movement of ADR and Occupancy. Conceptually, this measures the degree of causality between the two i.e. to which strong demand drives room rates upwards across various markets.

Analysis of Determinants of Volatility of Hotel Market Fundamentals

The total amount of volatility of certain fundamentals as well as the share of overall impact of certain components on various fundamentals will be examined. This portion of the analysis will seek to explain what determines variations in these measures. As such, a series of independent variables (see table 1) will be considered, measuring relative differences in certain market characteristics. These characteristics will form a series of independent variables and their effects on the hotel market fundamentals in question will be measured using a cross-sectional regression whereby the various independent variables will be regressed against variations in the various dependent variables across markets to determine any relationship between variables. These independent variables include:

1. Average Annual Employment Growth – This is the annualized average growth in employment by market over the time period covered by the data. It is found by calculating the quarterly growth rate in total employment and then annualizing it.

2. Average Available Rooms – This is found by averaging the number of available rooms over the time period covered by the data. Rather than using available room stock at any given point, averaging available rooms over the data set better reflects the degree of impact that available

room stock has on the various dependent variables in question given that they are measured over the same time period.

3. The Wharton Regulation Index (WRI): This index measures the degree to which government policies and practices impact the ease and speed of developing real estate, especially housing, across markets. "Lower values in the Wharton Regulation Index, which is standardized across all municipalities in the original sample, can be thought of as signifying the adoption of more laissez-faire policies toward real estate development. Metropolitan areas with high values of the Wharton Regulation Index, conversely have zoning regulations or project approval practices that constrain new residential real estate development."[11] In addition, there is a strong positive correlation between the WRI and the degree to which a market is land constrained, i.e. a high WRI corresponds to a highly land constrained market[12].

4. Seasonality Standard Deviation – This is measured as the average annual standard deviation of ADR over the period covered by the data. This variable measures the degree of seasonality in a market as defined by the degree to which ADR varies between quarters. The seasonality variable requires a separate analysis, discussed here:

   The Seasonality Standard Deviation will result from analysis of the data set. This analysis will characterize each market based on degree of seasonality. This will be measured by the standard deviation of the four quarters each year. Then these will be averaged for which data exists to arrive at a single measure for each market. In addition to serving as a variable for the further study of volatility in the cross-sectional regression analysis, a seasonality measure by itself yields useful insights into the characteristics of hotel markets. Standard deviation is the chosen metric because it incorporates the relative differences of all quarters in the measurement of seasonality, whereas calculation of a range, for example, does not provide a comprehensive measure of seasonality given that the two inner data points (range only takes into account 2 of the 4 quarters in a year) have no impact.

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[11] Saiz, 6.

[12] Saiz, 6.

Full service markets showed more seasonality, in terms of ADR annual standard deviation from the annual mean, than did limited service markets, with full service markets being more seasonal overall. Generally speaking, those markets which exhibit seasonality in the full service sector also exhibit seasonality in the limited service sector albeit usually to a lesser degree. And there is an apparent trend between a market's relative seasonality compared to the other markets in one hotel sector versus another. Those markets exhibiting the most seasonality are those considered to be major tourist destinations: South Florida markets, Arizona markets, New York City, and other major metropolitan tourist destinations. All of these findings follow general intuition as to which markets are likely to exhibit seasonality.

5. Concentration Index – This variable measures the degree to which a market is concentrated in a central location, taking into account the number of submarkets within a market and the relative size of the submarkets. The formula is defined as follows:

$$Concentration\ Index = \sum_{i=1}^{m} \left(\frac{N_i}{N} \right)^2$$

Where N_i equals the size of each submarket in terms of available rooms and N equals the number of available rooms in the market overall. It follows that a market with only one submarket will have a concentration index of 1, a market with two submarkets that are equal in size will have a concentration index of 0.5 (0.25 + 0.25), and so on.

6. Supply Elasticity – This measure, also developed by Albert Saiz, measures not only the regulatory, but also the physical constraints on housing supply. Note that because the supply elasticity focuses on housing supply constraints, it will be used as a proxy for an equivalent measure for hotel supply elasticity. This measure of supply elasticity can be further described as follows, "these elasticities are thus based on economic fundamentals related to natural and man-made land constraints, and should prove useful in calibrating general equilibrium models of interregional labor mobility and to predict the response of housing markets to future demand shocks."[13]

[13] Saiz, 22.

7. Average Available Rooms Per Worker – This takes average available rooms (2) and divides the number by the average number of employees in a given market over the time period covered. This measurement reflects the degree of "specialization." Specialization can refer to the degree to which hotels target different customer segments, perhaps by forming niche strategies. A market with a large number of hotel rooms per worker will likely have stronger hotel demand, and also demand driven by more factors than a market where the stock of available rooms is relatively small relative to the employment base. In these well supplied markets, hotels are likelier to differentiate and serve a particular niche or narrower segment of visitors. For example, Albany has 0.0121 rooms per worker, whereas Miami has 0.0363 rooms. Miami has a variety of demand drivers that are likely to attract hotel patrons, from beach tourism to cultural tourism or convention traffic, airport demand, or demand from a large business community. These multiple demand drivers are likely to result in a larger hotel room stock relative to the number of permanent workers in the city. Whereas in Albany, several of those demand drivers are likely to be weaker or absent altogether.

8. Employment Volatility – This measures the volatility of the change in employment by quarter defined as the variance of rate of change in employment between consecutive quarters. This shows the degree to which employment is stable and does not reflect any linear trending in the data.

The significance of these variables to the volatility of hotel demand fundamentals will be studied using a cross-sectional regression methodology. The cross-sectional regression will measure which of the list of variables are indeed determinants of the various measured components of hotel volatility. The measures of hotel market volatility analyzed through the cross sectional regression will include the following dependent variables: (1) Demand Share, (2) Occupancy Share, (3) Covariance Share, (4) absolute Absorption variance (5) absolute Change in Occupancy variance, and (6) absolute Change in ADR variance, and (7) absolute Change in RevPAR variance.

The various independent variables will be shown across markets and regressed against the various dependent variables corresponding to the markets. Initially each independent variable will be used in each regression before eliminating those lacking significance. The results of the regression analysis will show the corresponding coefficients of each independent variable and a corresponding t-statistics. Based on low t-stats, implying insignificance, variables will then be systematically eliminated until we are left with a set of statistically significant variables for each of the independent variables in question.

The important results of these regressions will be an R^2 value for each model, coefficients for each of the variables, and the t-stats. The R^2 can be interpreted as the degree to which the independent variable in question can be explained by the independent variables included in the model, out of 1, or 100%. The coefficients observed for the data will first show, according to the sign of each, the direction in which each variable impacts the independent variable being studied, and also the sensitivity of the dependent variable to each. Finally the t-stat will measure the degree to which the variable is an accurate predictor of variations in the independent variable. T-stats would ideally be greater than +/- 1.6 for the corresponding dependent variable to be considered to provide significant accuracy.

Table 1|Summary of values of independent variables used in cross-sectional regression analysis

	Average Available Rooms		Seas StdDev		Concentration Index			Supply	Avail. Rms.	Avg. Ann.	Employment
Market	***Full***	***Limited***	***Full***	***Limited***	***Full***	***Limited***	WRI*	Elasticity*	Per Worker	Emp. Growth	Volatility
ALBANY	5,105	4,393	7.9%	6.2%	0.51	0.52	-0.09	1.70	0.0121	0.6%	2.44E-05
ALBUQU	6,281	6,958	2.7%	3.5%	0.37	0.34	0.37	2.11	0.0189	1.8%	4.20E-05
ATLANT	39,374	37,093	4.4%	2.9%	0.15	0.10	0.03	2.55	0.0195	1.8%	6.43E-05
AUSTIN	10,440	8,762	2.7%	2.5%	0.25	0.22	-0.28	3.00	0.0182	3.3%	6.69E-05
BALTIM	14,633	8,650	4.8%	4.1%	0.28	0.26	1.6	1.23	0.0122	0.7%	2.95E-05
BOSTON	30,771	9,694	6.1%	5.9%	0.25	0.18	1.7	0.86	0.0109	0.2%	4.73E-05
CHICAG	59,997	28,776	6.0%	4.0%	0.25	0.14	0.02	0.81	0.0150	0.6%	3.45E-05
CHRLTE	10,758	12,988	3.1%	3.3%	0.23	0.18	-0.53	3.09	0.0156	2.1%	6.55E-05
CINCIN	12,661	10,113	2.8%	7.6%	0.27	0.26	-0.58	2.46	0.0133	1.0%	2.82E-05
CLEVEL	10,145	8,656	3.0%	5.5%	0.30	0.28	-0.16	1.02	0.0096	0.1%	3.44E-05
COLUMB	10,414	9,631	1.5%	2.3%	0.21	0.22	0.26	2.71	0.0124	1.4%	2.96E-05
COLUSC	2,929	5,551	2.0%	1.9%	0.51	0.50	-0.76	2.64	0.0091	1.3%	4.44E-05
DALLAS	33,183	24,128	3.8%	2.0%	0.20	0.16	-0.23	2.18	0.0192	1.7%	5.29E-05
DAYTON	4,227	5,847	2.3%	3.5%	0.52	0.50	-0.5	3.71	0.0091	-0.2%	3.61E-05
DENVER	18,989	11,823	2.4%	4.0%	0.21	0.20	0.84	1.53	0.0158	1.7%	4.96E-05
DETROI	18,572	16,729	2.6%	2.4%	0.20	0.18	0.05	1.24	0.0091	-0.3%	8.03E-05
FORTLA	16,519	10,115	20.6%	18.2%	0.26	0.27	0.72	0.65	0.0266	2.0%	7.87E-05
FORTWO	9,570	10,320	2.4%	4.4%	0.25	0.21	-0.27	2.80	0.0134	2.1%	7.21E-05
HARTFO	6,032	4,397	1.7%	3.8%	0.50	0.51	0.49	1.50	0.0098	0.0%	3.05E-05
HOUSTO	27,380	22,417	3.3%	2.3%	0.15	0.13	-0.4	2.30	0.0131	2.2%	3.72E-05
INDIAN	11,103	12,474	5.7%	5.4%	0.30	0.22	-0.74	4.00	0.0133	1.5%	3.90E-05
KANSAS	13,967	10,274	2.1%	2.8%	0.32	0.26	-0.79	3.19	0.0152	1.0%	2.40E-05
LANGEL	58,865	33,041	2.5%	2.8%	0.13	0.13	0.49	0.63	0.0149	-0.2%	4.55E-05
MEMPHI	7,972	9,440	2.1%	2.6%	0.31	0.34	1.18	1.76	0.0140	1.3%	5.47E-05
MIAMI	33,864	11,634	17.8%	11.5%	0.32	0.28	0.94	0.60	0.0363	1.1%	5.53E-05
MINNEA	17,713	11,787	3.2%	3.4%	0.24	0.22	0.38	1.45	0.0111	1.3%	3.44E-05
NASHVI	13,497	15,199	3.4%	4.3%	0.28	0.18	-0.41	2.24	0.0210	1.6%	4.50E-05
NEWARK	11,665	4,426	2.5%	2.4%	0.51	0.51	0.47	1.16	0.0118	0.0%	4.02E-05
NEWORL	20,910	9,412	11.9%	7.3%	0.65	0.33	-1.24	0.81	0.0371	0.1%	7.55E-04
NEWYRK	69,990	17,448	8.4%	5.9%	0.22	0.18	0.65	0.76	0.0141	0.0%	3.87E-05
OAKLAN	10,747	9,200	2.2%	2.4%	0.27	0.31	0.62	0.70	0.0113	0.8%	5.15E-05
OMAHA	4,885	4,241	3.0%	3.6%	0.50	0.51	-0.56	3.47	0.0119	1.5%	2.64E-05
ORLAND	62,615	31,423	9.8%	6.5%	0.25	0.16	0.32	1.12	0.0780	3.2%	9.82E-05
PHILAD	23,129	11,882	2.8%	2.7%	0.22	0.22	1.13	1.65	0.0101	0.4%	2.27E-05
PHOENI	28,478	17,119	23.9%	17.5%	0.20	0.17	0.61	1.61	0.0202	2.7%	1.14E-04
PITTSB	11,354	7,356	2.6%	2.6%	0.40	0.33	0.1	1.20	0.0104	0.6%	1.61E-05
PORTLA	11,999	8,586	2.8%	4.0%	0.29	0.23	0.27	1.07	0.0137	2.0%	6.95E-05
RALEIG	9,359	9,736	2.1%	1.8%	0.22	0.17	0.64	2.11	0.0146	2.5%	5.07E-05
RICHMO	8,005	8,138	2.0%	3.9%	0.33	0.30	-0.38	2.60	0.0145	1.2%	3.92E-05
SANTON	14,130	13,493	4.0%	5.6%	0.31	0.22	-0.21	2.98	0.0206	2.1%	2.81E-05
SDIEGO	29,641	18,352	3.9%	7.3%	0.21	0.16	0.46	0.67	0.0269	1.6%	4.84E-05
SEATTL	18,690	11,793	4.5%	6.3%	0.28	0.17	0.92	0.88	0.0126	1.9%	6.81E-05
SFRANC	35,912	12,255	2.5%	6.3%	0.30	0.21	0.72	0.66	0.0373	0.0%	7.58E-05
SLOUIS	17,150	13,106	3.0%	5.2%	0.27	0.21	-0.73	2.36	0.0135	0.6%	2.40E-05
TAMPA	21,017	16,961	11.5%	9.9%	0.23	0.18	-0.22	1.00	0.0202	1.6%	7.28E-05
TUCSON	8,208	5,340	20.9%	15.5%	0.36	0.34	1.52	1.42	0.0260	1.7%	7.10E-05
WASHIN	58,862	21,852	4.8%	3.7%	0.17	0.11	0.31	1.61	0.0232	1.6%	2.44E-05
WBEACH	9,719	4,552	27.3%	20.7%	0.50	0.54	0.31	0.83	0.0219	2.0%	8.28E-05

*Source: Saiz, Albert, "The Geographic Determinants of Housing Supply," Quarterly Journal of Economics, 5 Jan, 2010, Web.

Other Analyses

The sensitivity of ADR to changes in Occupancy, similar in principle to the Covariance Share, will be analyzed with the ADR Sensitivity Regression measured as a time series. First the correlation and R^2 (R^2 is equivalent to the square of correlation) between Change in ADR and Change in Occupancy will be measured as well as the coefficient between the two. This will show how sensitive ADR is to changes in occupancy, as determined by the coefficient, and to what extent changes in ADR can be explained by changes in occupancy. Next, one to four quarter lags of Change in Occupancy will be regressed against changes in ADR to determine whether the same period Change in Occupancy serves as the best indicator or whether ADR changes are better predicted by changes in occupancy occurring in prior quarters.

As a final means for understanding market behavior and risk, this paper will construct two RevPAR correlation matrices, one using correlation based on quarterly RevPAR movements and another based on quarterly YOY Change in RevPAR, the latter correcting for the effects of seasonality. The quarterly matrix will provide a different yet still useful set of information. Correlations between markets can be valuable for short and long term revenue management strategies and portfolio diversification.

Chapter 4: Results

The results of the research will be presented in the order of the following questions: Which markets have the most volatile vacancy (occupancy) rates and what are the determinants of volatility in Change in Occupancy? Which markets have the most volatile RevPAR and what are the determinants of the variations in volatility? What are the results of the Vacancy Decomposition Analysis and what are factors that determine whether vacancy in a given market is demand or supply driven? What are the results of the RevPAR Decomposition Analysis and what are the factors that determine whether RevPAR volatility is driven by changes in occupancy or changes in ADR? Finally, which markets RevPAR movements are most correlated?

The results of the research as presented in this chapter will lead to a characterization of markets based on the fundamentals that drive them and market characteristics that influence those fundamentals. These results describe the results of the model presented in the Methodology chapter and will form a basis for a better understanding of how hotel markets function at the revenue level. And they will include measures that may serve as a reference for the formulation of portfolio selection strategies as well as risk management practices.

First, the analysis seeks to explain the values for the Demand Share, Occupancy Share, and Covariance Share, and then the variance of absorption, occupancy, ADR and RevPAR. With varying success, the aforementioned independent variables (Employment Growth, Average Available Rooms, Wharton Regulation Index, Seasonal Standard Deviation, Concentration Index, Supply Elasticity, Available Rooms per Worker, and Employment Volatility) are able to explain variations in the values of each of the seven independent variables across markets and by hotel type. The first regression run on each independent variable includes all eight independent variables, then based on the t-statistics of the resulting terms, variables are eliminated. Resulting are regression equations explaining a portion of the variation in each dependent variable using only independent variables that show significance. For the non-share dependent variables, the relative levels of certain measures (ADR and occupancy levels, for instance) were tested in the later iterations to see if the level of ADR or occupancy affected overall volatility in cases where the test was appropriate. This section will identify and seek to better explain the relationships between the independent variables found to be significant by analyzing the sign (+/-) of the variable coefficient and the type of impact which it implies.

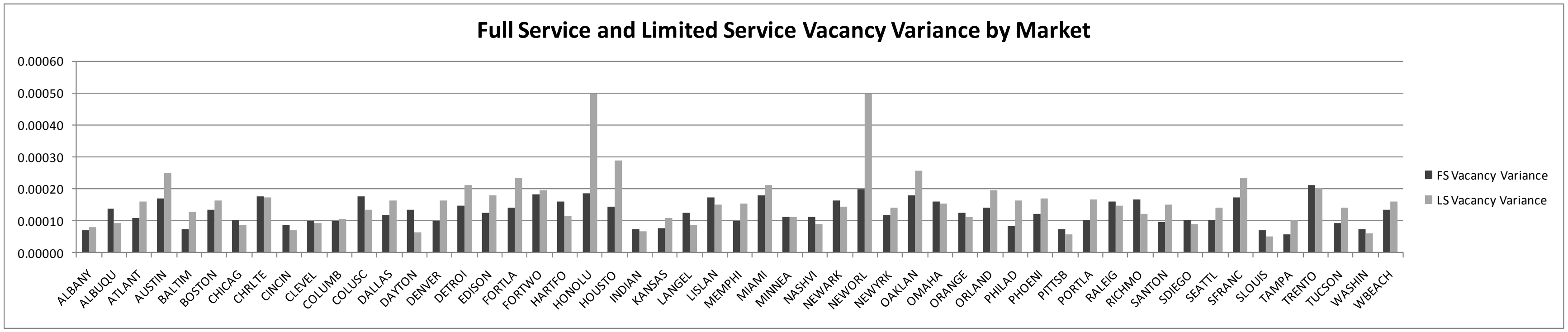
Vacancy (Occupancy) Volatility

Vacancy volatility, measured as the variance in Change in Vacancy, is found to be larger in limited service markets than full service markets (see table 2). In addition to limited service markets displaying more volatility on average, they also vary in terms of the volatility of their vacancy across markets more than do full service markets. The most volatile full service markets in terms of vacancy are Trenton, New Orleans, Honolulu and Forth Worth, and the least volatile are Tampa, Albany and St Louis. Graph 1 shows full and limited service volatilities by market and sector.

Table 2|Vacancy volatility results and rankings for full service and limited service markets

	σ^2V Variance		σ^2V Rank	
	Full Service	Limited Service	FS	LS
ALBANY	0.00007	0.00008	52	47
ALBUQU	0.00014	0.00009	21	42
ATLANT	0.00011	0.00016	33	22
AUSTIN	0.00017	0.00025	11	5
BALTIM	0.00007	0.00013	50	33
BOSTON	0.00013	0.00016	24	18
CHICAG	0.00010	0.00009	34	46
CHRLTE	0.00018	0.00017	8	14
CINCIN	0.00009	0.00007	44	48
CLEVEL	0.00010	0.00009	39	41
COLUMB	0.00010	0.00011	41	39
COLUSC	0.00018	0.00014	7	32
DALLAS	0.00012	0.00016	30	19
DAYTON	0.00013	0.00006	23	50
DENVER	0.00010	0.00016	40	20
DETROI	0.00015	0.00021	17	9
EDISON	0.00012	0.00018	26	13
FORTLA	0.00014	0.00023	20	7
FORTWO	0.00018	0.00020	4	12
HARTFO	0.00016	0.00011	15	35
HONOLU	0.00019	0.00050	3	1
HOUSTO	0.00014	0.00029	18	3
INDIAN	0.00007	0.00007	48	49
KANSAS	0.00008	0.00011	46	38
LANGEL	0.00013	0.00009	25	45
LISLAN	0.00017	0.00015	10	26
MEMPHI	0.00010	0.00015	38	24
MIAMI	0.00018	0.00021	5	8
MINNEA	0.00011	0.00011	32	36
NASHVI	0.00011	0.00009	31	43
NEWARK	0.00016	0.00014	13	28
NEWORL	0.00020	0.00050	2	2
NEWYRK	0.00012	0.00014	29	31
OAKLAN	0.00018	0.00026	6	4
OMAHA	0.00016	0.00015	14	23
ORANGE	0.00012	0.00011	27	37
ORLAND	0.00014	0.00020	19	11
PHILAD	0.00008	0.00016	45	17
PHOENI	0.00012	0.00017	28	15
PITTSB	0.00007	0.00006	47	52
PORTLA	0.00010	0.00017	36	16
RALEIG	0.00016	0.00015	16	27
RICHMO	0.00017	0.00012	12	34
SANTON	0.00010	0.00015	42	25
SDIEGO	0.00010	0.00009	37	44
SEATTL	0.00010	0.00014	35	29
SFRANC	0.00017	0.00023	9	6
SLOUIS	0.00007	0.00005	51	53
TAMPA	0.00006	0.00010	53	40
TRENTO	0.00021	0.00020	1	10
TUCSON	0.00009	0.00014	43	30
WASHIN	0.00007	0.00006	49	51
WBEACH	0.00013	0.00016	22	21
Average	0.00013	0.00016		
Std Dev	0.00004	0.00009		

Graph 1|Vacancy volatility comparison of full service and limited service markets



For an understanding of what determines vacancy volatility, we turn to the cross-sectional analysis. Note that the regression uses occupancy volatility as a dependent variable, which yields the same conceptual results as vacancy volatility, by default, i.e. the same variables will show significance and while coefficients (sensitivities) of the various variables will have the opposite sign (+/-), their strength and accuracy will be relevant to vacancy volatility as well. In this case, none of the independent variables in question showed significance with the lone exception of employment volatility for full service. In limited service, employment growth also showed significance. As a final test, the average occupancy rate over the data period was included to test whether higher occupancy, or “tighter,” markets showed greater occupancy volatility. In limited service there was a significant relationship, whereas in full service there was not.

In both hotel sectors, the ability of the regression model to predict Change in Occupancy variance, as measured by R^2 is quite low, though higher for limited service (23%, or 29% with occupancy rate) than full service (12%).

Table 3 and 4|Change in occupancy cross-sectional regression significance results

Full Service Cross-Sectional Change in Occupancy Regression Analysis Results - T-Statistic Results

Independent Variable	Version	R-Squared	Avg Annual Employment Growth	Average Available Rooms	WRI	Seas StdDev	Concen-tration Index	Supply Elasticity	Average Available Rooms/ Worker	Employment Volatility	Avg ADR	Avg Occ
Δ in Occupancy Variance	1	0.18	0.19	-0.85	-0.25	-0.14	-0.52	-0.35	1.17	1.54	-	-
Δ in Occupancy Variance	2	0.18	0.13	-0.86	-	-	-0.58	-0.19	1.18	1.83	-	-
Δ in Occupancy Variance	3	0.18	-	-1.08	-	-	-0.77	-	1.65	1.92	-	-
Δ in Occupancy Variance	4	0.17	-	-0.79	-	-	-	-	1.58	1.76	-	-
Δ in Occupancy Variance	5	0.16	-	-	-	-	-	-	1.38	1.91	-	-
Δ in Occupancy Variance	**6**	**0.12**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.52**	**-**	**-**
Δ in Occupancy Variance	6a	0.13	-	-	-	-	-	-	-	2.51	-0.06	-0.28

Limited Service Cross-Sectional Change in Occupancy Regression Analysis Results - T-Statistic Results

Independent Variable	Version	R-Squared	Avg Annual Employment Growth	Average Available Rooms	WRI	Seas StdDev	Concen-tration Index	Supply Elasticity	Average Available Rooms/ Worker	Employment Volatility	Avg Occ	Avg ADR
Δ in Occupancy Variance	1	0.30	2.75	0.51	0.47	-0.88	0.72	-0.92	-0.82	2.57	-	-
Δ in Occupancy Variance	2	0.30	2.85	-	-	-0.91	0.53	-1.68	-0.76	2.69	-	-
Δ in Occupancy Variance	3	0.28	3.02	-	-	-0.76	-	-1.72	-	2.63	-	-
Δ in Occupancy Variance	4	0.27	2.96	-	-	-	-	-1.55	-	2.56	-	-
Δ in Occupancy Variance	**5**	**0.23**	**2.59**	**-**	**-**	**-**	**-**	**-**	**-**	**2.86**	**-**	**-**
Δ in Occupancy Variance	4	0.29	2.46	-	-	-	-	-	-	2.82	1.53	-0.31
Δ in Occupancy Variance	**5a**	**0.29**	**2.67**	**-**	**-**	**-**	**-**	**-**	**-**	**2.84**	**1.81**	**-**

Employment clearly has an impact on the volatility of vacancy and occupancy. Supply elasticity does not have an impact on occupancy volatility (though it comes close in limited service) which is somewhat unexpected since occupancy considers both supply and demand. The resulting regression equations are as follows:

$$OccVar_{FS} = 2.07 \times 10^{-4} + 0.21 \times EmpVol + \delta$$

-and-

$$OccVar_{LS} = 1.87 \times 10^{-4} + 4.85 \times 10^{-3} EmpGrowth + 0.47 \times EmpVol + \delta$$

-or-

$$OccVar_{LS} = -3.31 \times 10^{-4} + 4.88 \times 10^{-3} EmpGrowth + 0.45 \times EmpVol + 8.18 \times 10^{-6} \times AvgOccRate_{LS} + \delta$$

The relationship described by the equations reflects a similar sensitivity to employment volatility. However, limited service occupancy is also sensitive to additional variables. The level of ADR does not have a significant impact on volatility of occupancy in either sector. Thus more expensive markets do not inherently have more occupancy volatility than less expensive markets. This suggests that even during recession, expensive markets do not suffer drops in demand to a larger degree than do less expensive markets. Limited service markets with high occupancy rates have more volatile occupancy rates, but there is not a relationship between the two in full service markets.

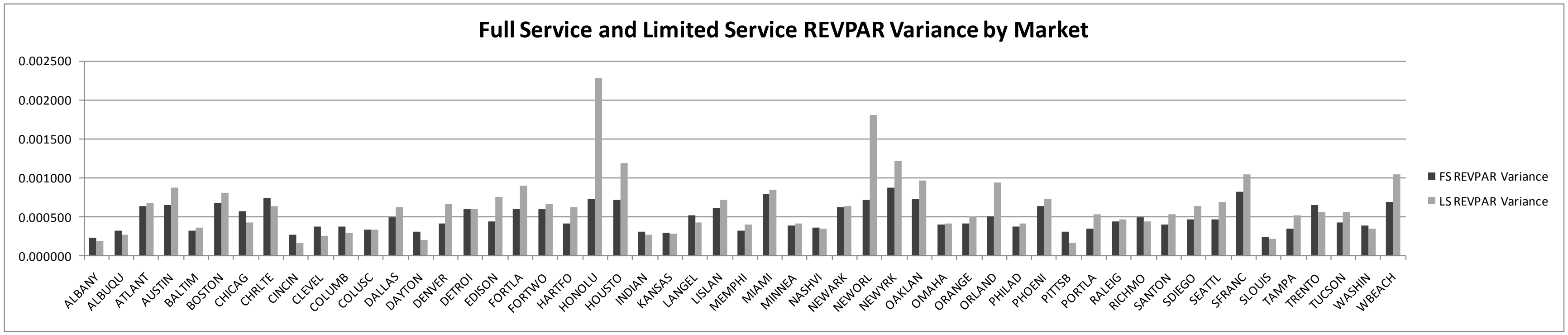
RevPAR Volatility

RevPAR volatility, measured as the variance in the change in real RevPAR over the data period, is shown in the table below. Like vacancy, limited service markets have more volatile RevPAR on average. This is not surprising given that occupancy is a component of RevPAR. Limited service markets also vary in terms of the volatility of their RevPAR across markets more than do full service markets, with a standard deviation more than double the latter. Most volatile full service markets are New York, San Francisco, and Miami, and least volatile are Albany, St Louis, and Cincinnati. Most volatile limited service markets are Honolulu, New Orleans, New York and Houston; and least volatile are Pittsburgh, Cincinnati, and Albany. A recurring theme in this research is the recurrence of New Orleans on the extreme ends of the ranges of various measures likely resulting from the irregularities resulting from Hurricane Katrina.

Table 5| RevPAR volatility results and rankings for full service and limited service markets

	σ^2% ΔRevPAR Variance		σ^2% ΔRevPAR Rank	
	Full Service	Limited Service	FS	LS
ALBANY	0.00023	0.00019	53	51
ALBUQU	0.00033	0.00027	44	46
ATLANT	0.00063	0.00068	14	17
AUSTIN	0.00064	0.00087	12	10
BALTIM	0.00032	0.00036	45	40
BOSTON	0.00068	0.00080	10	12
CHICAG	0.00057	0.00043	20	35
CHRLTE	0.00075	0.00063	4	22
CINCIN	0.00027	0.00016	51	52
CLEVEL	0.00037	0.00025	38	48
COLUMB	0.00038	0.00029	37	44
COLUSC	0.00033	0.00034	43	43
DALLAS	0.00049	0.00062	24	24
DAYTON	0.00030	0.00020	49	50
DENVER	0.00042	0.00066	31	19
DETROI	0.00060	0.00060	17	25
EDISON	0.00044	0.00076	28	13
FORTLA	0.00060	0.00091	18	9
FORTWO	0.00059	0.00067	19	18
HARTFO	0.00042	0.00063	30	23
HONOLU	0.00073	0.00227	6	1
HOUSTO	0.00072	0.00119	7	4
INDIAN	0.00031	0.00026	47	47
KANSAS	0.00030	0.00028	50	45
LANGEL	0.00052	0.00043	21	34
LISLAN	0.00061	0.00072	16	15
MEMPHI	0.00032	0.00040	46	39
MIAMI	0.00080	0.00085	3	11
MINNEA	0.00039	0.00041	35	37
NASHVI	0.00036	0.00035	40	41
NEWARK	0.00062	0.00064	15	20
NEWORL	0.00071	0.00180	8	2
NEWYRK	0.00087	0.00122	1	3
OAKLAN	0.00073	0.00097	5	7
OMAHA	0.00040	0.00041	34	36
ORANGE	0.00041	0.00051	32	31
ORLAND	0.00051	0.00094	22	8
PHILAD	0.00037	0.00041	39	38
PHOENI	0.00064	0.00073	13	14
PITTSB	0.00031	0.00016	48	53
PORTLA	0.00035	0.00053	41	29
RALEIG	0.00044	0.00047	27	32
RICHMO	0.00050	0.00044	23	33
SANTON	0.00040	0.00054	33	28
SDIEGO	0.00047	0.00064	25	21
SEATTL	0.00046	0.00069	26	16
SFRANC	0.00082	0.00104	2	6
SLOUIS	0.00024	0.00021	52	49
TAMPA	0.00034	0.00052	42	30
TRENTO	0.00065	0.00055	11	27
TUCSON	0.00043	0.00056	29	26
WASHIN	0.00038	0.00035	36	42
WBEACH	0.00069	0.00104	9	5
Average	0.00049	0.00062		
Std Dev	0.00017	0.00039		

Graph 2|RevPAR volatility comparison of full service and limited service markets



Determinants Analysis

For an understanding of what determines RevPAR volatility, we again turn to the cross-sectional analysis, the results of which are shown below.

Table 6 and 7|Change in RevPAR cross-sectional regression significance results

Full Service Cross-Sectional Change in REVPAR Regression Analysis Results - T-Statistic Results

Independent Variable	*Version*	*R-Squared*	*Avg Annual Employment Growth*	*Average Available Rooms*	*WRI*	*Seas StdDev*	*Concen-tration Index*	*Supply Elasticity*	*Average Available Rooms/ Worker*	*Employment Volatility*	*Avg ADR*
Δ in REVPAR Variance	1	0.32	0.17	1.51	0.41	1.19	-0.49	-0.35	-0.46	1.81	-
Δ in REVPAR Variance	**2**	**0.30**	**-**	**2.99**	**-**	**1.68**	**-**	**-**	**-**	**1.71**	**-**
Δ in REVPAR Variance	2a	0.41	-	0.36	-	0.67	-	-	-	1.48	2.85
Δ in REVPAR Variance	**2b**	**0.40**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.65**	**4.87**

Limited Service Cross-Sectional Change in REVPAR Regression Analysis Results - T-Statistic Results

Independent Variable	*Version*	*R-Squared*	*Avg Annual Employment Growth*	*Average Available Rooms*	*WRI*	*Seas StdDev*	*Concen-tration Index*	*Supply Elasticity*	*Average Available Rooms/ Worker*	*Employment Volatility*	*Avg ADR*
Δ in REVPAR Variance	1	0.59	1.38	1.48	0.70	0.51	0.27	-1.06	-0.19	4.54	-
Δ in REVPAR Variance	2	0.58	2.12	1.89	0.76	-	-	-1.29	-	5.42	-
Δ in REVPAR Variance	**3**	**0.58**	**2.27**	**1.82**	**-**	**-**	**-**	**-2.42**	**-**	**5.82**	**-**
Δ in REVPAR Variance	3a	0.68	3.86	0.89	-	-	-	-1.34	-	6.69	4.17
Δ in REVPAR Variance	**3b**	**0.66**	**3.99**	**-**	**-**	**-**	**-**	**-**	**-**	**6.97**	**5.51**

In both hotel sectors, the ability of the regression model to predict variations in Change in RevPAR variance (30% FS, and 58% LS) is better than Change in Vacancy variance and much higher with the inclusion of ADR level (40% FS, and 66% LS). Like Change in Occupancy, employment volatility is significant in both while employment growth is significant in limited service only. Market size (Average Available Rooms) was also significant, but more so in full service. Although the measurement methodology corrects for seasonality in the measures of RevPAR, seasonality is a significant variable in full service but not in limited service. And supply elasticity showed significance for limited service. As a final test, the average ADR level over the data period was included to test whether higher ADR markets showed greater RevPAR volatility in percentage terms. In both sectors, ADR level is very significant in RevPAR volatility, even when Change in RevPAR is measured in percentage terms.

The resulting regression equations are as follows:

$$REVPARVar_{FS} = 3.48x10^{-4} + 3.84\times10^{-9} \times AvailRooms_{FS} + 6.09\times10^{-4} \times SeasStDev_{FS} + 0.36 \times EmpVar + \delta$$

-or-

$$REVPARVar_{FS} = -1.55\times10^{-5} + 0.31\times EmpVar + 7.48\times10^{-6} \times AvgADR_{FS} + \delta$$

-and-

$$REVPARVar_{LS} = -4.55x10^{-4} + 8.48 \times 10^{-3} EmpGrowth + 3.88 \times 10^{-9} \times AvailRooms_{LS} - 9.90x10^{-5} \times SupElas + 1.85 \times EmpVar + \delta$$

-or-

$$REVPARVar_{LS} = -7.09x10^{-4} + 0.0143 \times EmpGrowth + 1.94 \times EmpVar + 2.67 \times 10^{-5} \times AvgADR_{LS} + \delta$$

Full service RevPAR volatility is more sensitive to employment volatility than is limited service. And the sensitivity to market size is very similar in both sectors, both of which experience more volatility in larger markets. Full service markets which are more seasonal experience more RevPAR volatility despite the measurement of Change in RevPAR correcting for seasonality. In limited service, the markets with more elastic supply have less volatility in RevPAR which suggests that in those markets supply adjusts more easily when RevPAR reaches a certain level, thus keeping it from varying further. In both cases where the average ADR level was considered, all non-employment-related variables were rendered insignificant, and the R^2 increased each time. From this substitution of variables, the implication is that the relative level of ADR has a stronger relationship with RevPAR volatility than does the combination of market size and seasonality, in full service, or market size and the degree of supply elasticity, in limited service. This relationship might be explained by more elastic demand for expensive markets as a whole, affecting occupancy. However, level of ADR was previously found to have no relationship with Change in Occupancy variance. Therefore, the relationship must be with the ADR component of RevPAR, which we will explore later.

Vacancy Decomposition Analysis

Below (see table 8) are the results of the vacancy decomposition analysis described in the Methodology chapter. Displayed are the volatility of demand, supply, covariance of demand and supply, and vacancy, for limited and full service hotels. Also displayed are the demand and supply shares of the vacancy volatility, or the amount of vacancy volatility due to either demand or supply. First will be a discussion of the levels of the various components of vacancy and their determinants.

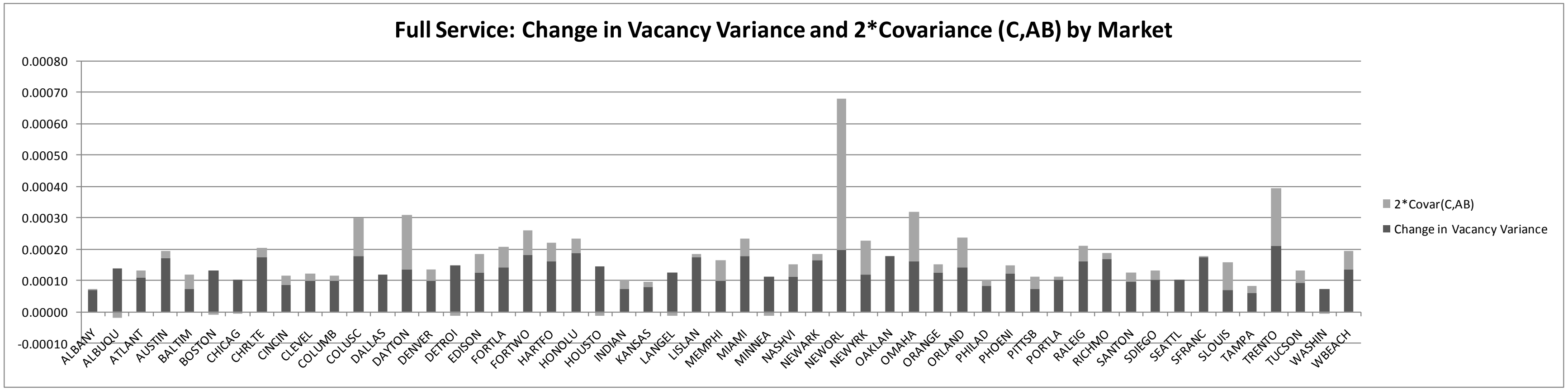
Graph 1 (shown under “Vacancy Volatility”) showed the vacancy volatility by market and hotel type. In a majority of markets, 31 out of 53, limited service exhibits more vacancy volatility than full service. In Graphs 3 and 4, the covariance term is stacked on top of the total vacancy variance for full service markets. The darker shaded area in Graph 4 corresponds with the level of volatility in Graph 1. This shows how much overall vacancy volatility is muted by the degree to which supply and demand move together. Trenton, Omaha, Dayton and Columbia, SC, to name several, have high covariances reducing the overall volatility of vacancy. In other words, though these markets have relatively high combined demand and supply volatilities, they move in step to a greater degree than do other markets.

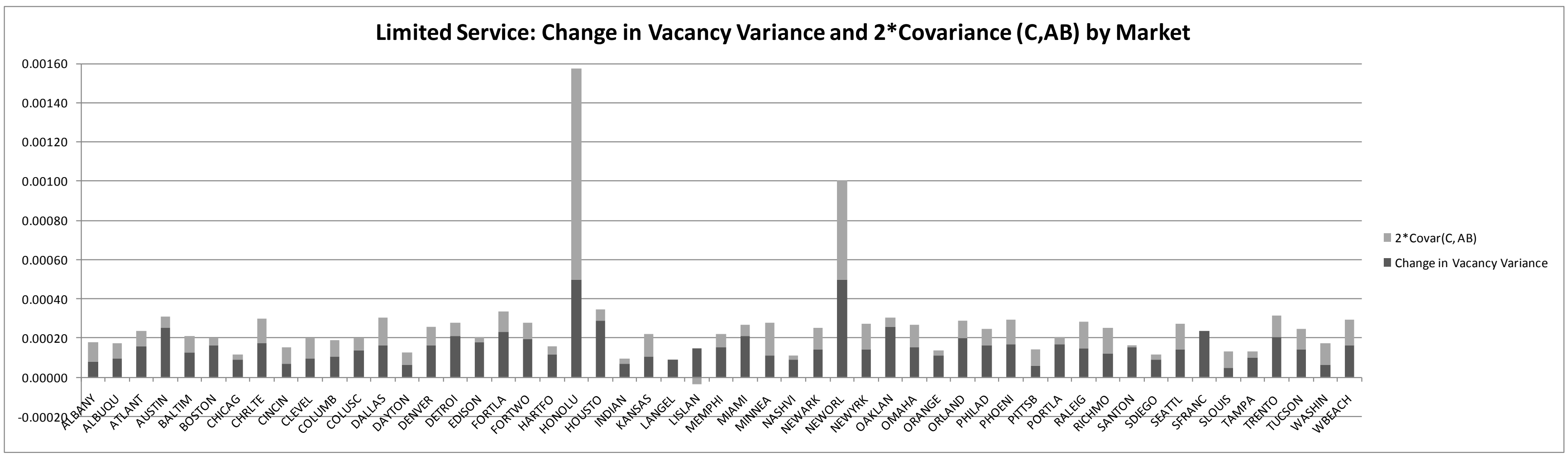
The volatility decomposition into supply and demand yields some interesting observations. The volatility of absorption alone is 33.1% lower (.00090 vs .000124) in full service hotels, but full service hotels also have lower supply volatility. The lower demand volatility in full service is somewhat surprising but the lower supply volatility is likely due to both increased barriers to entry for full service hotels, which are often more concentrated in city centers with more development constraints. Also, full service hotels are more complex developments and therefore delivering new product is more of a challenge than it is for limited service. This also can be seen in the covariance term, which is much higher for limited service hotels on average, suggesting that limited service supply adjusts more quickly and to a greater degree than does full service supply. Here, the increased ability of full service hotels to be permitted and the reduced time required for them to be built again can explain this observation. Although market size might skew volatility in limited service markets given that a hotel of similar size will cause a greater change in supply in a smaller market, it is not clear that this contributes to the higher supply volatility in limited service since limited service hotels are often smaller than their full service counterparts.

Table 8|Vacancy decomposition results

	Full Service						Limited Service					
Market	σ^2C	σ^2AB	2*Cov(C,AB)	σ^2V	Supply Share	Demand Share	σ^2C	σ^2AB	2*Cov(C,AB)	σ^2V	Supply Share	Demand Share
ALBANY	0.00003	0.00004	0.00000	0.00007	41.6%	58.4%	0.00009	0.00008	0.00010	0.00008	56.9%	43.1%
ALBUQU	0.00006	0.00006	-0.00002	0.00014	52.3%	47.7%	0.00008	0.00009	0.00008	0.00009	44.1%	55.9%
ATLANT	0.00004	0.00009	0.00002	0.00011	23.1%	76.9%	0.00013	0.00011	0.00008	0.00016	54.3%	45.7%
AUSTIN	0.00010	0.00009	0.00002	0.00017	50.7%	49.3%	0.00015	0.00016	0.00006	0.00025	47.5%	52.5%
BALTIM	0.00008	0.00004	0.00005	0.00007	71.4%	28.6%	0.00014	0.00007	0.00008	0.00013	74.3%	25.7%
BOSTON	0.00004	0.00009	-0.00001	0.00013	29.9%	70.1%	0.00005	0.00015	0.00004	0.00016	18.4%	81.6%
CHICAG	0.00004	0.00006	-0.00001	0.00010	37.9%	62.1%	0.00005	0.00006	0.00003	0.00009	44.0%	56.0%
CHRLTE	0.00011	0.00009	0.00003	0.00018	56.2%	43.8%	0.00017	0.00013	0.00012	0.00017	61.6%	38.4%
CINCIN	0.00006	0.00005	0.00003	0.00009	55.8%	44.2%	0.00010	0.00005	0.00008	0.00007	88.2%	11.8%
CLEVEL	0.00005	0.00007	0.00003	0.00010	41.4%	58.6%	0.00013	0.00007	0.00010	0.00009	83.5%	16.5%
COLUMB	0.00005	0.00006	0.00002	0.00010	46.0%	54.0%	0.00010	0.00009	0.00008	0.00011	52.1%	47.9%
COLUSC	0.00020	0.00009	0.00012	0.00018	81.1%	18.9%	0.00014	0.00006	0.00007	0.00014	76.4%	23.6%
DALLAS	0.00004	0.00008	0.00000	0.00012	31.8%	68.2%	0.00016	0.00014	0.00014	0.00016	56.6%	43.4%
DAYTON	0.00021	0.00010	0.00018	0.00013	89.7%	10.3%	0.00008	0.00005	0.00006	0.00006	69.8%	30.2%
DENVER	0.00006	0.00008	0.00004	0.00010	38.0%	62.0%	0.00015	0.00011	0.00009	0.00016	61.4%	38.6%
DETROI	0.00006	0.00007	-0.00001	0.00015	45.7%	54.3%	0.00017	0.00011	0.00006	0.00021	64.6%	35.4%
EDISON	0.00009	0.00009	0.00006	0.00012	48.5%	51.5%	0.00005	0.00016	0.00003	0.00018	19.2%	80.8%
FORTLA	0.00006	0.00015	0.00007	0.00014	17.1%	82.9%	0.00008	0.00026	0.00010	0.00023	11.0%	89.0%
FORTWO	0.00015	0.00011	0.00008	0.00018	59.4%	40.6%	0.00012	0.00016	0.00008	0.00020	41.2%	58.8%
HARTFO	0.00014	0.00008	0.00006	0.00016	66.0%	34.0%	0.00005	0.00011	0.00004	0.00011	25.6%	74.4%
HONOLU	0.00004	0.00019	0.00005	0.00019	8.8%	91.2%	0.00067	0.00090	0.00107	0.00050	26.9%	73.1%
HOUSTO	0.00004	0.00009	-0.00001	0.00014	33.7%	66.3%	0.00008	0.00026	0.00005	0.00029	19.8%	80.2%
INDIAN	0.00005	0.00005	0.00003	0.00007	53.0%	47.0%	0.00006	0.00004	0.00003	0.00007	63.1%	36.9%
KANSAS	0.00004	0.00005	0.00002	0.00008	44.9%	55.1%	0.00015	0.00007	0.00011	0.00011	90.3%	9.7%
LANGEL	0.00003	0.00008	-0.00001	0.00013	29.6%	70.4%	0.00001	0.00007	-0.00001	0.00009	19.6%	80.4%
LISLAN	0.00010	0.00009	0.00001	0.00017	53.5%	46.5%	0.00001	0.00010	-0.00003	0.00015	21.7%	78.3%
MEMPHI	0.00008	0.00008	0.00007	0.00010	49.2%	50.8%	0.00013	0.00009	0.00007	0.00015	64.4%	35.6%
MIAMI	0.00007	0.00017	0.00006	0.00018	21.7%	78.3%	0.00009	0.00017	0.00005	0.00021	30.7%	69.3%
MINNEA	0.00004	0.00006	-0.00001	0.00011	42.4%	57.6%	0.00014	0.00014	0.00017	0.00011	49.8%	50.2%
NASHVI	0.00009	0.00006	0.00004	0.00011	62.5%	37.5%	0.00005	0.00006	0.00002	0.00009	49.3%	50.7%
NEWARK	0.00010	0.00009	0.00002	0.00016	53.8%	46.2%	0.00010	0.00015	0.00011	0.00014	33.2%	66.8%
NEWORL	0.00039	0.00029	0.00048	0.00020	74.6%	25.4%	0.00080	0.00020	0.00051	0.00050	110.3%	-10.3%
NEWYRK	0.00010	0.00013	0.00011	0.00012	39.0%	61.0%	0.00015	0.00012	0.00013	0.00014	61.8%	38.2%
OAKLAN	0.00007	0.00011	0.00000	0.00018	38.8%	61.2%	0.00005	0.00026	0.00005	0.00026	9.2%	90.8%
OMAHA	0.00022	0.00010	0.00016	0.00016	87.5%	12.5%	0.00015	0.00012	0.00012	0.00015	58.1%	41.9%
ORANGE	0.00006	0.00009	0.00003	0.00012	39.2%	60.8%	0.00004	0.00010	0.00002	0.00011	21.4%	78.6%
ORLAND	0.00007	0.00017	0.00009	0.00014	15.5%	84.5%	0.00008	0.00021	0.00009	0.00020	16.9%	83.1%
PHILAD	0.00005	0.00005	0.00002	0.00008	50.9%	49.1%	0.00017	0.00007	0.00008	0.00016	81.3%	18.7%
PHOENI	0.00007	0.00007	0.00002	0.00012	50.0%	50.0%	0.00017	0.00012	0.00012	0.00017	63.8%	36.2%
PITTSB	0.00005	0.00006	0.00004	0.00007	38.1%	61.9%	0.00007	0.00007	0.00008	0.00006	47.7%	52.3%
PORTLA	0.00005	0.00006	0.00001	0.00010	46.7%	53.3%	0.00008	0.00012	0.00004	0.00017	39.5%	60.5%
RALEIG	0.00014	0.00007	0.00005	0.00016	71.1%	28.9%	0.00019	0.00009	0.00014	0.00015	84.9%	15.1%
RICHMO	0.00012	0.00006	0.00002	0.00017	67.4%	32.6%	0.00015	0.00011	0.00013	0.00012	65.5%	34.5%
SANTON	0.00005	0.00007	0.00003	0.00010	39.2%	60.8%	0.00007	0.00010	0.00001	0.00015	41.5%	58.5%
SDIEGO	0.00006	0.00007	0.00003	0.00010	44.2%	55.8%	0.00003	0.00008	0.00002	0.00009	22.5%	77.5%
SEATTL	0.00004	0.00006	0.00000	0.00010	43.5%	56.5%	0.00012	0.00015	0.00013	0.00014	39.1%	60.9%
SFRANC	0.00003	0.00015	0.00000	0.00017	16.7%	83.3%	0.00003	0.00020	-0.00001	0.00023	13.0%	87.0%
SLOUIS	0.00008	0.00007	0.00009	0.00007	58.0%	42.0%	0.00008	0.00005	0.00008	0.00005	75.0%	25.0%
TAMPA	0.00003	0.00005	0.00002	0.00006	27.2%	72.8%	0.00005	0.00009	0.00003	0.00010	29.3%	70.7%
TRENTO	0.00022	0.00018	0.00018	0.00021	60.3%	39.7%	0.00011	0.00021	0.00011	0.00020	25.4%	74.6%
TUCSON	0.00005	0.00009	0.00004	0.00009	29.0%	71.0%	0.00012	0.00012	0.00010	0.00014	49.8%	50.2%
WASHIN	0.00002	0.00005	-0.00001	0.00007	30.1%	69.9%	0.00008	0.00009	0.00011	0.00006	38.7%	61.3%
WBEACH	0.00009	0.00010	0.00006	0.00013	47.6%	52.4%	0.00011	0.00019	0.00013	0.00016	24.6%	75.4%
Average	0.00008	0.00009	0.00005	0.00013	46.3%	53.7%	0.00012	0.00013	0.00010	0.00016	47.9%	52.1%
Std Dev	0.00007	0.00004	0.00008	0.00004	17.8%	17.8%	0.00013	0.00012	0.00015	0.00009	23.9%	23.9%

Graphs 3 and 4|Vacancy variance and covariance contribution by market and sector





Determinants Analysis

For a more thorough examination of what leads to the relative levels of absorption and completion volatility, let us turn to a cross-sectional regression.

Table 9 and 10|Vacancy decomposition variances cross-sectional regression significance results

Full Service Ab, C, Cov(Ab,C) Cross-Sectional Regression Analysis Results - T-Statistic Results

Independent Variable	*Version*	*R-Squared*	*Avg Annual Employment Growth*	*Average Available Rooms*	*WRI*	*Seas StdDev*	*Concentration Index*	*Supply Elasticity*	*Average Available Rooms/ Worker*	*Employment Volatility*	*Avg Occ*	*Avg ADR*
Completion Variance	1	0.75	0.86	1.12	0.61	-1.35	4.09	2.27	-1.12	6.06	-	-
Completion Variance	2	0.75	-	0.73	-	-1.02	4.40	3.13	-0.76	6.41	-	-
Completion Variance	3	0.74	-	-	-	-1.33	4.92	3.19	-	6.72	-	-
Completion Variance	**4**	**0.73**	**-**	**-**	**-**	**-**	**4.75**	**3.84**	**-**	**6.55**	**-**	**-**
Completion Variance	4a	0.74	-	-	-	-	4.67	3.29	-	6.45	0.95	-0.34
Absorption Variance	1	0.73	-1.12	0.50	0.47	0.50	0.84	0.54	3.19	5.31	-	-
Absorption Variance	2	0.73	-1.99	-	-	0.89	-	0.60	4.29	6.47	-	-
Absorption Variance	3	0.72	-1.87	-	-	-	-	-	4.70	6.82	-	-
Absorption Variance	**4**	**0.70**	**-**	**-**	**-**	**-**	**-**	**-**	**4.20**	**7.27**	**-**	**-**
Absorption Variance	4a	0.75	-	-	-	-	-	-	2.72	8.03	2.66	-0.66
Absorption Variance	**4b**	**0.75**	**-**	**-**	**-**	**-**	**-**	**-**	**2.85**	**8.14**	**2.95**	**-**
Covariance (C, Ab)	4b	0.81	-0.65	1.49	0.57	0.16	3.40	2.72	0.48	7.83	-	-
Covariance (C, Ab)	**4b**	**0.81**	**-**	**2.27**	**-**	**-**	**4.81**	**3.24**	**-**	**9.11**	**-**	**-**

Limited Service Ab, C, Cov(Ab,C) Cross-Sectional Regression Analysis Results - T-Statistic Results

Independent Variable	*Version*	*R-Squared*	*Avg Annual Employment Growth*	*Average Available Rooms*	*WRI*	*Seas StdDev*	*Concentration Index*	*Supply Elasticity*	*Average Available Rooms/ Worker*	*Employment Volatility*	*Avg Occ*	*Avg ADR*
Completion Variance	1	0.89	1.52	-0.49	1.01	-1.81	0.23	2.28	-2.63	15.53	-	-
Completion Variance	1	0.88	1.67	-	-	-1.55	-	2.75	-3.21	17.46	-	-
Completion Variance	1	0.88	1.22	-	-	-	-	3.67	-3.12	17.13	-	-
Completion Variance	**1**	**0.87**	**-**	**-**	**-**	**-**	**-**	**3.83**	**-2.96**	**17.16**	**-**	**-**
Completion Variance	1	0.88	-	-	-	-	-	3.67	-3.02	16.95	1.45	-0.82
Absorption Variance	1	0.37	2.69	0.30	0.29	-0.22	0.94	-2.02	-0.59	1.95	-	
Absorption Variance	2	0.37	3.02	-	-	-	1.07	-3.31	-0.56	2.10	-	
Absorption Variance	3	0.35	2.83	-	-	-	-	-3.15	-0.54	2.16	-	
Absorption Variance	**4**	**0.34**	**3.15**	**-**	**-**	**-**	**-**	**-3.29**	**-**	**2.11**	**-**	
Absorption Variance	4a	0.42	2.71	-	-	-	-	-1.09	-	2.43	-	
Absorption Variance	**4b**	**0.40**	**2.47**	**-**	**-**	**-**	**-**	**-**	**-**	**2.71**	**-**	
Covariance (C, Ab)	4b	0.74	1.95	-0.04	0.00	-0.46	1.04	0.56	-2.39	9.04	-	-
Covariance (C, Ab)	**4b**	**0.73**	**2.32**	**-**	**-**	**-**	**1.80**	**-**	**-2.54**	**10.72**	**-**	**-**

Supply: Full service completions volatility has a high predictability (73%), with more volatility in markets that are concentrated, supply elastic, and have volatile employment. Limited service completions volatility has a very high predictability (87%), with more volatility in markets that also are concentrated and having volatile employment, but in markets that are less specialized, i.e. having fewer rooms per worker. The relationship to supply elasticity is expected given that supply elastic markets should experience more supply shocks, by definition.

The regression equations for completions volatility are as follows:

$$CompVar_{FS} = -4.91x10^{-5} + 2.29\times10^{-4} \times ConInd_{FS} + 2.18\times10^{-5} \times SupElas + 0.36\times EmpVar + \delta$$

$$CompVar_{LS} = 4.50x10^{-4} + 2.63\times10^{-5} \times SupElas - 3.08\times10^{-3} \times AvRmsPerWkr_{LS} + 1.04\times EmpVar + \delta$$

While both sectors are similarly sensitive to supply elasticity, limited service is far more sensitive to employment volatility than is full service.

Demand: Absorption volatility has fewer determinants than some of the independent variables already discussed, though is much more predictable in full service (76%) than limited service (40%). In full service markets, absorption volatility is highly dependent upon employment volatility, drawing a close link between employment and absorption. This is generally true in limited service markets as well though the link is somewhat weaker (lower t-statistic), but limited service markets see employment growth play a more important role in absorption volatility. Specialization only has an effect on full service markets once again and supply elasticity only affects limited service. In both limited and full service markets, occupancy level was tested as an independent variable, i.e. whether a "tight" market has inherently more demand volatility. While this was only found to be significant in limited service markets, its inclusion made supply elasticity insignificant and the overall predictability did not improve much.

The regression equations are as follows:

$$AbVar_{FS} = 4.5x10^{-5} + 1.38\times10^{-3} \times AvRmsPerWkr_{FS} + 0.26\times EmpVar + \delta$$

-or-

$$AbVar_{FS} = -1.32\times10^{-4} + 9.59\times10^{-4} \times AvRmsPerWkr_{FS} + 0.27\times EmpVar + 2.9\times10^{-6} \times AvgADR + \delta$$

-and-

$$AbVar_{LS} = 1.24x10^{-4} + 2.50\times10^{-3}\, EmpGrowth - 2.59\times10^{-5} \times SupElas + 0.14\times EmpVar + \delta$$

-or-

$$AbVar_{LS} = -3.74\times10^{-4} + 1.81\times10^{-3} \times AvRmsPerWkr_{FS} + 0.17\times EmpVar + 7.23\times10^{-6} \times AvgADR + \delta$$

As seen from the equations, full service absorption is much more sensitive to employment volatility than is limited service though perhaps because of the latter's sensitivity to employment growth as well. Interestingly, the opposite was true in completion variance. Also, employment volatility is very significant to the variance of supply and demand, however due to its strong significance to covariance, its significance to the variance of Change in Vacancy (measured earlier) is much less. Therefore, employment volatility has a very strong relationship with the volatility of completions and absorption, but economically volatile markets are also more likely to have supply and demand move together. Thus the impact of economic volatility on the volatility of vacancy is not as strong. In both cases, ADR level was found to be significant, with more expensive markets exhibiting more absorption volatility.

The degree of specialization also has an impact on hotel volatility, where absorption volatility is higher when the number of rooms per worker is higher. This would seem to make sense given that a market that relies on outside demand also has more volatile demand. This variable does not have a significant impact on limited service markets, perhaps because more rooms per worker implies something different for limited service markets, i.e. perhaps in markets with a large number of rooms per worker, limited service demand is inherently more homogeneous (perhaps more local) and therefore demand is subject to fewer external factors creating less volatility in limited service than in full service. Finally, supply elastic limited service markets have lower absorption volatility.

The covariance term was included in the regression, not so much to determine what factors lead to a higher covariance, but to complete the analysis of the vacancy decomposition. The Change in Occupancy (and vacancy, by default) variance was shown earlier to not be very predictable by the model. However, all three of its components—absorption, completions, and covariance between the two—were shown to be much more predictable individually.

Demand vs Supply

Based on the vacancy decomposition and the results shown in Table 8, we can now characterize markets as supply driven or demand driven. Markets can be characterized based on their relative shares of Change in Vacancy variance attributable to completions or absorption i.e. supply or demand, respectively. The five most demand and supply driven markets in each hotel sector are thus:

Tables 10 and 11|Top demand and supply driven markets

Most Demand Driven Markets				
	Full Service	Demand Share	Limited Service	Demand Share
1	HONOLU	91.2%	OAKLAN	90.8%
2	ORLAND	84.5%	FORTLA	89.0%
3	SFRANC	83.3%	SFRANC	87.0%
4	FORTLA	82.9%	ORLAND	83.1%
5	MIAMI	78.3%	BOSTON	81.6%

Most Supply Driven Markets				
	Full Service	Demand Share	Limited Service	Demand Share
1	DAYTON	10.3%	NEWORL	-10.3%
2	OMAHA	12.5%	KANSAS	9.7%
3	COLUSC	18.9%	CINCIN	11.8%
4	NEWORL	25.4%	RALEIG	15.1%
5	BALTIM	28.6%	CLEVEL	16.5%

New Orleans is the most supply driven limited service market. The performance of the New Orleans limited service market can be explained by a sharp drop in supply resulting from Hurricane Katrina outweighing the impact on demand, although demand would have dropped as well. Indeed, limited service lost roughly 25% of its stock of available rooms whereas full service lost only 6%, perhaps explaining the higher Supply Share in limited service. Unlike other markets which did not experience one-time demand or supply shocks to such a significant degree, the findings do not necessarily reflect the inherent characteristics of the New Orleans limited service market or full service market.

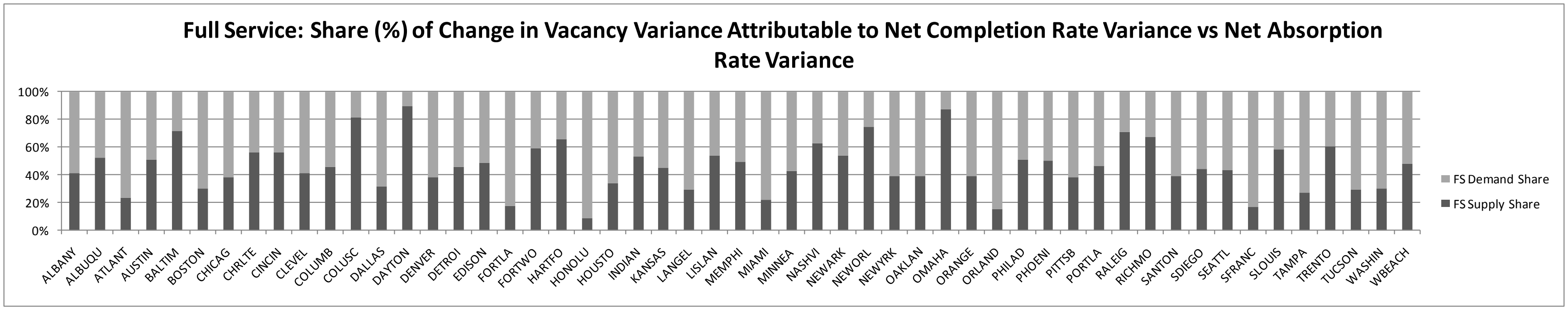
Orlando is a heavily demand driven market. This could be due to multiple factors. The volatility of tourism demand might create significant demand volatility given the high proportion of hotel demand in Orlando coming from tourist travel. It is also the case that Orlando is on the low end of the supply volatility range, perhaps because such a large portion of the stock of available rooms is controlled by Disney World that the portion of the hotel market subject to typical construction market dynamics affecting supply volatility is relatively small.

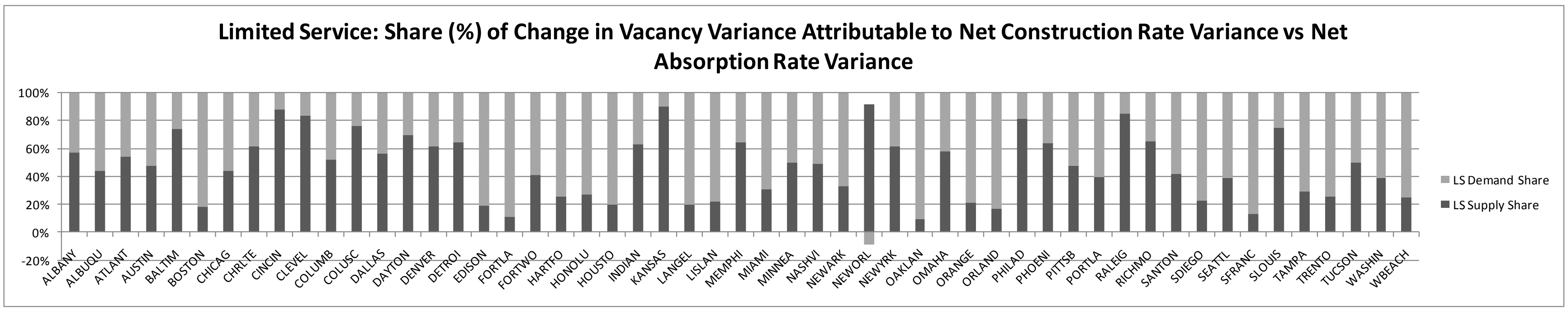
It follows intuition that it seems to be the case that major metropolitan areas and markets attracting significant tourist travel are more demand driven and secondary and tertiary markets tend to be the most supply driven. In the latter markets, the delivery of a single new hotel would create a supply shock of a much larger magnitude than some of the most demand driven markets listed above where a new hotel is a smaller portion of the overall stock or where the vacancy created by a new hotel delivery are more likely to be absorbed by the normal (read: high) fluctuations in hotel demand in the positive direction.

Limited service and full service markets are similarly demand or supply driven overall, with the arithmetic average of the Supply Shares of the two being 46.3% for full service hotels and 47.9% for limited service hotels.

Graph 5 shows the demand and supply shares as a share of total full service vacancy volatility and Graph 6 shows the same for limited service. New Orleans has a negative Supply Share due to the covariance term. In New Orleans, supply is such a small contributor to overall demand, that when the covariance between supply and demand is subtracted, the value is negative. This is somewhat misleading given that supply does add some degree of volatility.

Graphs 5 and 6|Vacancy decomposition into Demand Share and Supply Share by market and sector





Determinants Analysis

A cross-sectional regression allows the further analysis of the determinants of whether a market is supply driven or demand driven.

Tables 12 and 13| Vacancy decomposition shares cross-sectional regression significance results

Full Service Demand Share Cross-Sectional Regression Analysis Results - T-Statistic Results

Independent Variable	Version	R-Squared	Avg Annual Employment Growth	Average Available Rooms	WRI	Seas StdDev	Concentration Index	Supply Elasticity	Average Available Rooms/ Worker	Employment Volatility
Demand Share	1	0.66	-0.91	-0.12	-0.78	1.74	-3.28	-2.44	2.72	-2.19
Demand Share	2	0.66	-0.97	-	-0.78	1.76	-4.23	-2.48	3.24	-2.22
Demand Share	3	0.66	-1.03	-	-	1.68	-4.20	-2.49	3.32	-2.09
Demand Share	4	0.65	-	-	-	1.37	-4.14	-3.72	3.17	-2.03
Demand Share	**5**	**0.63**	**-**	**-**	**-**	**-**	**-3.93**	**-4.27**	**3.73**	**-1.97**

Limited Service Demand Share Cross-Sectional Regression Analysis Results - T-Statistic Results

Independent Variable	Version	R-Squared	Avg Annual Employment Growth	Average Available Rooms	WRI	Seas StdDev	Concentration Index	Supply Elasticity	Average Available Rooms/ Worker	Employment Volatility
Demand Share	1	0.46	1.33	1.23	0.07	0.15	1.24	-3.01	0.69	-2.90
Demand Share	2	0.45	2.48	1.62	0.05	-	1.59	-3.28	-	-2.87
Demand Share	**3**	**0.45**	**2.54**	**1.70**	**-**	**-**	**1.63**	**-4.68**	**-**	**-3.39**

First, the independent variables are able to predict 63% of the variation in Demand Share for full service and 45% for limited service. However, significant variables differ between full and limited service. The degree of specialization affects Demand Share in full service hotels and employment growth and market size affect Demand Share in limited service markets. The regression equations are as follows:

$$DemandShare_{FS} = 0.78 - 0.62 \times ConcInd_{FS} - 0.08 \times SupElas + 5.97 \times AvRmsPerWkr_{FS} - 371.64 \times EmpVar + \delta$$

-and-

$$DemandShare_{LS} = 0.46 + 8.35 \times EmpGrowth + 8.67 \times 10^{-6} \times AvailRooms_{FS} + 0.54 \times ConcInd - 0.15 \times SupElas - 898.89 \times EmpVar + \delta$$

Full service hotel markets have a lower Demand Share when they are concentrated, but the opposite is true in limited service markets, and full service exhibits a stronger trend as well (much higher absolute value of the t-statistic). Evidently, hotels concentrated in a central area is a sign of a supply driven full service market and a demand driven limited service market. A high degree of specialization creates a more demand driven full service market, but does not have a significant impact on the limited service market perhaps based on the higher portion of full service business reliant on tourism, which is considered to provide volatile demand. Both markets are more demand driven when supply is constrained, an expected result. However, the sensitivity in limited service is nearly double that of full service. Counter-intuitively, a highly volatile employment base is a sign of a supply driven full and limited service market.

RevPAR Decomposition Analysis

Like Change in Vacancy variance, Change in RevPAR variance will now be decomposed into its various components. Table 14 shows the results of the RevPAR decomposition analysis described in the Methodology chapter. Displayed are the volatilities of Change in ADR, Change in Occupancy, and Change in RevPAR. Also displayed are the covariance terms that measure the co-movement between ADR and occupancy. Unlike in the vacancy volatility decomposition, the covariance term amplifies the volatility of the combined term, RevPAR in this case.

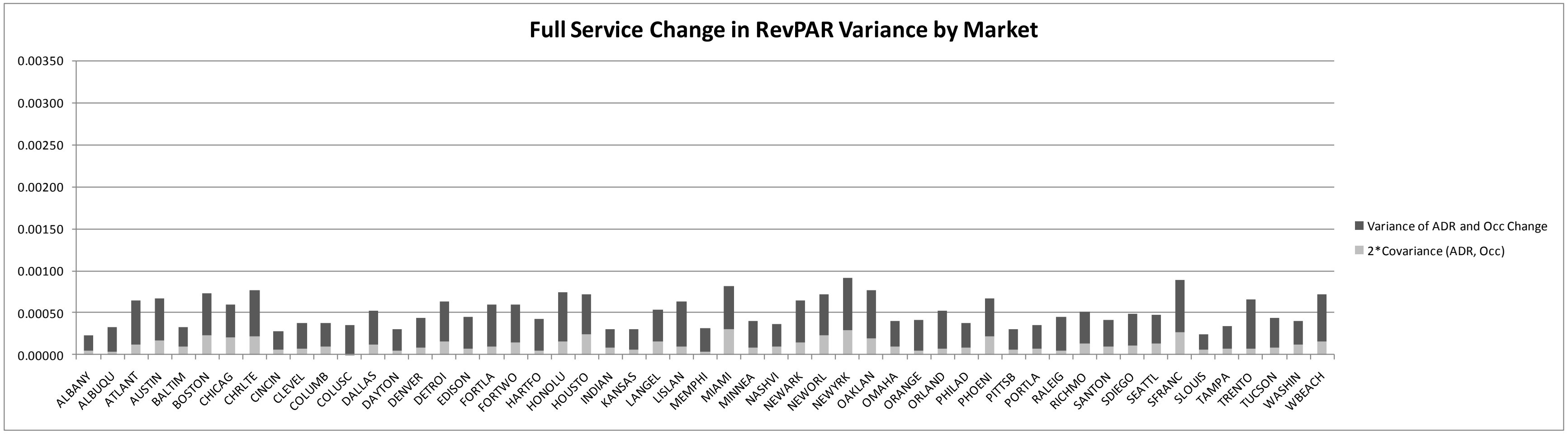
Graph 2 (shown in "RevPAR Volatility") shows the RevPAR volatility by market and hotel type. Only 18 of the 53 markets analyzed displayed higher full service than limited service RevPAR volatility. As mentioned previously, RevPAR volatility is higher for full service than limited service on average. Based on the level of the variances of the components, this results from both higher Change in ADR variance and higher Change in Occupancy variance.

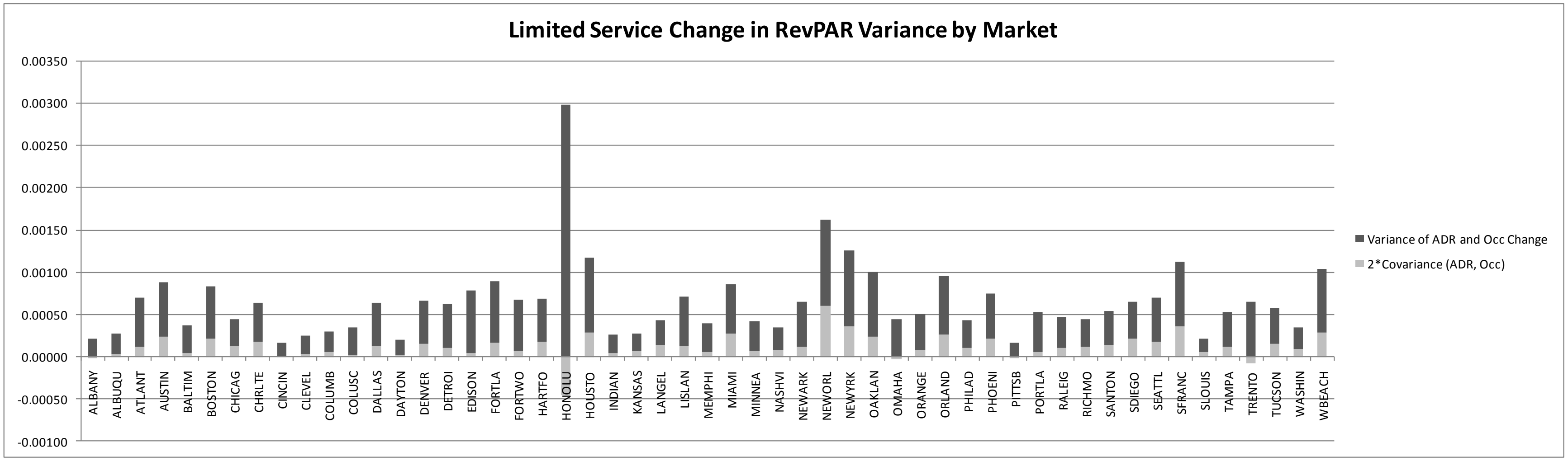
The volatility decomposition into occupancy and ADR yields some interesting observations. The volatility of ADR and occupancy are higher in limited service hotels and the degree to which the two move together is about the same in either sector. However, the volatilities of all components and RevPAR itself have a much higher standard deviation in the limited service sector. As such, there is far less consistency across markets between limited service ADR and occupancy volatilities. The higher volatility of Change in ADR can be interpreted as less pricing power on the part of hotel managers. This could result from a variety of things, with one possibility being the homogeneity of the product as compared to full service hotels. A more commoditized product would suggest that hotel managers must respond to rate changes more quickly and more fully if their hotel does not benefit from differentiation. It can also suggest less that in full service hotels the use of revenue management practices, which continually adjust room rates, is less ubiquitous.

Table 14| RevPAR volatility decomposition results

	Full Service							Limited Service						
Market	σ^2ADR	$\sigma^2\Delta$Occ	2*Cov	$\sigma^2\Delta$REVPAR	ADR Share	Occ Share	Cov Share	σ^2ADR	$\sigma^2\Delta$Occ	2*Cov	$\sigma^2\Delta$REVPAR	ADR Share	Occ Share	Cov Share
ALBANY	0.00005	0.00013	0.00004	0.000230	33.4%	66.6%	9.7%	0.00006	0.00015	-0.00002	0.000193	26.9%	73.1%	-5.4%
ALBUQU	0.00008	0.00022	0.00003	0.000326	29.6%	70.4%	4.7%	0.00006	0.00018	0.00003	0.000274	28.7%	71.3%	6.1%
ATLANT	0.00028	0.00025	0.00012	0.000631	52.8%	47.2%	9.7%	0.00028	0.00031	0.00011	0.000680	48.0%	52.0%	8.2%
AUSTIN	0.00021	0.00029	0.00017	0.000644	43.8%	56.2%	13.1%	0.00020	0.00045	0.00024	0.000868	35.6%	64.4%	13.6%
BALTIM	0.00011	0.00011	0.00010	0.000321	50.5%	49.5%	15.6%	0.00013	0.00019	0.00005	0.000362	41.2%	58.8%	6.5%
BOSTON	0.00025	0.00025	0.00023	0.000678	50.4%	49.6%	17.2%	0.00024	0.00037	0.00022	0.000804	42.2%	57.8%	13.4%
CHICAG	0.00021	0.00018	0.00021	0.000569	52.7%	47.3%	18.1%	0.00015	0.00017	0.00013	0.000428	47.8%	52.2%	15.2%
CHRLTE	0.00021	0.00033	0.00022	0.000747	42.2%	57.8%	14.7%	0.00013	0.00033	0.00018	0.000632	34.6%	65.4%	14.3%
CINCIN	0.00006	0.00017	0.00005	0.000270	29.7%	70.3%	9.9%	0.00006	0.00011	0.00000	0.000165	35.2%	64.8%	0.4%
CLEVEL	0.00011	0.00020	0.00007	0.000373	38.4%	61.6%	8.9%	0.00008	0.00015	0.00003	0.000253	35.4%	64.6%	5.6%
COLUMB	0.00009	0.00018	0.00010	0.000377	37.2%	62.8%	13.5%	0.00005	0.00019	0.00005	0.000292	25.5%	74.5%	8.9%
COLUSC	0.00010	0.00025	-0.00001	0.000334	28.6%	71.4%	-1.9%	0.00012	0.00020	0.00002	0.000341	38.9%	61.1%	3.0%
DALLAS	0.00015	0.00026	0.00012	0.000493	39.3%	60.7%	11.8%	0.00016	0.00035	0.00013	0.000620	35.1%	64.9%	10.6%
DAYTON	0.00006	0.00020	0.00004	0.000303	28.1%	71.9%	6.9%	0.00005	0.00013	0.00002	0.000200	32.0%	68.0%	5.8%
DENVER	0.00015	0.00020	0.00009	0.000418	44.8%	55.2%	10.3%	0.00021	0.00030	0.00015	0.000659	42.5%	57.5%	11.6%
DETROI	0.00016	0.00031	0.00016	0.000604	38.5%	61.5%	12.9%	0.00016	0.00036	0.00011	0.000601	33.8%	66.2%	9.0%
EDISON	0.00014	0.00024	0.00007	0.000437	38.8%	61.2%	7.9%	0.00023	0.00051	0.00004	0.000759	32.4%	67.6%	2.8%
FORTLA	0.00019	0.00031	0.00010	0.000602	40.4%	59.6%	8.2%	0.00025	0.00049	0.00016	0.000906	36.6%	63.4%	8.9%
FORTWO	0.00012	0.00033	0.00015	0.000594	32.7%	67.3%	12.2%	0.00012	0.00049	0.00007	0.000670	22.3%	77.7%	4.9%
HARTFO	0.00013	0.00025	0.00004	0.000420	35.6%	64.4%	5.2%	0.00022	0.00029	0.00018	0.000629	45.4%	54.6%	14.0%
HONOLU	0.00026	0.00033	0.00015	0.000729	45.0%	55.0%	10.5%	0.00213	0.00085	-0.00046	0.002274	75.5%	24.5%	-10.1%
HOUSTO	0.00017	0.00031	0.00024	0.000717	40.9%	59.1%	16.9%	0.00017	0.00071	0.00029	0.001194	27.0%	73.0%	12.2%
INDIAN	0.00009	0.00013	0.00009	0.000311	44.6%	55.4%	14.3%	0.00009	0.00012	0.00005	0.000264	43.8%	56.2%	9.3%
KANSAS	0.00008	0.00016	0.00006	0.000296	37.9%	62.1%	10.8%	0.00006	0.00016	0.00006	0.000279	31.5%	68.5%	11.1%
LANGEL	0.00015	0.00023	0.00016	0.000516	42.8%	57.2%	15.8%	0.00011	0.00018	0.00015	0.000430	42.5%	57.5%	16.9%
LISLAN	0.00027	0.00026	0.00010	0.000609	50.6%	49.4%	8.4%	0.00031	0.00028	0.00013	0.000721	52.5%	47.5%	8.7%
MEMPHI	0.00009	0.00019	0.00003	0.000316	34.4%	65.6%	4.7%	0.00008	0.00026	0.00006	0.000397	28.3%	71.7%	7.5%
MIAMI	0.00020	0.00031	0.00031	0.000798	42.9%	57.1%	19.3%	0.00026	0.00032	0.00027	0.000851	46.8%	53.2%	15.9%
MINNEA	0.00012	0.00020	0.00008	0.000387	41.0%	59.0%	10.7%	0.00013	0.00022	0.00007	0.000411	38.5%	61.5%	8.2%
NASHVI	0.00009	0.00017	0.00010	0.000360	39.2%	60.8%	13.6%	0.00009	0.00018	0.00008	0.000354	37.8%	62.2%	11.8%
NEWARK	0.00025	0.00025	0.00014	0.000619	50.1%	49.9%	11.5%	0.00025	0.00030	0.00011	0.000640	46.1%	53.9%	8.7%
NEWORL	0.00017	0.00033	0.00023	0.000712	38.9%	61.1%	16.1%	0.00053	0.00049	0.00060	0.001801	51.1%	48.9%	16.6%
NEWYRK	0.00043	0.00019	0.00029	0.000870	63.5%	36.5%	16.9%	0.00069	0.00020	0.00036	0.001220	69.6%	30.4%	14.9%
OAKLAN	0.00027	0.00031	0.00020	0.000731	47.4%	52.6%	13.4%	0.00026	0.00050	0.00024	0.000971	38.2%	61.8%	12.4%
OMAHA	0.00007	0.00024	0.00010	0.000401	28.7%	71.3%	12.0%	0.00010	0.00035	-0.00003	0.000415	19.3%	80.7%	-4.0%
ORANGE	0.00016	0.00022	0.00005	0.000412	42.8%	57.2%	5.6%	0.00018	0.00025	0.00008	0.000506	43.1%	56.9%	7.5%
ORLAND	0.00016	0.00029	0.00008	0.000511	38.4%	61.6%	7.4%	0.00026	0.00043	0.00026	0.000943	41.2%	58.8%	13.8%
PHILAD	0.00015	0.00014	0.00009	0.000370	50.7%	49.3%	12.0%	0.00013	0.00021	0.00010	0.000410	40.3%	59.7%	12.5%
PHOENI	0.00022	0.00023	0.00022	0.000640	49.5%	50.5%	17.2%	0.00025	0.00030	0.00021	0.000725	46.7%	53.3%	14.5%
PITTSB	0.00009	0.00015	0.00006	0.000306	40.2%	59.8%	9.9%	0.00005	0.00012	-0.00001	0.000159	27.7%	72.3%	-1.8%
PORTLA	0.00010	0.00018	0.00007	0.000353	39.1%	60.9%	10.6%	0.00013	0.00034	0.00006	0.000530	31.0%	69.0%	5.7%
RALEIG	0.00017	0.00023	0.00005	0.000442	42.6%	57.4%	6.0%	0.00015	0.00021	0.00011	0.000466	43.9%	56.1%	11.3%
RICHMO	0.00009	0.00029	0.00014	0.000496	31.1%	68.9%	13.9%	0.00009	0.00024	0.00011	0.000437	33.4%	66.6%	12.8%
SANTON	0.00013	0.00018	0.00010	0.000402	43.8%	56.2%	11.8%	0.00012	0.00029	0.00013	0.000537	34.4%	65.6%	12.6%
SDIEGO	0.00022	0.00016	0.00011	0.000473	55.4%	44.6%	11.5%	0.00024	0.00020	0.00021	0.000640	53.1%	46.9%	16.3%
SEATTL	0.00016	0.00018	0.00014	0.000462	47.9%	52.1%	15.0%	0.00023	0.00029	0.00017	0.000692	46.1%	53.9%	12.5%
SFRANC	0.00032	0.00031	0.00027	0.000815	50.9%	49.1%	16.3%	0.00034	0.00043	0.00036	0.001040	45.7%	54.3%	17.2%
SLOUIS	0.00006	0.00013	0.00006	0.000239	35.2%	64.8%	12.5%	0.00007	0.00009	0.00006	0.000213	44.9%	55.1%	13.0%
TAMPA	0.00015	0.00013	0.00007	0.000343	52.5%	47.5%	9.9%	0.00016	0.00025	0.00012	0.000523	41.8%	58.2%	11.6%
TRENTO	0.00020	0.00039	0.00008	0.000647	35.8%	64.2%	6.0%	0.00023	0.00042	-0.00008	0.000554	33.7%	66.3%	-7.2%
TUCSON	0.00015	0.00020	0.00009	0.000425	43.6%	56.4%	10.2%	0.00016	0.00026	0.00015	0.000564	41.7%	58.3%	13.6%
WASHIN	0.00014	0.00013	0.00013	0.000383	50.2%	49.8%	16.5%	0.00013	0.00013	0.00009	0.000350	50.7%	49.3%	13.5%
WBEACH	0.00031	0.00025	0.00016	0.000691	54.2%	45.8%	11.3%	0.00040	0.00035	0.00028	0.001043	52.6%	47.4%	13.5%
Average	0.00016	0.00023	0.00012	0.00049	42.3%	57.7%	11.5%	0.00022	0.00029	0.00012	0.00062	40.0%	60.0%	9.2%
Std Dev	0.00008	0.00007	0.00007	0.00017	7.9%	7.9%	4.1%	0.00029	0.00015	0.00014	0.00039	10.4%	10.4%	6.2%

Graphs 6 and 7| RevPAR variance and covariance contribution by market and sector





ADR Sensitivity to Changes in Occupancy

Before performing an analysis on the determinants of ADR change, we will analyze the relationship between ADR and changes in occupancy. This relationship has been well documented in existing literature and here we will perform an analysis of the sensitivity of ADR to changes in occupancy, by market, using a longitudinal approach.

First, we measure the sensitivity of ADR to changes in vacancy, measured as the regression coefficient (see tables 14 and 15). This analysis examines the correlation between the two events: Change in ADR, measured in percentage terms, and Change in Occupancy, also measured in percentage terms. Sensitivities range from 1.12 in New York full service to 0.09 in Columbia. Note that sensitivity is measured as percentage Change in ADR corresponding to percent Change in Occupancy and that a 1% Change in Occupancy is less than 1% change in the nominal rate since occupancy is always less than 100%. For instance, a 1% increase in 80.0% occupancy would result in a new occupancy rate of 80.8% for an increase of 0.8% in nominal terms. Sensitivities to Changes in Occupancy are very similar between sectors at the aggregate level, as seen by the average sensitivity, though variations within markets do occur.

The analysis also answers the question: An ADR change is most related to a Change in Occupancy occurring when? This question is answered by the Quarter Lag column in Table 15, which shows the quarter of occupancy change that most correlates with changes in ADR. So, for instance, New York Full Service has a Quarter Lag of 1, meaning that changes in ADR are most related to changes in occupancy occurring one quarter prior. This would imply that full service hotel managers in New York are not as likely to immediately react to changes in occupancy as markets in which the Quarter Lag is greater. Whereas full service markets like Miami and Washington DC seem to exhibit a more immediate response to changes in occupancy (Quarter Lag: 0).

The results are organized first by highest R^2 and then by magnitude of sensitivity. New York leads both categories, meaning both that when occupancies move in New York, the response in ADR is more extreme than other markets (although it has a lag), and also that when ADR moves in New York, the change is more explained by changes in occupancy than in other markets. It is not surprising that there seems to be a trend between higher sensitivities and higher R^2 values because R^2 measures the amount of the Change in ADR that can be explained by a Change in Occupancy. Therefore, a higher sensitivity will result in a higher portion of the total Change in ADR that is due to Change in Occupancy. In other words, if occupancy volatility in one market is similar to that of another but the first market has a higher sensitivity to occupancy change, then a greater portion of its Change in ADR is a result of changes in occupancy and less due to other factors than the second market.

It also seems to be the case that smaller markets are less sensitive to changes in occupancy. As seen by the averages, changes in occupancy seem to have similar effects on full and limited service sectors overall.

The incidence of both a high R^2 and high rent sensitivity would imply a high level of revenue volatility overall given that RevPAR is the product of occupancy and ADR. Therefore, in a market such as the full service market in New York, an increase in occupancy is not only more likely to coincide with an increase in ADR than in any other market, but the increase in ADR is likely to be greater than in any other market, creating an even larger expected change in RevPAR.

Table 15| Full service ADR sensitivity to changes in occupancy

Ranked in Order of Highest R^2

Rank	Market	Rent Sensitivity	R^2	Quarter Lag*
1	NEWYRK	1.12	0.51	1
2	OAKLAN	0.64	0.46	2
3	CHICAG	0.74	0.45	2
4	MIAMI	0.50	0.41	0
5	CHRLTE	0.50	0.38	3
6	DETROI	0.48	0.37	3
7	PHOENI	0.59	0.36	2
8	AUSTIN	0.47	0.35	2
9	WBEACH	0.67	0.35	2
10	BOSTON	0.61	0.35	1
11	NEWARK	0.59	0.33	4
12	SFRANC	0.59	0.33	2
13	TAMPA	0.59	0.31	3
14	RICHMO	0.32	0.31	1
15	HOUSTO	0.44	0.30	2
16	LANGEL	0.45	0.30	2
17	EDISON	0.43	0.28	2
18	ORANGE	0.43	0.27	3
19	SDIEGO	0.62	0.26	2
20	PORTLA	0.40	0.26	2
21	NASHVI	0.37	0.26	3
22	COLUMB	0.34	0.26	2
23	SEATTL	0.49	0.25	2
24	NEWORL	0.36	0.25	0
25	ATLANT	0.55	0.25	3
26	WASHIN	0.49	0.24	0
27	OMAHA	0.26	0.23	1
28	SANTON	0.48	0.22	1
29	CINCIN	0.27	0.22	3
30	ORLAND	0.35	0.21	3
31	MINNEA	0.36	0.21	3
32	TRENTO	0.31	0.21	3
33	HONOLU	0.39	0.20	2
34	BALTIM	0.47	0.20	0
35	PHILAD	0.46	0.20	4
36	TUCSON	0.38	0.20	1
37	MEMPHI	0.30	0.19	4
38	DALLAS	0.33	0.19	3
39	LISLAN	0.43	0.17	4
40	INDIAN	0.35	0.17	0
41	ALBANY	0.26	0.16	2
42	FORTWO	0.24	0.16	1
43	HARTFO	0.29	0.16	4
44	RALEIG	0.34	0.15	4
45	KANSAS	0.29	0.15	2
46	CLEVEL	0.28	0.14	3
47	ALBUQU	0.23	0.14	2
48	SLOUIS	0.24	0.14	2
49	DENVER	0.31	0.13	2
50	DAYTON	0.17	0.08	2
51	PITTSB	0.21	0.07	1
52	FORTLA	0.19	0.06	0
53	COLUSC	0.09	0.02	4
	Average	*0.42*	*0.24*	*2.11*

Ranked in Order of Most Sensitive

Rank	Market	Sensitivity	R^2	Quarter Lag*
1	NEWYRK	1.12	0.51	1
2	CHICAG	0.74	0.45	2
3	WBEACH	0.67	0.35	2
4	OAKLAN	0.64	0.46	2
5	SDIEGO	0.62	0.26	2
6	BOSTON	0.61	0.35	1
7	NEWARK	0.59	0.33	4
8	PHOENI	0.59	0.36	2
9	SFRANC	0.59	0.33	2
10	TAMPA	0.59	0.31	3
11	ATLANT	0.55	0.25	3
12	MIAMI	0.50	0.41	0
13	CHRLTE	0.50	0.38	3
14	WASHIN	0.49	0.24	0
15	SEATTL	0.49	0.25	2
16	SANTON	0.48	0.22	1
17	DETROI	0.48	0.37	3
18	AUSTIN	0.47	0.35	2
19	BALTIM	0.47	0.20	0
20	PHILAD	0.46	0.20	4
21	LANGEL	0.45	0.30	2
22	HOUSTO	0.44	0.30	2
23	ORANGE	0.43	0.27	3
24	EDISON	0.43	0.28	2
25	LISLAN	0.43	0.17	4
26	PORTLA	0.40	0.26	2
27	HONOLU	0.39	0.20	2
28	TUCSON	0.38	0.20	1
29	NASHVI	0.37	0.26	3
30	MINNEA	0.36	0.21	3
31	NEWORL	0.36	0.25	0
32	INDIAN	0.35	0.17	0
33	ORLAND	0.35	0.21	3
34	COLUMB	0.34	0.26	2
35	RALEIG	0.34	0.15	4
36	DALLAS	0.33	0.19	3
37	RICHMO	0.32	0.31	1
38	DENVER	0.31	0.13	2
39	TRENTO	0.31	0.21	3
40	MEMPHI	0.30	0.19	4
41	HARTFO	0.29	0.16	4
42	KANSAS	0.29	0.15	2
43	CLEVEL	0.28	0.14	3
44	CINCIN	0.27	0.22	3
45	ALBANY	0.26	0.16	2
46	OMAHA	0.26	0.23	1
47	FORTWO	0.24	0.16	1
48	SLOUIS	0.24	0.14	2
49	ALBUQU	0.23	0.14	2
50	PITTSB	0.21	0.07	1
51	FORTLA	0.19	0.06	0
52	DAYTON	0.17	0.08	2
53	COLUSC	0.09	0.02	4
	Average	0.42		

* R squared was tested using vacancy rate from same quarter and prior quarters. Results reflect sensitivity to quarter with highest R squared.

Table 16| Limited service ADR sensitivity to changes in occupancy

Ranked in Order of Highest R^2

Rank	Market	Rent Sensitivity	R^2	Quarter Lag*
1	CHRLTE	0.49	0.56	3
2	PHOENI	0.66	0.50	3
3	LANGEL	0.56	0.48	2
4	MEMPHI	0.41	0.47	4
5	SEATTL	0.59	0.42	3
6	SFRANC	0.58	0.41	2
7	ORANGE	0.55	0.40	3
8	CHICAG	0.61	0.40	3
9	BOSTON	0.52	0.39	3
10	DENVER	0.51	0.39	3
11	TAMPA	0.51	0.39	3
12	RALEIG	0.54	0.39	4
13	WASHIN	0.63	0.39	3
14	NEWYRK	1.25	0.39	1
15	RICHMO	0.38	0.37	3
16	MINNEA	0.46	0.37	3
17	ORLAND	0.47	0.36	3
18	NEWORL	0.61	0.35	0
19	EDISON	0.41	0.34	3
20	OAKLAN	0.41	0.33	2
21	SDIEGO	0.63	0.32	2
22	HOUSTO	0.28	0.31	0
23	AUSTIN	0.38	0.31	2
24	DETROI	0.37	0.30	3
25	SANTON	0.40	0.30	1
26	WBEACH	0.57	0.28	2
27	NASHVI	0.40	0.28	4
28	PHILAD	0.38	0.26	3
29	ALBUQU	0.29	0.25	2
30	ATLANT	0.47	0.24	2
31	KANSAS	0.28	0.24	2
32	HARTFO	0.43	0.23	1
33	LISLAN	0.52	0.23	3
34	MIAMI	0.44	0.23	1
35	FORTWO	0.25	0.23	4
36	TUCSON	0.37	0.21	2
37	PORTLA	0.29	0.20	3
38	SLOUIS	0.37	0.19	1
39	DAYTON	0.27	0.18	2
40	CINCIN	0.32	0.18	3
41	BALTIM	0.34	0.17	4
42	DALLAS	0.26	0.16	1
43	COLUMB	0.20	0.15	1
44	CLEVEL	0.24	0.12	3
45	FORTLA	0.23	0.11	1
46	TRENTO	0.22	0.09	4
47	COLUSC	0.22	0.09	4
48	ALBANY	0.17	0.09	4
49	NEWARK	0.26	0.08	1
50	INDIAN	0.22	0.06	0
51	HONOLU	0.36	0.05	3
52	PITTSB	0.14	0.05	3
53	OMAHA	0.08	0.02	3
	Average	*0.41*	*0.27*	*2.43*

Ranked in Order of Most Sensitive

Rank	Market	Sensitivity	R^2	Quarter Lag*
1	NEWYRK	1.25	0.39	1
2	PHOENI	0.66	0.50	3
3	SDIEGO	0.63	0.32	2
4	WASHIN	0.63	0.39	3
5	NEWORL	0.61	0.35	0
6	CHICAG	0.61	0.40	3
7	SEATTL	0.59	0.42	3
8	SFRANC	0.58	0.41	2
9	WBEACH	0.57	0.28	2
10	LANGEL	0.56	0.48	2
11	ORANGE	0.55	0.40	3
12	RALEIG	0.54	0.39	4
13	BOSTON	0.52	0.39	3
14	LISLAN	0.52	0.23	3
15	DENVER	0.51	0.39	3
16	TAMPA	0.51	0.39	3
17	CHRLTE	0.49	0.56	3
18	ORLAND	0.47	0.36	3
19	ATLANT	0.47	0.24	2
20	MINNEA	0.46	0.37	3
21	MIAMI	0.44	0.23	1
22	HARTFO	0.43	0.23	1
23	OAKLAN	0.41	0.33	2
24	EDISON	0.41	0.34	3
25	MEMPHI	0.41	0.47	4
26	NASHVI	0.40	0.28	4
27	SANTON	0.40	0.30	1
28	PHILAD	0.38	0.26	3
29	RICHMO	0.38	0.37	3
30	AUSTIN	0.38	0.31	2
31	SLOUIS	0.37	0.19	1
32	DETROI	0.37	0.30	3
33	TUCSON	0.37	0.21	2
34	HONOLU	0.36	0.05	3
35	BALTIM	0.34	0.17	4
36	CINCIN	0.32	0.18	3
37	PORTLA	0.29	0.20	3
38	ALBUQU	0.29	0.25	2
39	KANSAS	0.28	0.24	2
40	HOUSTO	0.28	0.31	0
41	DAYTON	0.27	0.18	2
42	DALLAS	0.26	0.16	1
43	NEWARK	0.26	0.08	1
44	FORTWO	0.25	0.23	4
45	CLEVEL	0.24	0.12	3
46	FORTLA	0.23	0.11	1
47	COLUSC	0.22	0.09	4
48	TRENTO	0.22	0.09	4
49	INDIAN	0.22	0.06	0
50	COLUMB	0.20	0.15	1
51	ALBANY	0.17	0.09	4
52	PITTSB	0.14	0.05	3
53	OMAHA	0.08	0.02	3
	Average	0.41		

* R squared was tested using vacancy rate from same quarter and prior quarters. Results reflect sensitivity to quarter with highest R squared.

Determinants Analysis

Again, cross-sectional regression yields a better understanding of the determinants of the levels of RevPAR components. Since Change in Occupancy—one of the two components of Change in RevPAR—has already been analyzed, only Change in ADR will now be analyzed. Later, the determinants of covariance share will be determined through the cross-sectional regression technique.

Tables 17 and 18| RevPAR decomposition variances cross-sectional regression significance results

Full Service Cross-Sectional Change in ADR Regression Analysis Results - T-Statistic Results

Independent Variable	Version	R-Squared	Avg Annual Employment Growth	Average Available Rooms	WRI	Seas StdDev	Concen-tration Index	Supply Elasticity	Average Available Rooms/ Worker	Employment Volatility	Avg ADR
ADR Variance	1	0.42	0.64	2.63	0.96	1.21	0.39	-0.87	-1.25	0.69	-
ADR Variance	2	0.41	-	3.71	1.82	1.81	-	-	-1.15	1.10	-
ADR Variance	3	0.39	-	3.63	1.54	2.09	-	-	-0.88	-	-
ADR Variance	**4**	**0.38**	**-**	**3.63**	**1.68**	**1.91**	**-**	**-**	**-**	**-**	**-**
ADR Variance	4a	0.58	-	1.37	0.42	1.05	-	-	-	-	4.60
ADR Variance	4b	0.58	-	1.37	-	1.12	-	-	-	-	5.06
ADR Variance	4c	0.57	-	1.29	-	-	-	-	-	-	5.68
ADR Variance	**4d**	**0.55**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**7.57**

Limited Service Cross-Sectional Change in ADR Regression Analysis Results - T-Statistic Results

Independent Variable	Version	R-Squared	Avg Annual Employment Growth	Average Available Rooms	WRI	Seas StdDev	Concen-tration Index	Supply Elasticity	Average Available Rooms/ Worker	Employment Volatility	Avg ADR
ADR Variance	1	0.48	0.55	1.56	0.85	1.23	0.84	-1.14	-1.20	3.47	-
ADR Variance	2	0.46	-	1.34	-	1.68	-	-2.10	-1.03	3.50	-
ADR Variance	3	0.45	-	1.03	-	1.45	-	-2.79	-	3.34	-
ADR Variance	**4**	**0.41**	**-**	**-**	**-**	**-**	**-**	**-3.66**	**-**	**3.45**	**-**
ADR Variance	4a	0.75	-	-	-	-	-	-0.01	-	4.68	7.66
ADR Variance	**4b**	**0.75**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**4.78**	**9.55**

Change in ADR volatility inherently is a measure of the behavior of hotel managers and possibly the prevalence of revenue management systems which adjust room rates. That said, hotel managers clearly respond to market forces when setting rate and therefore certain market characteristics do have a significant impact on ADR volatility. In both hotel sectors, ADR volatility is much better predicted (55% FS, and 75% LS) including the relative level of ADR than it is when omitted (38% FS, and 41% LS).

The regression equations are as follows:

$$ADRVar_{FS} = 9.29\times10^{-5} + 2.06\times10^{-9}\times AvailRooms_{FS} + 2.43\times10^{-5}\times WRI + 2.97\times SeasStd_{FS} + \delta$$

-or-

$$ADRVar_{FS} = -2.04\times10^{-4} + 5.59\times10^{-6}\times AvgADR_{FS} + \delta$$

-and-

$$ADRVar_{LS} = 2.46\times10^{-4} - 5.69\times10^{-5}\times SupElas + 0.48\times EmpVar + \delta$$

-or-

$$ADRVar_{LS} = -2.99 \times 10^{-4} + 0.43 \times EmpVar + 6.96 \times 10^{-6} \times AvgADR_{LS} + \delta$$

Larger full service markets show more ADR volatility, suggesting that managers have less ability to hold rate in larger markets. This can be understood when imagining a small market in which travelers have fewer alternatives to a particular hotel which thus enjoys more inelastic demand. The manager of such a hotel would have less pressure to price rooms competitively. A stricter regulatory environment in terms of development constraints (higher WRI) and seasonality also suggest more ADR volatility. Though ADR volatility does not reflect any seasonality, more seasonal markets still experience more volatility. This could result if the reliance on demand in a particular quarter or two results in more annual demand volatility or if it causes managers or yield management practices to price rooms more erratically. Based on the time series regression calculations earlier in this paper showing the correlation between occupancy change and ADR change, it follows that a market with volatile occupancy should also experience volatility in ADR. This relationship should exhibit causality in either direction, with high ADR volatility also causing occupancy volatility, as ADR levels change demand. In expensive markets (high ADR), ADR is much more volatile, even in percentage terms. This also corresponds with the previous findings of the determinants of RevPAR volatility. This could imply that more expensive markets perhaps exhibit more aggressive yield management practices or hotel managers who are more motivated to adjust rate to capture demand. The larger coefficient for ADR level in limited service is partially the result of ADR measured in absolute terms which is lower in limited service.

Change in ADR vs Change in Occupancy vs Covariance

Based on the RevPAR decomposition results shown previously in Table 14, we can now characterize markets as being more driven by changes in ADR, changes in occupancy, or the co-movement of the two. ADR Share and Occupancy Share represent the portion, out of 100%, of Change in RevPAR attributable to either ADR or occupancy. Then Covariance Share shows a portion of that previous total attributable to the co-movement of the two components. A market in which ADR and occupancy are more correlated, will have a higher Covariance Share.

Graph 8 shows the portion of full service RevPAR variance resulting from either Change in ADR variance or Change in Occupancy variance by market. Graph 9 shows the parallel results for the shares relating to limited service markets.

Graphs 6 and 7, shown previously under the discussion of Revpar Volatility, also show the total RevPAR variance broken out into the combined portion resulting from Change in ADR variance and Change in Occupancy variance, and the portion resulting from the covariance term, or the degree to which the two move in tandem. Unlike in the variance decomposition, the covariance term increases the overall volatility. To illustrate this, Graphs 6 and 7 show the covariance portion of overall volatility placed underneath the components i.e. opposite position the position of the vacancy covariance portion in the vacancy graphs.

The arithmetic average full service ADR Share, 42.3%, is slightly higher than that of limited service, at 40.0%, implying that RevPAR volatility in full service markets is only slightly more ADR driven. Therefore, there is only a negligible difference in the comparison between full and limited service ADR Shares and Occupancy Shares. The noticeable difference between full and limited service can be seen in the standard deviation i.e., there is a greater variation between ADR and Occupancy Shares in limited service markets than full service markets.

In both full and limited service, the majority of markets are occupancy driven, although a substantial share does owe more of their RevPAR volatility to ADR. The five most ADR and occupancy driven markets in each hotel sector are as follows:

Tables 19 and 20|Top ADR driven and occupancy driven markets

Most ADR Driven Markets				
	Full Service	ADR Share	Limited Service	ADR Share
1	NEWYRK	63.5%	HONOLU	75.5%
2	SDIEGO	55.4%	NEWYRK	69.6%
3	WBEACH	54.2%	SDIEGO	53.1%
4	ATLANT	52.8%	WBEACH	52.6%
5	CHICAG	52.7%	LISLAN	52.5%

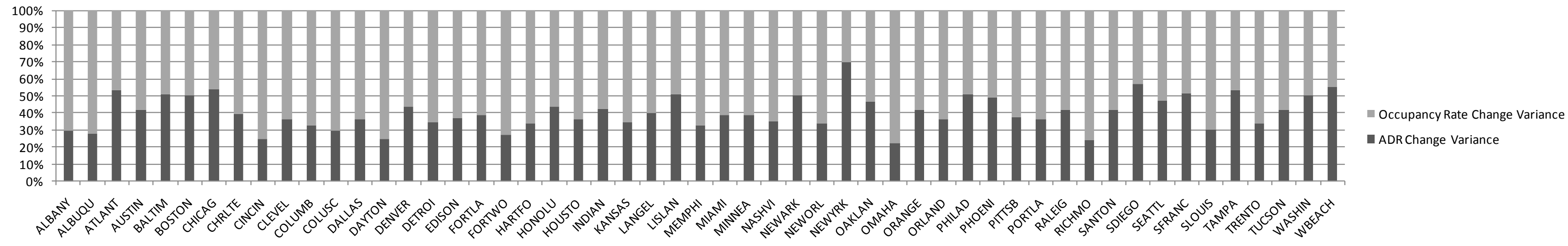
Most Occupancy Driven Markets				
	Full Service	Occ Share	Limited Service	Occ Share
1	DAYTON	71.9%	OMAHA	80.7%
2	COLUSC	71.4%	FORTWO	77.7%
3	OMAHA	71.3%	COLUMB	74.5%
4	ALBUQU	70.4%	ALBANY	73.1%
5	CINCIN	70.3%	HOUSTO	73.0%

The most ADR driven markets are those traditionally associated with the most tourist demand. And the reverse is true for the most occupancy driven markets. There is also a trend between a market being more driven by ADR and having a higher volatility in RevPAR, a positive correlation of .477 for full service and .584 for limited service.

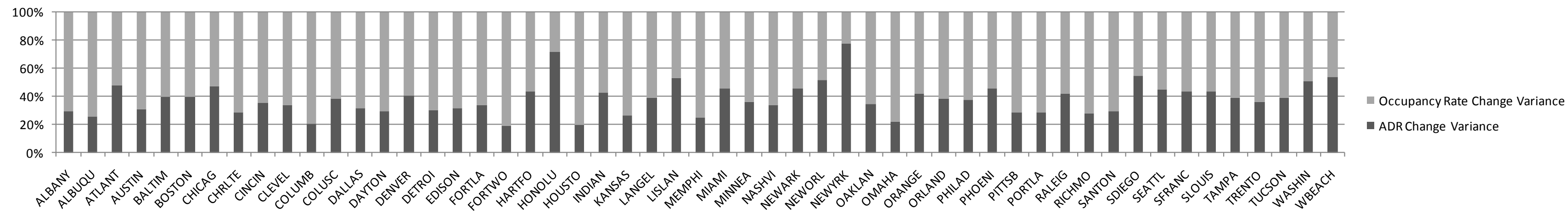
There is also a positive trend between the degree to which a market is demand driven, as found in the Vacancy Decomposition Analysis, and the RevPAR volatility, at least in the full service sector. The correlation between Demand Share and RevPAR variance is 0.337 for full service and 0.289. This suggests that demand driven full service markets have more volatile RevPAR but there is minimal discernable relationship in limited service.

Graphs 8 and 9| RevPAR decomposition into ADR Share and Occupancy Share by market and sector

Full Service % of Change in RevPAR Variance Attributable to Occupancy Rate Change Variance vs ADR Change Variance



Limited Service: Share (%) of Change in RevPAR Variance Attributable to Occupancy Rate Change Variance vs ADR Change Variance



Determinants Analysis

In order to better understand what variables affect whether RevPAR volatility in a market is driven by ADR, Occupancy or Covariance, we turn to cross-sectional regression analysis once again. Given that Occupancy Share is one minus ADR Share, only occupancy share will be analyzed. However, by default, ADR share will have the same significant variables, though with opposite sensitivities.

Tables 21 and 22| RevPAR decomposition shares cross-sectional regression significance results

Full Service Occupancy and Covariance Share Cross-Sectional Regression Analysis Results - T-Statistic Results

Independent Variable	Version	R-Squared	Avg Annual Employment Growth	Average Available Rooms	WRI	Seas StdDev	Concentration Index	Supply Elasticity	Average Available Rooms/ Worker	Employment Volatility
Occupancy Share	1	0.56	-0.80	-3.03	-1.50	-1.56	0.49	1.05	2.19	-0.76
Occupancy Share	2	0.55	-1.22	-4.39	-1.49	-1.65	-	1.38	2.50	-
Occupancy Share	3	0.53	-	-4.27	-1.78	-2.04	-	0.91	2.18	-
Occupancy Share	**4**	**0.52**	**-**	**-4.87**	**-2.67**	**-2.32**	**-**	**-**	**2.14**	**-**
Covariance Share	1	0.40	-1.22	1.85	0.27	1.89	-2.04	0.87	-1.10	2.05
Covariance Share	2	0.40	-1.24	1.85	-	1.97	-2.15	0.89	-1.10	2.14
Covariance Share	3	0.37	-1.91	1.25	-	1.62	-2.56	-	-	1.78
Covariance Share	**4**	**0.34**	**-2.50**	**-**	**-**	**2.04**	**-4.24**	**-**	**-**	**2.14**

Limited Service Occupancy and Covariance Share Cross-Sectional Regression Analysis Results - T-Statistic Results

Independent Variable	Version	R-Squared	Avg Annual Employment Growth	Average Available Rooms	WRI	Seas StdDev	Concentration Index	Supply Elasticity	Average Available Rooms/ Worker	Employment Volatility
Occupancy Share	1	0.41	0.84	-1.75	-0.66	-2.06	0.23	0.71	0.84	-1.27
Occupancy Share	2	0.40	0.70	-2.71	-	-2.09	-	1.54	1.03	-1.14
Occupancy Share	3	0.36	-	-2.17	-	-1.55	-	2.68	-	-0.93
Occupancy Share	**4**	**0.34**	**-**	**-2.14**	**-**	**-1.66**	**-**	**2.88**	**-**	**-**
Covariance Share	1	0.42	-0.91	0.51	1.21	1.40	-2.28	-0.01	0.61	1.68
Covariance Share	2	0.41	-0.75	0.82	1.54	1.50	-2.24	-	-	2.13
Covariance Share	3	0.39	-	-	1.66	1.34	-4.04	-	-	2.32
Covariance Share	**3**	**0.37**	**-**	**-**	**2.16**	**-**	**-3.84**	**-**	**-**	**2.72**

The model explains Occupancy Share better in full service markets (52%) than limited service markets (34%). Market size and seasonality both have a significant impact on full and limited service Occupancy Shares, with market size being a very telling statistic for full service. Covariance share is roughly equally predictable in full (34%) as limited service (37%) markets. Covariance Share depends on the concentration index and employment volatility in both sectors. In full service, employment growth, seasonality show significance whereas in limited service, WRI shows significance.

Occupancy Share regression equations are as follows:

$$OccShare_{FS} = 0.63 - 2.84\times10^{-6} \times AvailRooms_{FS} - 0.04\times WRI - 0.36\times SeasStd_{FS} + 1.97\times AvRmsPerWkr_{FS} + \delta$$

-and-

$$OccShare_{LS} = 0.61 - 3.25\times10^{-6} \times AvailRooms_{LS} - 0.47\times SeasStdDev_{LS} + 0.04\times SupElas + \delta$$

And Covariance Share regression equations are as follows:

$$CovShare_{FS} = 0.18 - 1.56 \times EmpGrowth + 0.18 \times SeasStdDev_{FS} - 0.21 \times ConInd_{FS} + 117.0 \times EmpVar + \delta$$

-and-

$$CovShare_{LS} = 0.14 + 0.02 \times WRI - 0.20 \times ConInd_{LS} + 170.1 \times EmpVar + \delta$$

In full and limited service, larger and more seasonal markets have lower Occupancy Shares (higher ADR Shares) with limited service being more sensitive to both. This could speak to different revenue management practices in larger and more seasonal markets, perhaps because hotels managers in these markets have less pricing power and must constantly adjust ADR to capture demand. In full service markets a stricter regulatory environment suggests a lower Occupancy Share which is probably only explained through some indirect relationship. And, more rooms per worker suggest a higher Occupancy Share. As before, when a larger number of rooms are dedicated to external demand, the market as a whole is likely more prone to fluctuations in occupancy. Finally, in limited service markets, higher supply elasticity implies that RevPAR is more driven by occupancy change than ADR change.

Full and limited service markets with volatile employment tend to see occupancy and RevPAR moving together. However, growing employment is a sign of lower covariances in full service markets. And highly concentrated full and limited service markets have lower covariances and less co-movement of occupancy and rate. Seasonal full service markets have higher covariances as do limited service markets with a higher WRI. The latter can be explained by markets with strict regulatory environments not adding supply as quickly to meet demand, and ADR being more sensitive to occupancy.

Notes on Cross-Sectional Regression Analysis

Since RevPAR is the product of occupancy and ADR, the determinants of RevPAR volatility are largely related to the determinants for their various components. Surprisingly, in both full service and limited service markets market size, i.e. total available rooms, increases RevPAR volatility (more significantly in full service) though the variable is not significant at either of the component levels. Otherwise, the same variables showing significance at the ADR and occupancy levels also show significance in RevPAR volatility, and to roughly similar degrees.

Two general trends in the significance of the independent variables warrant mention. First, with the exception of full service completion variance, supply elasticity has only shown significance for limited service market regression equations. The values for supply elasticity used in this analysis were based on housing market supply elasticity and were used as a proxy for hotel market supply elasticity. Based on the results, this may have been a better proxy for limited service supply elasticity given that limited service hotels are more likely to be in suburban submarkets, which are more likely to have a concentration of residential areas. Therefore, a supply elasticity value might be skewed to the non-CBD areas of the various markets similar to how the concentration of limited service hotels might also be to a greater extent than full service hotels. Further, even in the same submarket, hotel and residential properties might be subject to very different development constraints. And second, total rooms per available worker only shows significance—and increases volatility—in full service regression equations except in limited service completions variance (and C, Ab covariance). This could be due to the fact that the variable suggests means something different for either sector. For instance, if full service hotels owe a larger portion of their demand to tourism and tourism demand is indeed volatile, then a large portion of full service hotels relative to workers suggests that the excess capacity draws more of its demand from external sources including tourism which contributes volatility. Whereas if limited service hotels draw a larger portion of their demand from non-tourism drivers locally, then a large number of rooms per worker might have much different implications for the sources of demand, which are not necessarily more volatile.

Market Correlation Analysis

For purposes of portfolio diversification and revenue risk management, this paper includes an analysis of the correlation that changes in RevPAR in each limited service and full service market exhibit with every other market in their respective sector. The full detail of the correlation matrices can be found in Appendix 2. No full service markets and very few limited service markets were (weakly) negatively correlated (see tables 23 and 24). However, many markets have very low correlations and would enhance portfolio diversification strategies given that the performance of two assets can still be positively correlated and reduce overall variance of the portfolio.

Of course, this analysis only considers revenue, and does not consider the degree to which revenue correlations may translate to NOI correlations, or correlations between value fluctuations, i.e.

considering cap rates, across markets. Listed below are the five most correlated and least correlated markets with each market in question and their corresponding correlations. Note that New Orleans had a consistently weak correlation with many of the listed markets likely due to abnormal events in that market. Thus, it has been excluded from all lists of least correlated markets.

There are some interesting findings from this analysis. First, geographical diversification alone does not result in diversifying away portfolio volatility. An example of this can be seen in the Boston full service market, where three of the five most correlated markets are in California. A seemingly diverse portfolio including Boston, San Francisco and New York hotels would yield few of the benefits of diversification. To achieve true diversification requires selecting markets with inherently different characteristics. Boston full service seems to be most correlated with markets considered mature financial centers, whereas it is least correlated with smaller markets and Texas markets, like Houston, known for not being supply constrained.

Another noteworthy result of this analysis is the lack of negatively correlated markets. Though certain limited service markets are slightly negatively correlated, domestic markets are almost universally positively correlated across both hotel sectors. Some positive correlations are rather low, offering the benefits of diversification. This general positive trend across markets in a variety of geographies, as well as the strong correlation between markets in varied regions, suggest the strength of market drivers at the national level. This seems to suggest a large degree of systematic (and thus non-diversifiable) risk in hotel markets. However, it might be the case that correlations become lower or negative in some cases when looking at NOI correlations given the impact of local determinants on operating costs. Such an analysis is beyond the scope of the available data and this paper, however.

Table 23| Full service market correlations, most correlated and least correlated

Most Correlated Markets

	Correl. to Average	1 Market	1 Correl.	2 Market	2 Correl.	3 Market	3 Correl.	4 Market	4 Correl.	5 Market	5 Correl.
ALBANY	0.486	SDIEGO	0.574	RICHMO	0.530	WBEACH	0.522	BALTIM	0.509	LISLAN	0.477
ALBUQU	0.505	DENVER	0.551	PHOENI	0.549	MINNEA	0.543	SLOUIS	0.535	FORTWO	0.517
ATLANT	0.685	DALLAS	0.634	TUCSON	0.618	RALEIG	0.608	CHRLTE	0.604	PHOENI	0.604
AUSTIN	0.734	DALLAS	0.756	TUCSON	0.719	DENVER	0.710	CHICAG	0.697	PHOENI	0.662
BALTIM	0.724	SDIEGO	0.695	LISLAN	0.682	MINNEA	0.660	OAKLAN	0.660	NEWARK	0.654
BOSTON	0.843	NEWYRK	0.862	SFRANC	0.823	OAKLAN	0.822	NEWARK	0.819	LANGEL	0.814
CHICAG	0.902	SEATTL	0.801	CHRLTE	0.798	NEWYRK	0.796	LANGEL	0.791	SDIEGO	0.777
CHRLTE	0.844	CHICAG	0.798	NEWYRK	0.773	DALLAS	0.763	PHILAD	0.756	SEATTL	0.749
CINCIN	0.624	CHICAG	0.653	RICHMO	0.647	PHILAD	0.641	NEWYRK	0.597	ORLAND	0.589
CLEVEL	0.767	PHOENI	0.722	CHRLTE	0.712	DALLAS	0.699	RALEIG	0.693	NASHVI	0.674
COLUMB	0.690	CHICAG	0.657	BALTIM	0.644	RALEIG	0.639	FORTLA	0.622	SEATTL	0.610
COLUSC	0.634	RALEIG	0.603	COLUMB	0.602	MIAMI	0.601	FORTLA	0.585	DETROI	0.564
DALLAS	0.851	PHOENI	0.794	SEATTL	0.776	CHRLTE	0.763	CHICAG	0.760	AUSTIN	0.756
DAYTON	0.400	SDIEGO	0.513	LISLAN	0.510	BALTIM	0.445	WBEACH	0.420	FORTWO	0.414
DENVER	0.763	MINNEA	0.771	CHICAG	0.765	AUSTIN	0.710	DALLAS	0.702	SEATTL	0.683
DETROI	0.809	CHICAG	0.766	NEWYRK	0.760	NEWARK	0.755	CHRLTE	0.741	BOSTON	0.737
EDISON	0.707	NEWARK	0.871	LISLAN	0.719	OAKLAN	0.709	DETROI	0.701	BOSTON	0.686
FORTLA	0.656	MIAMI	0.876	ORLAND	0.664	COLUMB	0.622	WBEACH	0.593	RALEIG	0.586
FORTWO	0.702	PHOENI	0.699	DALLAS	0.693	SEATTL	0.659	OMAHA	0.658	TUCSON	0.638
HARTFO	0.709	NEWARK	0.727	BOSTON	0.721	NEWYRK	0.706	LANGEL	0.700	DETROI	0.669
HONOLU	0.582	ORLAND	0.668	MIAMI	0.613	LANGEL	0.592	NEWYRK	0.581	ORANGE	0.567
HOUSTO	0.523	DALLAS	0.563	SEATTL	0.558	DENVER	0.525	SANTON	0.496	OAKLAN	0.472
INDIAN	0.553	CLEVEL	0.576	RALEIG	0.536	CHICAG	0.534	SLOUIS	0.533	PHOENI	0.525
KANSAS	0.734	RALEIG	0.711	NEWYRK	0.682	PHILAD	0.668	OAKLAN	0.655	DETROI	0.647
LANGEL	0.851	NEWYRK	0.923	BOSTON	0.814	SFRANC	0.805	CHICAG	0.791	SDIEGO	0.762
LISLAN	0.691	NEWARK	0.767	DETROI	0.736	EDISON	0.719	SDIEGO	0.719	BALTIM	0.682
MEMPHI	0.525	PHOENI	0.663	FORTWO	0.615	DALLAS	0.609	NASHVI	0.603	RALEIG	0.556
MIAMI	0.680	FORTLA	0.876	ORLAND	0.653	HONOLU	0.613	SFRANC	0.612	NEWYRK	0.610
MINNEA	0.810	DENVER	0.771	DALLAS	0.744	NEWYRK	0.733	BOSTON	0.720	RALEIG	0.697
NASHVI	0.686	PHOENI	0.696	CHICAG	0.684	RALEIG	0.683	CLEVEL	0.674	DALLAS	0.666
NEWARK	0.821	EDISON	0.871	BOSTON	0.819	NEWYRK	0.793	OAKLAN	0.791	CHICAG	0.770
NEWORL	0.325	MINNEA	0.352	EDISON	0.339	DETROI	0.335	NEWARK	0.330	NEWYRK	0.323
NEWYRK	0.908	LANGEL	0.923	BOSTON	0.862	SFRANC	0.826	CHICAG	0.796	NEWARK	0.793
OAKLAN	0.853	SFRANC	0.823	BOSTON	0.822	NEWARK	0.791	CHICAG	0.776	NEWYRK	0.766
OMAHA	0.592	SEATTL	0.664	FORTWO	0.658	PHOENI	0.600	DALLAS	0.587	TUCSON	0.575
ORANGE	0.737	LANGEL	0.727	NEWYRK	0.715	CHICAG	0.675	OAKLAN	0.666	SEATTL	0.660
ORLAND	0.765	NEWYRK	0.726	LANGEL	0.720	TAMPA	0.710	PHILAD	0.707	RICHMO	0.688
PHILAD	0.810	NEWYRK	0.777	CHICAG	0.759	CHRLTE	0.756	LANGEL	0.724	RALEIG	0.708
PHOENI	0.834	DALLAS	0.794	RALEIG	0.778	TUCSON	0.753	CHRLTE	0.741	CLEVEL	0.722
PITTSB	0.582	CHRLTE	0.617	DALLAS	0.585	RALEIG	0.571	CLEVEL	0.558	NEWYRK	0.543
PORTLA	0.666	SEATTL	0.668	DALLAS	0.650	CHRLTE	0.641	TUCSON	0.635	DENVER	0.620
RALEIG	0.830	PHOENI	0.778	CHICAG	0.769	DALLAS	0.752	OAKLAN	0.723	CHRLTE	0.716
RICHMO	0.786	NEWYRK	0.764	LANGEL	0.741	CHICAG	0.735	CHRLTE	0.727	NEWARK	0.698
SANTON	0.569	TUCSON	0.669	DALLAS	0.549	AUSTIN	0.541	TAMPA	0.518	COLUMB	0.501
SDIEGO	0.777	CHICAG	0.777	LANGEL	0.762	NEWYRK	0.734	OAKLAN	0.731	LISLAN	0.719
SEATTL	0.834	CHICAG	0.801	DALLAS	0.776	CHRLTE	0.749	NEWYRK	0.748	LANGEL	0.746
SFRANC	0.818	NEWYRK	0.826	OAKLAN	0.823	BOSTON	0.823	LANGEL	0.805	CHICAG	0.763
SLOUIS	0.738	PHOENI	0.704	CHICAG	0.681	SEATTL	0.663	RALEIG	0.662	PHILAD	0.658
TAMPA	0.738	OAKLAN	0.715	ORLAND	0.710	CHICAG	0.678	SDIEGO	0.666	LANGEL	0.657
TRENTO	0.488	NEWARK	0.676	EDISON	0.671	BALTIM	0.557	LISLAN	0.542	PHILAD	0.533
TUCSON	0.770	PHOENI	0.753	AUSTIN	0.719	DALLAS	0.693	CHICAG	0.682	SANTON	0.669
WASHIN	0.678	NEWYRK	0.672	WBEACH	0.669	LANGEL	0.653	BOSTON	0.649	OAKLAN	0.623
WBEACH	0.708	PHOENI	0.677	WASHIN	0.669	NEWYRK	0.655	CLEVEL	0.623	ORLAND	0.612

*Least Correlated Markets**

	1 Market	1 Correl.	2 Market	2 Correl.	3 Market	3 Correl.	4 Market	4 Correl.	5 Market	5 Correl.
ALBANY	HONOLU	0.069	MEMPHI	0.103	TRENTO	0.129	PORTLA	0.136	HOUSTO	0.179
ALBUQU	DAYTON	0.039	TRENTO	0.108	LISLAN	0.147	HARTFO	0.152	FORTLA	0.170
ATLANT	DAYTON	0.199	ALBANY	0.220	TRENTO	0.305	INDIAN	0.313	PITTSB	0.350
AUSTIN	TRENTO	0.159	ALBANY	0.232	DAYTON	0.256	LISLAN	0.345	ORANGE	0.396
BALTIM	PORTLA	0.216	ALBUQU	0.280	HOUSTO	0.284	HONOLU	0.293	SANTON	0.332
BOSTON	DAYTON	0.183	MEMPHI	0.295	SANTON	0.339	HOUSTO	0.350	OMAHA	0.359
CHICAG	DAYTON	0.385	ALBUQU	0.432	HONOLU	0.441	HOUSTO	0.458	MEMPHI	0.465
CHRLTE	INDIAN	0.352	ALBANY	0.361	HOUSTO	0.383	DAYTON	0.384	TRENTO	0.389
CINCIN	DAYTON	0.114	ALBUQU	0.180	OMAHA	0.237	ALBANY	0.261	MEMPHI	0.261
CLEVEL	HOUSTO	0.270	TRENTO	0.281	DAYTON	0.320	ALBANY	0.330	ALBUQU	0.363
COLUMB	TRENTO	0.227	ALBUQU	0.313	MEMPHI	0.318	OMAHA	0.340	DAYTON	0.344
COLUSC	DAYTON	0.141	TRENTO	0.152	MEMPHI	0.165	FORTWO	0.266	OMAHA	0.266
DALLAS	TRENTO	0.324	ALBANY	0.340	DAYTON	0.366	FORTLA	0.439	EDISON	0.462
DAYTON	HOUSTO	0.035	PORTLA	0.039	ALBUQU	0.039	HONOLU	0.060	CINCIN	0.114
DENVER	DAYTON	0.190	ALBANY	0.208	WBEACH	0.350	LISLAN	0.381	OMAHA	0.388
DETROI	HOUSTO	0.306	ALBUQU	0.311	HONOLU	0.333	ALBANY	0.340	DAYTON	0.361
EDISON	HONOLU	0.197	MEMPHI	0.208	NASHVI	0.219	PITTSB	0.227	DAYTON	0.281
FORTLA	TRENTO	0.125	ALBUQU	0.170	INDIAN	0.190	DAYTON	0.215	MEMPHI	0.244
FORTWO	TRENTO	0.242	COLUSC	0.266	EDISON	0.314	CINCIN	0.334	MIAMI	0.337
HARTFO	ALBUQU	0.152	SANTON	0.160	DAYTON	0.200	MEMPHI	0.251	HOUSTO	0.314
HONOLU	TRENTO	0.044	DAYTON	0.060	ALBANY	0.069	LISLAN	0.136	EDISON	0.197
HOUSTO	DAYTON	0.035	WBEACH	0.112	LISLAN	0.178	ALBANY	0.179	PITTSB	0.246
INDIAN	TRENTO	0.168	FORTLA	0.190	DAYTON	0.204	MIAMI	0.265	HOUSTO	0.266
KANSAS	DAYTON	0.205	ALBANY	0.254	CINCIN	0.314	HONOLU	0.331	FORTLA	0.333
LANGEL	SANTON	0.305	MEMPHI	0.314	DAYTON	0.330	ALBUQU	0.389	HOUSTO	0.391
LISLAN	HONOLU	0.136	ALBUQU	0.147	SANTON	0.153	HOUSTO	0.178	PORTLA	0.241
MEMPHI	ALBANY	0.103	COLUSC	0.165	TRENTO	0.175	WASHIN	0.202	EDISON	0.208
MIAMI	TRENTO	0.110	DAYTON	0.204	ALBUQU	0.222	MEMPHI	0.258	INDIAN	0.265
MINNEA	DAYTON	0.302	ALBANY	0.353	HOUSTO	0.393	TRENTO	0.394	LISLAN	0.416
NASHVI	TRENTO	0.106	EDISON	0.219	ALBANY	0.256	HOUSTO	0.277	DAYTON	0.283
NEWARK	DAYTON	0.257	MEMPHI	0.259	HONOLU	0.274	ALBUQU	0.349	OMAHA	0.356
NEWORL	MEMPHI	0.037	DAYTON	0.076	OMAHA	0.082	INDIAN	0.084	ALBANY	0.089
NEWYRK	DAYTON	0.336	MEMPHI	0.361	ALBUQU	0.377	SANTON	0.391	HOUSTO	0.422
OAKLAN	DAYTON	0.226	ALBUQU	0.344	MEMPHI	0.357	OMAHA	0.391	ALBANY	0.423
OMAHA	PITTSB	0.204	TRENTO	0.222	CINCIN	0.237	FORTLA	0.262	COLUSC	0.266
ORANGE	DAYTON	0.242	PITTSB	0.275	CINCIN	0.301	MEMPHI	0.346	SANTON	0.346
ORLAND	DAYTON	0.199	TRENTO	0.273	MEMPHI	0.286	INDIAN	0.322	ALBUQU	0.343
PHILAD	ALBUQU	0.315	HOUSTO	0.348	ALBANY	0.351	HONOLU	0.378	DAYTON	0.393
PHOENI	TRENTO	0.240	HOUSTO	0.326	DAYTON	0.380	ALBANY	0.424	EDISON	0.434
PITTSB	TRENTO	0.178	ALBANY	0.182	OMAHA	0.204	DAYTON	0.222	EDISON	0.227
PORTLA	DAYTON	0.039	ALBANY	0.136	BALTIM	0.216	LISLAN	0.241	TRENTO	0.252
RALEIG	DAYTON	0.202	ALBANY	0.268	HOUSTO	0.315	SANTON	0.352	TRENTO	0.354
RICHMO	DAYTON	0.263	MEMPHI	0.329	ALBUQU	0.382	HOUSTO	0.404	AUSTIN	0.421
SANTON	TRENTO	0.050	LISLAN	0.153	HARTFO	0.160	DAYTON	0.212	MEMPHI	0.222
SDIEGO	HOUSTO	0.275	ALBUQU	0.277	PITTSB	0.308	MEMPHI	0.342	SANTON	0.343
SEATTL	DAYTON	0.344	TRENTO	0.366	ALBUQU	0.382	COLUSC	0.391	ALBANY	0.402
SFRANC	DAYTON	0.251	SANTON	0.274	ALBUQU	0.279	OMAHA	0.322	MEMPHI	0.337
SLOUIS	HONOLU	0.285	DAYTON	0.298	ALBANY	0.307	HOUSTO	0.333	MIAMI	0.345
TAMPA	MEMPHI	0.281	ALBUQU	0.314	PITTSB	0.326	INDIAN	0.334	HOUSTO	0.349
TRENTO	HONOLU	0.044	SANTON	0.050	NASHVI	0.106	ALBUQU	0.108	MIAMI	0.110
TUCSON	TRENTO	0.225	DAYTON	0.298	PITTSB	0.395	LISLAN	0.409	HARTFO	0.412
WASHIN	MEMPHI	0.202	TRENTO	0.224	ALBUQU	0.237	HOUSTO	0.259	OMAHA	0.287
WBEACH	HOUSTO	0.112	TRENTO	0.231	PITTSB	0.293	MEMPHI	0.316	PORTLA	0.324

*Least correlated markets exclude New Orleans due to generally weak correlations likely resulting from Hurricane Katrina

Table 24| Limited service market correlations, most correlated and least correlated

		Most Correlated Markets										Least Correlated Markets*									
	Correl. to	1		2		3		4		5		1		2		3		4		5	
	Average	Market	Correl.	Market	Correl.	Market	Correl.	Market	Correl.	Market	Correl.	Market	Correl.	Market	Correl.	Market	Correl.	Market	Correl.	Market	Correl.
ALBANY	0.258	NEWARK	0.448	SLOUIS	0.446	LANGEL	0.420	HARTFO	0.376	SANTON	0.375	HONOLU	(0.084)	AUSTIN	(0.027)	RALEIG	(0.019)	COLUSC	(0.002)	CHRLTE	0.029
ALBUQU	0.386	SLOUIS	0.619	INDIAN	0.524	KANSAS	0.493	NASHVI	0.478	TUCSON	0.455	LISLAN	(0.099)	TRENTO	(0.079)	EDISON	0.067	BOSTON	0.072	SDIEGO	0.081
ATLANT	0.688	MEMPHI	0.681	DALLAS	0.625	DETROI	0.612	MINNEA	0.606	PHOENI	0.603	ALBANY	0.036	PITTSB	0.105	ALBUQU	0.166	SLOUIS	0.208	COLUMB	0.253
AUSTIN	0.722	DALLAS	0.735	SFRANC	0.701	CHICAG	0.677	FORTWO	0.655	DENVER	0.627	ALBANY	(0.027)	LISLAN	0.102	HARTFO	0.139	TRENTO	0.155	WBEACH	0.223
BALTIM	0.624	WASHIN	0.731	LANGEL	0.679	RICHMO	0.632	DAYTON	0.612	DETROI	0.588	PITTSB	0.009	HONOLU	0.056	OMAHA	0.074	ALBUQU	0.114	HOUSTO	0.118
BOSTON	0.675	EDISON	0.789	NEWARK	0.726	HARTFO	0.706	OAKLAN	0.696	WASHIN	0.680	HOUSTO	(0.040)	HONOLU	0.010	SANTON	0.070	ALBUQU	0.072	SLOUIS	0.103
CHICAG	0.857	CHRLTE	0.769	PHOENI	0.733	NASHVI	0.727	DENVER	0.719	SFRANC	0.712	HONOLU	0.221	HOUSTO	0.223	ALBANY	0.226	SLOUIS	0.317	FORTLA	0.322
CHRLTE	0.797	CHICAG	0.769	NASHVI	0.736	PHOENI	0.734	CINCIN	0.721	MEMPHI	0.690	ALBANY	0.029	HOUSTO	0.188	LISLAN	0.253	ALBUQU	0.255	SLOUIS	0.258
CINCIN	0.743	CHRLTE	0.721	CHICAG	0.692	DALLAS	0.635	RICHMO	0.621	PHOENI	0.618	LISLAN	0.126	ALBANY	0.203	EDISON	0.317	HOUSTO	0.336	FORTLA	0.356
CLEVEL	0.622	DETROI	0.640	CHICAG	0.638	CHRLTE	0.607	EDISON	0.577	OMAHA	0.559	ALBANY	0.152	LISLAN	0.169	PITTSB	0.192	HOUSTO	0.194	FORTLA	0.201
COLUMB	0.579	FORTWO	0.598	SEATTL	0.581	COLUSC	0.539	DALLAS	0.532	AUSTIN	0.532	TRENTO	0.133	ALBANY	0.160	SANTON	0.160	WASHIN	0.190	HOUSTO	0.193
COLUSC	0.672	PHOENI	0.731	NASHVI	0.708	MEMPHI	0.679	CHRLTE	0.654	TAMPA	0.644	ALBANY	(0.002)	HOUSTO	0.029	NEWARK	0.134	PITTSB	0.188	SANTON	0.201
DALLAS	0.840	FORTWO	0.784	AUSTIN	0.735	DENVER	0.712	CHICAG	0.707	MEMPHI	0.701	ALBANY	0.210	LISLAN	0.215	HONOLU	0.327	TRENTO	0.332	SLOUIS	0.349
DAYTON	0.643	WASHIN	0.625	BALTIM	0.612	CHICAG	0.591	RICHMO	0.586	DALLAS	0.577	HONOLU	0.093	ALBUQU	0.160	SANTON	0.219	HOUSTO	0.229	ALBANY	0.239
DENVER	0.742	KANSAS	0.726	RALEIG	0.724	MINNEA	0.720	CHICAG	0.719	DALLAS	0.712	HONOLU	0.141	LISLAN	0.153	ALBANY	0.158	WBEACH	0.256	LANGEL	0.276
DETROI	0.665	EDISON	0.720	CHICAG	0.708	BOSTON	0.670	MINNEA	0.654	CLEVEL	0.640	HONOLU	0.025	HOUSTO	0.058	PITTSB	0.069	ALBANY	0.158	ALBUQU	0.162
EDISON	0.670	BOSTON	0.789	DETROI	0.720	NEWARK	0.702	CHICAG	0.662	OAKLAN	0.647	PITTSB	(0.006)	HOUSTO	0.007	HONOLU	0.037	ALBUQU	0.067	SLOUIS	0.139
FORTLA	0.598	MIAMI	0.780	ORLAND	0.664	WBEACH	0.627	TAMPA	0.614	MINNEA	0.577	PITTSB	0.077	SLOUIS	0.094	ALBANY	0.114	ALBUQU	0.125	NEWARK	0.170
FORTWO	0.720	DALLAS	0.784	MEMPHI	0.668	PORTLA	0.658	AUSTIN	0.655	PHOENI	0.650	ALBANY	0.114	LISLAN	0.187	SLOUIS	0.225	HARTFO	0.251	WASHIN	0.274
HARTFO	0.625	BOSTON	0.706	WASHIN	0.659	NEWARK	0.629	EDISON	0.623	DETROI	0.622	HONOLU	0.004	HOUSTO	0.015	SANTON	0.087	ALBUQU	0.105	PITTSB	0.129
HONOLU	0.399	TUCSON	0.566	AUSTIN	0.499	MIAMI	0.452	OMAHA	0.436	FORTLA	0.431	ALBANY	(0.084)	LISLAN	(0.074)	NEWARK	(0.025)	HARTFO	0.004	BOSTON	0.010
HOUSTO	0.363	DALLAS	0.504	FORTWO	0.498	SANTON	0.482	PORTLA	0.448	AUSTIN	0.374	BOSTON	(0.040)	LISLAN	(0.027)	PHILAD	(0.011)	EDISON	0.007	HARTFO	0.015
INDIAN	0.577	PHOENI	0.674	KANSAS	0.649	NASHVI	0.646	DALLAS	0.637	DENVER	0.633	LISLAN	0.023	TRENTO	0.086	WBEACH	0.117	HOUSTO	0.154	NEWARK	0.155
KANSAS	0.592	DENVER	0.726	PHOENI	0.677	INDIAN	0.649	DALLAS	0.629	NASHVI	0.597	LISLAN	0.007	SDIEGO	0.083	ALBANY	0.152	WBEACH	0.166	HONOLU	0.172
LANGEL	0.691	SDIEGO	0.777	WASHIN	0.764	ORANGE	0.747	OAKLAN	0.679	BALTIM	0.679	OMAHA	0.135	PITTSB	0.136	HONOLU	0.159	ALBUQU	0.193	KANSAS	0.205
LISLAN	0.423	EDISON	0.572	NEWYRK	0.535	BALTIM	0.526	PHILAD	0.520	LANGEL	0.519	ALBUQU	(0.099)	HONOLU	(0.074)	OMAHA	(0.061)	SANTON	(0.051)	PITTSB	(0.036)
MEMPHI	0.747	NASHVI	0.771	PHOENI	0.730	DALLAS	0.701	CHRLTE	0.690	DENVER	0.682	HONOLU	0.168	ALBANY	0.187	PITTSB	0.215	LISLAN	0.223	SLOUIS	0.294
MIAMI	0.646	FORTLA	0.780	MINNEA	0.667	SEATTL	0.621	WBEACH	0.596	TUCSON	0.571	ALBANY	0.050	PITTSB	0.100	NEWARK	0.170	LISLAN	0.176	HOUSTO	0.207
MINNEA	0.735	DENVER	0.720	CHICAG	0.678	DALLAS	0.668	MEMPHI	0.667	MIAMI	0.667	PITTSB	0.146	HOUSTO	0.161	ALBANY	0.170	LISLAN	0.227	HONOLU	0.240
NASHVI	0.743	PHOENI	0.818	MEMPHI	0.771	CHRLTE	0.736	CHICAG	0.727	COLUSC	0.708	ALBANY	0.086	HOUSTO	0.120	LISLAN	0.172	HONOLU	0.188	NEWARK	0.262
NEWARK	0.604	BOSTON	0.726	EDISON	0.702	LANGEL	0.646	CHICAG	0.631	HARTFO	0.629	HONOLU	(0.025)	SLOUIS	0.132	COLUSC	0.134	PITTSB	0.135	ALBUQU	0.136
NEWORL	0.436	FORTWO	0.546	DALLAS	0.476	ATLANT	0.460	MEMPHI	0.430	SANTON	0.405	SLOUIS	(0.131)	ALBANY	(0.107)	PITTSB	0.012	PHILAD	0.069	INDIAN	0.078
NEWYRK	0.722	OAKLAN	0.776	SFRANC	0.743	SDIEGO	0.702	CHICAG	0.675	BOSTON	0.674	SLOUIS	0.084	ALBUQU	0.097	HONOLU	0.102	ALBANY	0.119	HOUSTO	0.146
OAKLAN	0.760	SFRANC	0.848	NEWYRK	0.776	SDIEGO	0.731	ORANGE	0.705	BOSTON	0.696	ALBUQU	0.141	SANTON	0.207	ALBANY	0.214	SLOUIS	0.226	HOUSTO	0.258
OMAHA	0.509	PORTLA	0.614	CLEVEL	0.559	TUCSON	0.553	CHRLTE	0.552	CHICAG	0.511	LISLAN	(0.061)	PHILAD	0.052	BALTIM	0.074	WBEACH	0.119	LANGEL	0.135
ORANGE	0.745	WASHIN	0.750	LANGEL	0.747	OAKLAN	0.705	SDIEGO	0.679	SFRANC	0.674	PITTSB	0.016	ALBANY	0.086	ALBUQU	0.156	SANTON	0.209	SLOUIS	0.213
ORLAND	0.630	TAMPA	0.723	SEATTL	0.675	FORTLA	0.664	WBEACH	0.612	SFRANC	0.570	ALBANY	0.061	HOUSTO	0.101	SLOUIS	0.118	LISLAN	0.143	DETROI	0.166
PHILAD	0.635	PHOENI	0.639	RALEIG	0.635	COLUSC	0.628	EDISON	0.628	WASHIN	0.596	HOUSTO	(0.011)	SANTON	(0.011)	PITTSB	(0.009)	HONOLU	0.030	OMAHA	0.052
PHOENI	0.819	NASHVI	0.818	RALEIG	0.813	CHRLTE	0.734	CHICAG	0.733	COLUSC	0.731	ALBANY	0.103	PITTSB	0.141	HOUSTO	0.167	LISLAN	0.175	SANTON	0.316
PITTSB	0.322	DALLAS	0.472	PORTLA	0.469	INDIAN	0.459	SLOUIS	0.439	CINCIN	0.433	WBEACH	(0.091)	TRENTO	(0.088)	LISLAN	(0.036)	PHILAD	(0.009)	EDISON	(0.006)
PORTLA	0.673	DALLAS	0.684	CHRLTE	0.683	FORTWO	0.658	CHICAG	0.658	SEATTL	0.641	LISLAN	(0.031)	ALBANY	0.085	BALTIM	0.143	WBEACH	0.181	FORTLA	0.234
RALEIG	0.690	PHOENI	0.813	DENVER	0.724	CHICAG	0.705	NASHVI	0.685	CHRLTE	0.657	ALBANY	(0.019)	HOUSTO	0.036	SANTON	0.114	PITTSB	0.132	SLOUIS	0.172
RICHMO	0.693	PHOENI	0.657	NASHVI	0.643	BALTIM	0.632	MEMPHI	0.621	CINCIN	0.621	HONOLU	0.137	HOUSTO	0.200	FORTLA	0.233	MIAMI	0.255	WBEACH	0.306
SANTON	0.478	TUCSON	0.509	DALLAS	0.509	CINCIN	0.502	HOUSTO	0.482	KANSAS	0.481	LISLAN	(0.051)	PHILAD	(0.011)	BOSTON	0.070	HARTFO	0.087	RALEIG	0.114
SDIEGO	0.657	LANGEL	0.777	OAKLAN	0.731	NEWYRK	0.702	ORANGE	0.679	SFRANC	0.623	PITTSB	0.022	ALBUQU	0.081	KANSAS	0.083	SLOUIS	0.106	HOUSTO	0.177
SEATTL	0.769	SFRANC	0.755	OAKLAN	0.689	ORLAND	0.675	DENVER	0.663	CHICAG	0.660	ALBANY	0.112	LISLAN	0.205	DETROI	0.226	SLOUIS	0.304	ALBUQU	0.304
SFRANC	0.787	OAKLAN	0.848	SEATTL	0.755	NEWYRK	0.743	CHICAG	0.712	AUSTIN	0.701	ALBANY	0.045	SLOUIS	0.122	ALBUQU	0.206	OMAHA	0.255	HOUSTO	0.267
SLOUIS	0.374	ALBUQU	0.619	INDIAN	0.502	TUCSON	0.500	RICHMO	0.482	KANSAS	0.447	TRENTO	0.022	WBEACH	0.022	LISLAN	0.049	NEWYRK	0.084	FORTLA	0.094
TAMPA	0.719	ORLAND	0.723	PHOENI	0.673	COLUSC	0.644	WBEACH	0.622	SEATTL	0.618	HOUSTO	0.148	ALBANY	0.155	PITTSB	0.206	ALBUQU	0.231	LISLAN	0.252
TRENTO	0.558	ORANGE	0.562	SDIEGO	0.560	TAMPA	0.543	BALTIM	0.541	LANGEL	0.540	PITTSB	(0.088)	ALBUQU	(0.079)	SLOUIS	0.022	HONOLU	0.059	INDIAN	0.086
TUCSON	0.742	PHOENI	0.713	COLUSC	0.633	NASHVI	0.624	CHICAG	0.612	CHRLTE	0.607	HOUSTO	0.129	PITTSB	0.201	LISLAN	0.224	ALBANY	0.265	BOSTON	0.331
WASHIN	0.723	LANGEL	0.764	ORANGE	0.750	BALTIM	0.731	WBEACH	0.696	BOSTON	0.680	PITTSB	0.086	HOUSTO	0.107	ALBUQU	0.113	OMAHA	0.138	SANTON	0.151
WBEACH	0.620	WASHIN	0.696	FORTLA	0.627	TAMPA	0.622	LANGEL	0.617	ORLAND	0.612	PITTSB	(0.091)	SLOUIS	0.022	ALBUQU	0.082	HOUSTO	0.089	INDIAN	0.117

*Least correlated markets exclude New Orleans due to generally weak correlations likely resulting from Hurricane Katrina

Chapter 5: Conclusion

The research presented in this paper seeks to provide a methodology and characterization of various hotel markets. The biggest component of the risk associated with hotels considered in this paper is volatility of revenue, as measured by RevPAR. All other hotel market fundamentals are components of RevPAR, whether vacancy (occupancy), room rates, absorption or completions, and the degree to which any of two components of a composite measure move in tandem. As such, a thorough understanding of the volatility associated with the various hotel fundamentals contributes to a comprehensive understanding of volatility of hotel revenue and, more generally, risk in hotel markets.

Perhaps the most surprising conclusion from this research is that limited service RevPAR shows a higher degree of volatility than does full service. This is surprising given that limited service hotels are generally considered to be safer investments. However, a more comprehensive consideration of what determines volatility and risk in a hotel property will allow some insights into this. In the 2010 HOST report published by Smith Travel Research, total departmental profit from rooms in the preceding year was 55% for full service hotels and 74.1% for limited service hotels.[14] Because departmental expenses are considered to be mostly variable, volatilities of the two sectors remain mostly unchanged on a percentage basis at the departmental profit level. However, expenses considered to generally be completely or mostly fixed—administrative, marketing, utilities, property maintenance, property taxes, insurance and reserves for replacement—were roughly similar as a percentage of sales (33.6% in full service, 35.8% in limited service).[15] Therefore, fixed expenses were a significantly higher component of departmental profits for full service than limited service, given the higher limited service departmental profit margins. A side note: limited service room revenue is a much larger portion of total revenues than in full service (96.6% versus 62.8%),[16] but it is reasonable to assume that other sources of revenue in full service hotels, food & beverage making up most of the remainder, are similarly volatile. Based on these metrics, full service experiences significantly higher operating leverage than limited service. Now it is important to understand the impact that this operating leverage can have on volatility.

[14] Smith Travel Research, 2010 HOST Report.
[15] Ibid.
[16] Ibid.

The San Francisco market can provide an illustration of the impact of operating leverage. First, RevPAR variances are higher for limited service, 0.00104 versus 0.00080. Using US average departmental profit margins for each sector and management and franchise fees as provided by the 2010 HOST Report, as well as fixed expenses reported as a percentage of sales in the HOST report calculated as a percentage of average real RevPAR over the time period and held fixed, the resulting higher volatility of NOI compared to that of RevPAR can be observed (see table 25).

Table 25| San Francisco potential effects of operating leverage

	Full Service	Limited Service
Observed Change in RevPAR Variance	*0.00082*	*0.00104*
Average RevPAR[1]	*$63.86*	*$36.45*
Departmental Profit Margin[2,3]	*51.7%*	*68.3%*
Departmental Profit (PAR)	*$33.01*	*$24.89*
Fixed Expenses (PAR)[2]	*$21.07*	*$13.12*
Average NOI (PAR)	*$11.94*	*$11.77*
Estimated Change in NOI Variance	*0.00616*	*0.00552*

[1] All dollar amounts in 1Q 1987 dollars

[2] Source: 2010 HOST Report, Smith Travel Research.

[3] After deductions for (variable) Management and Franchise Fees

In this example, Change in RevPAR variance is more volatile in limited service than full service. Upon converting the revenue to net operating income, both variances increased substantially but full service is now higher than limited service. Volatility did increase substantially in both hotel sectors, however substantially more in full service. While a similar analysis can be performed on all markets using reported averages, the results will be similar, and reiterate the contribution to overall risk that operating leverage can have. This also indicates that on average, the extent to which full service hotels exhibit more volatility in net operating income than do their limited service counterparts is far more the result of their operating structure than volatility in revenue. In fact, the relative volatility of full service and limited service revenue, as this paper has shown, is exactly the opposite.

This paper began by analyzing full service and limited service variances in changes in vacancy and RevPAR. It showed that revenues and hotel demand are more volatile across full service markets, on average, though limited service markets are less homogeneous in this respect.

Providing an initial characterization and basis for further analysis are measures of seasonality. Of the 53 markets considered, only a handful are highly seasonal, with the vast majority showing less than 10% standard deviation. While 10% standard deviation still reflects seasonal differences in demand, the seasonality across markets is quite skewed to the most seasonal markets. The most seasonal markets are those markets that are commonly associated with strong demand in the winter months and unpleasant summer weather, such as Florida and Arizona markets including West Palm Beach, Fort Lauderdale, Miami, Tucson, and Phoenix. In full service markets, the least seasonal are some of those not generally associated with tourist demand, i.e. markets such as Columbus, Hartford, Richmond, and Raleigh. The same seems to be true in limited service markets. Los Angeles limited service is curiously lacking in seasonality however. This could be due to the geographic distribution of limited service hotels within the Los Angeles market and the likely concentration of them in non-tourism driven areas, certainly a possibility given how geographically diverse the Los Angeles market is.

To reach a more definitive conclusion would require the analysis of hotel markets by locational attribute (urban, suburban, airport, etc) and price segment simultaneously to observe different characteristics between groups of hotels in different markets that show more similar characteristics to one another. This possibility in the case of Los Angeles points to a general consideration when interpreting the data. Limited service and full service markets can have significantly different composition from one market to another. The geographic characteristics of limited service hotels in one market could vary significantly from another. For instance, a large portion of limited service hotels might be on highways in one market, near airports in another, and in urban locations in yet another. These differences will at times lead to outliers in the general trends observed in the results of the research presented in this paper.

This leads to an opportunity for further research. A similar analysis performed on a data set including a more homogeneous grouping of hotels across markets would likely show even stronger relationships between certain variables and measures of volatility. For instance, rather than analyzing full service markets, additional research might look specifically at hotels in the same price segment and locational segment, upscale urban hotels for instance. This analysis would likely produce different results given that certain segments of the full service hotel sector likely respond to some of the determinants analyzed in this paper, while segments do not.

Then this paper analyzed the relationship between changes in occupancy and ADR. In some markets, namely non-primary markets such as Pittsburgh, Omaha, Indianapolis, and Albany, to name a few, the relationship is quite weak. These findings suggest that hotel managers in these markets wield a relatively large degree of pricing control. Whereas in primary markets such as New York, Boston and Chicago, ADR is much more sensitive to changes in occupancy. This phenomenon is generally consistent across full service and limited service markets. These findings suggest that demand is more elastic in larger markets. It is likely that when consumers have more hotel options from which to choose, hotels must compete on rate to maintain their occupancy levels. However, in non-primary markets, the rate competition is not nearly as prominent. It could also point to the prevalence of more active or more ubiquitous revenue management systems in larger markets.

The decomposition analyses allow for the further characterization of the different markets. The results explain what drives markets, whether market dynamics are more the result of supply or demand, and whether RevPAR is more the result of movements in ADR or occupancy. This is the final step in the characterization of different markets based on their observed dynamics.

For a characterization that can be made based on the analysis in this paper, take New York City. Vacancy for full service is slightly less volatile than the market average, but it is more dependent on demand. Changes in RevPAR in New York full service are much more the result of changes in ADR than they are changes in Occupancy relative to other markets. Though the volatility of occupancy change is close to the average across the 53 markets, New York has more ADR volatility than any other market, which contributes to New York full service being the most volatile market in terms of RevPAR overall. However, the RevPAR volatility in New York full service still pales in comparison to many limited service markets. The behavior of hotel market fundamentals in New York or any other market can be described in similar fashion. The result is an empirical model for comparing the dynamics of one hotel market to the next.

Then the cross-sectional regression analysis attempts to explain the market characterizations from the preceding analysis. Employment growth and volatility, the size of markets, and the degree to which markets are seasonal often help explain whether markets are demand or supply driven, and whether RevPAR change is driven more by occupancy or ADR change. And the employment characteristics of a market have a consistently strong effect on the magnitude of volatility in the various measures. Important market characteristics impacting volatility are as follows:

- Larger markets experience more RevPAR volatility.
- Employment volatility contributes to RevPAR volatility, but employment growth only does so in limited service markets.

- Supply elasticity lessens revenue volatility in limited service markets. This might be true in full service markets given a better measure of supply elasticity corresponding to full service hotel development.

- Seasonal full service markets show more in-year volatility by definition, but also more long term volatility.

- Employment generally has a significant impact on hotel fundamentals, typically exhibiting a positive relationship between volatility in employment and volatility in various demand-related fundamentals.

Volatility of RevPAR is the most significant measure in the assessment of hotel market risk considered in this paper. Volatility of RevPAR is affected by employment characteristics, though more so in limited service where demand is perhaps more likely to be increasingly dependent on the local economy. And the relative level of ADR also has an impact, with high ADR markets being more volatile.

As a final analysis comparing markets, RevPAR over the time period analyzed in the data set was correlated between a market and all other markets. Unlike Gallagher and Mansour's study, few negative correlations were found and those which were negative exhibited a very weak relationship. However, plenty of markets showed weak positive correlations. Interpretation of the results of these correlations suggests that markets which have similar general characteristics such as size, geographical characteristics, and industry concentrations, exhibit similar movements regardless of their geographical proximity. And many market pairs exhibit weak enough positive correlations that inclusion of hotels from one market in a portfolio comprised mainly of hotels correlated with the other of the market pair in question would create diversification benefits in the form of reduced overall volatility of revenue at the portfolio level. The example used earlier, where a seemingly diversified portfolio of Boston, New York, San Francisco, and Los Angeles hotels actually benefits little from diversification, would benefit from the inclusion of hotels in markets like Memphis or San Antonio.

As mentioned in the Literature Review, Ismail, Dalbor and Mills find that elasticities of the RevPAR of various price segments increase as the price segment gets higher. However, this conclusion does not necessarily contradict the findings of this paper due to the differences in nature of the composition of the different sectors analyzed in this research. Remember that Ismail, Dalbor and Mills do not separate out the price segments by type of hotel, i.e. full service and limited service. Though limited service hotels do have a lower ADR than full service hotels in general, the composition of full service available rooms in a given market may include anything ranging from budget to luxury. And the same is true for limited service. Based on the parallel findings in this paper and those by Ismail, Dalbor and Mills, it is possible that the limited service components of the various price segments, on average, decrease the volatility of their respective price segments, and that the portion of the available rooms occupying the higher price segments increase the volatility of their respective hotel types analyzed in this paper, i.e. full or limited service hotels.

The analysis in this paper seeks to provide a more comprehensive and accurate understanding of the behavior and dynamics of hotel market fundamentals. This understanding can be implemented in the selection of portfolios that exhibit certain traits advantageous to the investment philosophy of hotel owners. As an example, an investment firm that foresees a series of positive demand shocks at a local or national level, or permanent changes in hotel demand in certain markets, might be better served to select hotels in those markets which show increased sensitivity to changes in occupancy. And this portfolio selection can be further aided by understanding which markets offer true diversification benefits, and which are falsely considered to be based on prevailing market views or misguided intuition.

More generally, this research characterizes markets based on their observed behavior over a time period long enough to observe dynamics over multiple market cycles. Though limitations exist as to the degree to which observed behavior in market fundamentals impacts hotel performance, which takes into account a complex array of other factors, any understanding of hotel markets would be enhanced by a thorough and comprehensive understanding of the fundamentals which affect how hotels generate revenue. This paper aims to answer the basic questions leading to the understanding of those fundamentals and contribute to the overall discussion of the dynamics of hotel markets, risk, and risk management strategies.

Appendices

Appendix 1

Market Definitions Summary			
Market	TWR Code	CBSA_Code	Description*
Albany	ALBANY	10580	Albany-Schenectady-Troy NY
Albuquerque	ALBUQU	10740	Albuquerque NM
Atlanta	ATLANT	12060	Atlanta-Sandy Springs-Marietta GA
Austin	AUSTIN	12420	Austin-Round Rock TX
Baltimore	BALTIM	12580	Baltimore-Tow son MD
Boston	BOSTON	14460	Boston-Cambridge-Quincy MA-NH
Boston	BOSTON	49340	Worcester MA
Boston	BOSTON	31700	Manchester-Nashua NH
Charlotte	CHRLTE	16740	Charlotte-Gastonia-Concord NC-SC
Chicago	CHICAG	16974	Chicago-Naperville-Joliet, IL Metropolitan Division
Chicago	CHICAG	29404	Lake County-Kenosha County, IL-WI Metropolitan Division
Cincinnati	CINCIN	17140	Cincinnati-Middletow n OH-KY-IN
Cleveland	CLEVEL	17460	Cleveland-Elyria-Mentor OH
Columbia, SC	COLUSC	17900	Columbia SC
Columbus	COLUMB	18140	Columbus OH
Dallas	DALLAS	19124	Dallas-Plano-Irving, TX Metropolitan Division
Dayton	DAYTON	19380	Dayton OH
Dayton	DAYTON	44220	Springfield OH
Denver	DENVER	19740	Denver-Aurora CO
Denver	DENVER	14500	Boulder CO
Detroit	DETROI	19820	Detroit-Warren-Livonia MI
Detroit	DETROI	33780	Monroe MI
Edison	EDISON	20764	Edison, NJ Metropolitan Division
Fort Lauderdale	FORTLA	22744	Fort Lauderdale-Pompano Beach-Deerfield Beach, FL Metropolitan Division
Fort Worth	FORTWO	23104	Fort Worth-Arlington, TX Metropolitan Division
Hartford	HARTFO	25540	Hartford-West Hartford-East Hartford CT
Honolulu	HONOLU	26180	Honolulu HI
Houston	HOUSTO	26420	Houston-Baytow n-Sugar Land TX
Indianapolis	INDIAN	26900	Indianapolis IN
Indianapolis	INDIAN	11300	Anderson IN
Kansas City	KANSAS	28140	Kansas City MO-KS
Los Angeles	LANGEL	31084	Los Angeles-Long Beach-Glendale, CA Metropolitan Division
Memphis	MEMPHI	32820	Memphis TN-MS-AR
Miami	MIAMI	33124	Miami-Miami Beach-Kendall, FL Metropolitan Division
Minneapolis	MINNEA	33460	Minneapolis-St. Paul-Bloomington MN-WI
Nashville	NASHVI	34980	Nashville-Davidson--Murfreesboro TN
New ark	NEWARK	35084	New ark-Union, NJ-PA Metropolitan Division
New Orleans	NEWORL	35380	New Orleans-Metairie-Kenner LA
New York City	NEWYRK	35644	New York-Wayne-White Plains, NY-NJ Metropolitan Division
Oakland	OAKLAN	36084	Oakland-Fremont-Hayw ard, CA Metropolitan Division
Omaha	OMAHA	36540	Omaha-Council Bluffs NE-IA
Orange County	ORANGE	42044	Santa Ana-Anaheim-Irvine, CA Metropolitan Division
Orlando	ORLAND	36740	Orlando FL
Philadelphia	PHILAD	37964	Philadelphia, PA Metropolitan Division
Philadelphia	PHILAD	15804	Camden, NJ Metropolitan Division
Phoenix	PHOENI	38060	Phoenix-Mesa-Scottsdale AZ
Pittsburgh	PITTSB	38300	Pittsburgh PA
Portland	PORTLA	38900	Portland-Vancouver-Beaverton OR-WA
Raleigh	RALEIG	39580	Raleigh-Cary NC
Raleigh	RALEIG	20500	Durham NC
Richmond	RICHMO	40060	Richmond VA
San Antonio	SANTON	41700	San Antonio TX
San Diego	SDIEGO	41740	San Diego-Carlsbad-San Marcos CA
San Francisco	SFRANC	41884	San Francisco-San Mateo-Redw ood City, CA Metropolitan Division
Seattle	SEATTL	42660	Seattle-Tacoma-Bellevue WA
St. Louis	SLOUIS	41180	St. Louis MO-IL
Tampa	TAMPA	45300	Tampa-St. Petersburg-Clearw ater FL
Trenton	TRENTO	45940	Trenton-Ew ing NJ
Tucson	TUCSON	46060	Tucson AZ
Washington, DC	WASHIN	47894	Washington-Arlington-Alexandria, DC-VA-MD-WV Metropolitan Division
Washington, DC	WASHIN	13644	Bethesda-Frederick-Gaithersburg, MD Metropolitan Division
West Palm Beach	WBEACH	48424	West Palm Beach-Boca Raton-Boynton Beach, FL Metropolitan Division

Appendix 2

Full Service Correlation Matrix

	ALBANY	ALBUQU	ATLANT	AUSTIN	BALTIM	BOSTON	CHICAG	CHRLTE	CINCIN	CLEVEL	COLUMB	COLUSC	DALLAS
ALBANY	1.00	0.25	0.22	0.23	0.51	0.38	0.47	0.36	0.26	0.33	0.36	0.33	0.34
ALBUQU	0.25	1.00	0.40	0.43	0.28	0.37	0.43	0.44	0.18	0.36	0.31	0.36	0.49
ATLANT	0.22	0.40	1.00	0.52	0.46	0.58	0.58	0.60	0.36	0.45	0.49	0.55	0.63
AUSTIN	0.23	0.43	0.52	1.00	0.40	0.63	0.70	0.60	0.45	0.62	0.56	0.44	0.76
BALTIM	0.51	0.28	0.46	0.40	1.00	0.60	0.65	0.58	0.41	0.53	0.64	0.46	0.60
BOSTON	0.38	0.37	0.58	0.63	0.60	1.00	0.76	0.69	0.52	0.63	0.47	0.50	0.68
CHICAG	0.47	0.43	0.58	0.70	0.65	0.76	1.00	0.80	0.65	0.67	0.66	0.49	0.76
CHRLTE	0.36	0.44	0.60	0.60	0.58	0.69	0.80	1.00	0.58	0.71	0.58	0.51	0.76
CINCIN	0.26	0.18	0.36	0.45	0.41	0.52	0.65	0.58	1.00	0.54	0.48	0.40	0.55
CLEVEL	0.33	0.36	0.45	0.62	0.53	0.63	0.67	0.71	0.54	1.00	0.55	0.37	0.70
COLUMB	0.36	0.31	0.49	0.56	0.64	0.47	0.66	0.58	0.48	0.55	1.00	0.60	0.59
COLUSC	0.33	0.36	0.55	0.44	0.46	0.50	0.49	0.51	0.40	0.37	0.60	1.00	0.47
DALLAS	0.34	0.49	0.63	0.76	0.60	0.68	0.76	0.76	0.55	0.70	0.59	0.47	1.00
DAYTON	0.40	0.04	0.20	0.26	0.45	0.18	0.39	0.38	0.11	0.32	0.34	0.14	0.37
DENVER	0.21	0.55	0.46	0.71	0.46	0.63	0.76	0.62	0.49	0.57	0.48	0.44	0.70
DETROI	0.34	0.31	0.60	0.54	0.64	0.74	0.77	0.74	0.49	0.61	0.56	0.56	0.66
EDISON	0.38	0.30	0.51	0.44	0.57	0.69	0.68	0.51	0.32	0.44	0.45	0.44	0.46
FORTLA	0.26	0.17	0.48	0.49	0.43	0.53	0.56	0.52	0.49	0.46	0.62	0.58	0.44
FORTWO	0.34	0.52	0.46	0.52	0.44	0.54	0.59	0.61	0.33	0.56	0.36	0.27	0.69
HARTFO	0.33	0.15	0.45	0.41	0.58	0.72	0.60	0.55	0.43	0.56	0.42	0.52	0.48
HONOLU	0.07	0.31	0.37	0.51	0.29	0.54	0.44	0.42	0.34	0.38	0.38	0.30	0.55
HOUSTO	0.18	0.31	0.40	0.46	0.28	0.35	0.46	0.38	0.27	0.27	0.38	0.32	0.56
INDIAN	0.38	0.32	0.31	0.45	0.42	0.40	0.53	0.35	0.31	0.58	0.36	0.31	0.47
KANSAS	0.25	0.43	0.56	0.40	0.54	0.62	0.57	0.63	0.31	0.57	0.40	0.55	0.64
LANGEL	0.48	0.39	0.47	0.52	0.57	0.81	0.79	0.73	0.55	0.61	0.43	0.45	0.66
LISLAN	0.48	0.15	0.44	0.34	0.68	0.61	0.66	0.58	0.34	0.50	0.53	0.50	0.48
MEMPHI	0.10	0.42	0.35	0.50	0.36	0.29	0.47	0.48	0.26	0.54	0.32	0.16	0.61
MIAMI	0.27	0.22	0.46	0.54	0.40	0.54	0.55	0.52	0.48	0.49	0.58	0.60	0.52
MINNEA	0.35	0.54	0.51	0.62	0.66	0.72	0.70	0.62	0.42	0.59	0.48	0.47	0.74
NASHVI	0.26	0.40	0.43	0.62	0.43	0.49	0.68	0.66	0.51	0.67	0.50	0.40	0.67
NEWARK	0.45	0.35	0.59	0.52	0.65	0.82	0.77	0.67	0.47	0.56	0.53	0.52	0.59
NEWORL	0.09	0.23	0.35	0.22	0.20	0.31	0.18	0.18	0.14	0.17	0.17	0.29	0.24
NEWYRK	0.45	0.38	0.60	0.58	0.61	0.86	0.80	0.77	0.60	0.67	0.51	0.56	0.72
OAKLAN	0.42	0.34	0.47	0.66	0.66	0.82	0.78	0.66	0.47	0.67	0.60	0.52	0.69
OMAHA	0.37	0.29	0.47	0.48	0.37	0.36	0.48	0.57	0.24	0.50	0.34	0.27	0.59
ORANGE	0.37	0.38	0.49	0.40	0.43	0.59	0.68	0.58	0.30	0.48	0.45	0.45	0.51
ORLAND	0.36	0.34	0.47	0.48	0.52	0.68	0.60	0.65	0.59	0.57	0.49	0.52	0.64
PHILAD	0.35	0.32	0.57	0.46	0.65	0.65	0.76	0.76	0.64	0.66	0.55	0.48	0.67
PHOENI	0.42	0.55	0.60	0.66	0.58	0.58	0.71	0.74	0.52	0.72	0.60	0.51	0.79
PITTSB	0.18	0.49	0.35	0.53	0.36	0.52	0.53	0.62	0.44	0.56	0.36	0.33	0.59
PORTLA	0.14	0.48	0.51	0.51	0.22	0.51	0.59	0.64	0.48	0.56	0.38	0.36	0.65
RALEIG	0.27	0.45	0.61	0.62	0.63	0.70	0.77	0.72	0.54	0.69	0.64	0.60	0.75
RICHMO	0.53	0.38	0.49	0.42	0.58	0.60	0.73	0.73	0.65	0.54	0.49	0.45	0.65
SANTON	0.45	0.46	0.46	0.54	0.33	0.34	0.49	0.46	0.36	0.38	0.50	0.48	0.55
SDIEGO	0.57	0.28	0.39	0.43	0.70	0.63	0.78	0.63	0.47	0.52	0.54	0.42	0.58
SEATTL	0.40	0.38	0.57	0.64	0.52	0.67	0.80	0.75	0.57	0.65	0.61	0.39	0.78
SFRANC	0.37	0.28	0.44	0.64	0.54	0.82	0.76	0.64	0.55	0.57	0.53	0.52	0.67
SLOUIS	0.31	0.53	0.53	0.55	0.61	0.58	0.68	0.59	0.48	0.62	0.52	0.41	0.62
TAMPA	0.44	0.31	0.38	0.54	0.55	0.59	0.68	0.59	0.44	0.58	0.48	0.40	0.53
TRENTO	0.13	0.11	0.30	0.16	0.56	0.48	0.51	0.39	0.31	0.28	0.23	0.15	0.32
TUCSON	0.43	0.46	0.62	0.72	0.49	0.57	0.68	0.60	0.46	0.60	0.50	0.47	0.69
WASHIN	0.34	0.24	0.39	0.51	0.56	0.65	0.56	0.51	0.39	0.49	0.43	0.51	0.48
WBEACH	0.52	0.36	0.48	0.40	0.56	0.60	0.57	0.56	0.41	0.62	0.50	0.53	0.49

Full Service Correlation Matrix (Continued)

	DAYTON	DENVER	DETROI	EDISON	FORTLA	FORTWO	HARTFO	HONOLU	HOUSTO	INDIAN	KANSAS	LANGEL	LISLAN
ALBANY	0.40	0.21	0.34	0.38	0.26	0.34	0.33	0.07	0.18	0.38	0.25	0.48	0.48
ALBUQU	0.04	0.55	0.31	0.30	0.17	0.52	0.15	0.31	0.31	0.32	0.43	0.39	0.15
ATLANT	0.20	0.46	0.60	0.51	0.48	0.46	0.45	0.37	0.40	0.31	0.56	0.47	0.44
AUSTIN	0.26	0.71	0.54	0.44	0.49	0.52	0.41	0.51	0.46	0.45	0.40	0.52	0.34
BALTIM	0.45	0.46	0.64	0.57	0.43	0.44	0.58	0.29	0.28	0.42	0.54	0.57	0.68
BOSTON	0.18	0.63	0.74	0.69	0.53	0.54	0.72	0.54	0.35	0.40	0.62	0.81	0.61
CHICAG	0.39	0.76	0.77	0.68	0.56	0.59	0.60	0.44	0.46	0.53	0.57	0.79	0.66
CHRLTE	0.38	0.62	0.74	0.51	0.52	0.61	0.55	0.42	0.38	0.35	0.63	0.73	0.58
CINCIN	0.11	0.49	0.49	0.32	0.49	0.33	0.43	0.34	0.27	0.31	0.31	0.55	0.34
CLEVEL	0.32	0.57	0.61	0.44	0.46	0.56	0.56	0.38	0.27	0.58	0.57	0.61	0.50
COLUMB	0.34	0.48	0.56	0.45	0.62	0.36	0.42	0.38	0.38	0.36	0.40	0.43	0.53
COLUSC	0.14	0.44	0.56	0.44	0.58	0.27	0.52	0.30	0.32	0.31	0.55	0.45	0.50
DALLAS	0.37	0.70	0.66	0.46	0.44	0.69	0.48	0.55	0.56	0.47	0.64	0.66	0.48
DAYTON	1.00	0.19	0.36	0.28	0.21	0.41	0.20	0.06	0.03	0.20	0.20	0.33	0.51
DENVER	0.19	1.00	0.58	0.54	0.47	0.56	0.45	0.41	0.53	0.41	0.59	0.58	0.38
DETROI	0.36	0.58	1.00	0.70	0.51	0.48	0.67	0.33	0.31	0.42	0.65	0.71	0.74
EDISON	0.28	0.54	0.70	1.00	0.44	0.31	0.58	0.20	0.38	0.32	0.56	0.59	0.72
FORTLA	0.21	0.47	0.51	0.44	1.00	0.34	0.46	0.51	0.30	0.19	0.33	0.51	0.42
FORTWO	0.41	0.56	0.48	0.31	0.34	1.00	0.43	0.47	0.44	0.45	0.54	0.60	0.38
HARTFO	0.20	0.45	0.67	0.58	0.46	0.43	1.00	0.35	0.31	0.50	0.52	0.70	0.66
HONOLU	0.06	0.41	0.33	0.20	0.51	0.47	0.35	1.00	0.34	0.27	0.33	0.59	0.14
HOUSTO	0.03	0.53	0.31	0.38	0.30	0.44	0.31	0.34	1.00	0.27	0.42	0.39	0.18
INDIAN	0.20	0.41	0.42	0.32	0.19	0.45	0.50	0.27	0.27	1.00	0.38	0.47	0.38
KANSAS	0.20	0.59	0.65	0.56	0.33	0.54	0.52	0.33	0.42	0.38	1.00	0.55	0.51
LANGEL	0.33	0.58	0.71	0.59	0.51	0.60	0.70	0.59	0.39	0.47	0.55	1.00	0.64
LISLAN	0.51	0.38	0.74	0.72	0.42	0.38	0.66	0.14	0.18	0.38	0.51	0.64	1.00
MEMPHI	0.34	0.50	0.38	0.21	0.24	0.61	0.25	0.29	0.36	0.35	0.46	0.31	0.25
MIAMI	0.20	0.51	0.49	0.46	0.88	0.34	0.44	0.61	0.33	0.26	0.38	0.54	0.45
MINNEA	0.30	0.77	0.66	0.56	0.48	0.63	0.51	0.55	0.39	0.46	0.64	0.67	0.42
NASHVI	0.28	0.60	0.60	0.22	0.40	0.59	0.37	0.40	0.28	0.51	0.54	0.54	0.36
NEWARK	0.26	0.62	0.76	0.87	0.48	0.40	0.73	0.27	0.46	0.42	0.63	0.74	0.77
NEWORL	0.08	0.27	0.33	0.34	0.18	0.16	0.25	0.20	0.22	0.08	0.27	0.21	0.18
NEWYRK	0.34	0.62	0.76	0.66	0.54	0.59	0.71	0.58	0.42	0.52	0.68	0.92	0.67
OAKLAN	0.23	0.64	0.71	0.71	0.55	0.54	0.66	0.51	0.47	0.48	0.65	0.74	0.67
OMAHA	0.41	0.39	0.45	0.34	0.26	0.66	0.38	0.29	0.46	0.36	0.43	0.47	0.31
ORANGE	0.24	0.50	0.54	0.59	0.46	0.49	0.49	0.57	0.44	0.42	0.60	0.73	0.55
ORLAND	0.20	0.50	0.48	0.38	0.66	0.56	0.63	0.67	0.37	0.32	0.52	0.72	0.38
PHILAD	0.39	0.56	0.68	0.54	0.48	0.55	0.67	0.38	0.35	0.43	0.67	0.72	0.65
PHOENI	0.38	0.60	0.62	0.43	0.49	0.70	0.52	0.51	0.33	0.53	0.63	0.64	0.50
PITTSB	0.22	0.54	0.43	0.23	0.29	0.48	0.37	0.39	0.25	0.39	0.42	0.51	0.31
PORTLA	0.04	0.62	0.41	0.41	0.38	0.57	0.35	0.49	0.46	0.31	0.57	0.53	0.24
RALEIG	0.20	0.66	0.70	0.54	0.59	0.52	0.60	0.48	0.31	0.54	0.71	0.61	0.61
RICHMO	0.26	0.56	0.57	0.52	0.46	0.45	0.52	0.42	0.40	0.44	0.60	0.74	0.53
SANTON	0.21	0.50	0.39	0.40	0.43	0.43	0.16	0.28	0.50	0.27	0.47	0.31	0.15
SDIEGO	0.51	0.51	0.70	0.60	0.47	0.56	0.58	0.38	0.28	0.45	0.54	0.76	0.72
SEATTL	0.34	0.68	0.57	0.53	0.50	0.66	0.51	0.57	0.56	0.44	0.52	0.75	0.48
SFRANC	0.25	0.66	0.65	0.60	0.55	0.46	0.67	0.53	0.45	0.38	0.57	0.80	0.62
SLOUIS	0.30	0.65	0.58	0.58	0.36	0.57	0.51	0.29	0.33	0.53	0.52	0.55	0.50
TAMPA	0.38	0.49	0.52	0.56	0.58	0.56	0.56	0.43	0.35	0.33	0.46	0.66	0.49
TRENTO	0.21	0.39	0.51	0.67	0.13	0.24	0.53	0.04	0.28	0.17	0.48	0.46	0.54
TUCSON	0.30	0.65	0.51	0.46	0.49	0.64	0.41	0.42	0.42	0.43	0.58	0.54	0.41
WASHIN	0.37	0.39	0.46	0.44	0.54	0.35	0.42	0.53	0.26	0.32	0.43	0.65	0.50
WBEACH	0.42	0.35	0.61	0.50	0.59	0.47	0.47	0.36	0.11	0.41	0.49	0.60	0.53

Full Service Correlation Matrix (Continued)

	MEMPHI	MIAMI	MINNEA	NASHVI	NEWARK	NEWORL	NEWYRK	OAKLAN	OMAHA	ORANGE	ORLAND	PHILAD	PHOENI	PITTSB
ALBANY	0.10	0.27	0.35	0.26	0.45	0.09	0.45	0.42	0.37	0.37	0.36	0.35	0.42	0.18
ALBUQU	0.42	0.22	0.54	0.40	0.35	0.23	0.38	0.34	0.29	0.38	0.34	0.32	0.55	0.49
ATLANT	0.35	0.46	0.51	0.43	0.59	0.35	0.60	0.47	0.47	0.49	0.47	0.57	0.60	0.35
AUSTIN	0.50	0.54	0.62	0.62	0.52	0.22	0.58	0.66	0.48	0.40	0.48	0.46	0.66	0.53
BALTIM	0.36	0.40	0.66	0.43	0.65	0.20	0.61	0.66	0.37	0.43	0.52	0.65	0.58	0.36
BOSTON	0.29	0.54	0.72	0.49	0.82	0.31	0.86	0.82	0.36	0.59	0.68	0.65	0.58	0.52
CHICAG	0.47	0.55	0.70	0.68	0.77	0.18	0.80	0.78	0.48	0.68	0.60	0.76	0.71	0.53
CHRLTE	0.48	0.52	0.62	0.66	0.67	0.18	0.77	0.66	0.57	0.58	0.65	0.76	0.74	0.62
CINCIN	0.26	0.48	0.42	0.51	0.47	0.14	0.60	0.47	0.24	0.30	0.59	0.64	0.52	0.44
CLEVEL	0.54	0.49	0.59	0.67	0.56	0.17	0.67	0.67	0.50	0.48	0.57	0.66	0.72	0.56
COLUMB	0.32	0.58	0.48	0.50	0.53	0.17	0.51	0.60	0.34	0.45	0.49	0.55	0.60	0.36
COLUSC	0.16	0.60	0.47	0.40	0.52	0.29	0.56	0.52	0.27	0.45	0.52	0.48	0.51	0.33
DALLAS	0.61	0.52	0.74	0.67	0.59	0.24	0.72	0.69	0.59	0.51	0.64	0.67	0.79	0.59
DAYTON	0.34	0.20	0.30	0.28	0.26	0.08	0.34	0.23	0.41	0.24	0.20	0.39	0.38	0.22
DENVER	0.50	0.51	0.77	0.60	0.62	0.27	0.62	0.64	0.39	0.50	0.50	0.56	0.60	0.54
DETROI	0.38	0.49	0.66	0.60	0.76	0.33	0.76	0.71	0.45	0.54	0.48	0.68	0.62	0.43
EDISON	0.21	0.46	0.56	0.22	0.87	0.34	0.66	0.71	0.34	0.59	0.38	0.54	0.43	0.23
FORTLA	0.24	0.88	0.48	0.40	0.48	0.18	0.54	0.55	0.26	0.46	0.66	0.48	0.49	0.29
FORTWO	0.61	0.34	0.63	0.59	0.40	0.16	0.59	0.54	0.66	0.49	0.56	0.55	0.70	0.48
HARTFO	0.25	0.44	0.51	0.37	0.73	0.25	0.71	0.66	0.38	0.49	0.63	0.67	0.52	0.37
HONOLU	0.29	0.61	0.55	0.40	0.27	0.20	0.58	0.51	0.29	0.57	0.67	0.38	0.51	0.39
HOUSTO	0.36	0.33	0.39	0.28	0.46	0.22	0.42	0.47	0.46	0.44	0.37	0.35	0.33	0.25
INDIAN	0.35	0.26	0.46	0.51	0.42	0.08	0.52	0.48	0.36	0.42	0.32	0.43	0.53	0.39
KANSAS	0.46	0.38	0.64	0.54	0.63	0.27	0.68	0.65	0.43	0.60	0.52	0.67	0.63	0.42
LANGEL	0.31	0.54	0.67	0.54	0.74	0.21	0.92	0.74	0.47	0.73	0.72	0.72	0.64	0.51
LISLAN	0.25	0.45	0.42	0.36	0.77	0.18	0.67	0.67	0.31	0.55	0.38	0.65	0.50	0.31
MEMPHI	1.00	0.26	0.55	0.60	0.26	0.04	0.36	0.36	0.45	0.35	0.29	0.45	0.66	0.33
MIAMI	0.26	1.00	0.54	0.40	0.48	0.25	0.61	0.58	0.29	0.50	0.65	0.43	0.50	0.32
MINNEA	0.55	0.54	1.00	0.59	0.59	0.35	0.73	0.67	0.49	0.55	0.56	0.55	0.69	0.50
NASHVI	0.60	0.40	0.59	1.00	0.36	0.10	0.57	0.52	0.43	0.46	0.42	0.57	0.70	0.52
NEWARK	0.26	0.48	0.59	0.36	1.00	0.33	0.79	0.79	0.36	0.63	0.55	0.67	0.55	0.42
NEWORL	0.04	0.25	0.35	0.10	0.33	1.00	0.32	0.23	0.08	0.09	0.20	0.20	0.16	0.13
NEWYRK	0.36	0.61	0.73	0.57	0.79	0.32	1.00	0.77	0.50	0.72	0.73	0.78	0.69	0.54
OAKLAN	0.36	0.58	0.67	0.52	0.79	0.23	0.77	1.00	0.39	0.67	0.63	0.62	0.62	0.44
OMAHA	0.45	0.29	0.49	0.43	0.36	0.08	0.50	0.39	1.00	0.48	0.38	0.44	0.60	0.20
ORANGE	0.35	0.50	0.55	0.46	0.63	0.09	0.72	0.67	0.48	1.00	0.51	0.56	0.61	0.28
ORLAND	0.29	0.65	0.56	0.42	0.55	0.20	0.73	0.63	0.38	0.51	1.00	0.71	0.66	0.48
PHILAD	0.45	0.43	0.55	0.57	0.67	0.20	0.78	0.62	0.44	0.56	0.71	1.00	0.69	0.50
PHOENI	0.66	0.50	0.69	0.70	0.55	0.16	0.69	0.62	0.60	0.61	0.66	0.69	1.00	0.52
PITTSB	0.33	0.32	0.50	0.52	0.42	0.13	0.54	0.44	0.20	0.28	0.48	0.50	0.52	1.00
PORTLA	0.37	0.45	0.50	0.51	0.43	0.21	0.60	0.52	0.49	0.59	0.56	0.55	0.61	0.38
RALEIG	0.56	0.59	0.70	0.68	0.64	0.14	0.71	0.72	0.36	0.58	0.61	0.71	0.78	0.57
RICHMO	0.33	0.50	0.58	0.52	0.70	0.20	0.76	0.61	0.44	0.66	0.69	0.69	0.66	0.48
SANTON	0.22	0.41	0.46	0.36	0.37	0.25	0.39	0.44	0.47	0.35	0.47	0.40	0.49	0.29
SDIEGO	0.34	0.47	0.64	0.56	0.65	0.18	0.73	0.73	0.52	0.65	0.50	0.64	0.59	0.31
SEATTL	0.47	0.55	0.66	0.59	0.63	0.12	0.75	0.68	0.66	0.66	0.65	0.64	0.72	0.46
SFRANC	0.34	0.61	0.65	0.50	0.76	0.27	0.83	0.82	0.32	0.64	0.63	0.62	0.58	0.51
SLOUIS	0.44	0.35	0.64	0.48	0.61	0.13	0.59	0.60	0.52	0.53	0.50	0.66	0.70	0.46
TAMPA	0.28	0.51	0.50	0.43	0.61	0.16	0.61	0.71	0.46	0.57	0.71	0.60	0.60	0.33
TRENTO	0.17	0.11	0.39	0.11	0.68	0.31	0.49	0.46	0.22	0.36	0.27	0.53	0.24	0.18
TUCSON	0.50	0.49	0.63	0.59	0.53	0.24	0.64	0.59	0.58	0.55	0.58	0.61	0.75	0.40
WASHIN	0.20	0.53	0.53	0.46	0.55	0.21	0.67	0.62	0.29	0.62	0.58	0.50	0.49	0.38
WBEACH	0.32	0.57	0.56	0.48	0.56	0.27	0.66	0.55	0.39	0.54	0.61	0.53	0.68	0.29

Full Service Correlation Matrix (Continued)

	PORTLA	RALEIG	RICHMO	SANTON	SDIEGO	SEATTL	SFRANC	SLOUIS	TAMPA	TRENTO	TUCSON	WASHIN	WBEACH
ALBANY	0.14	0.27	0.53	0.45	0.57	0.40	0.37	0.31	0.44	0.13	0.43	0.34	0.52
ALBUQU	0.48	0.45	0.38	0.46	0.28	0.38	0.28	0.53	0.31	0.11	0.46	0.24	0.36
ATLANT	0.51	0.61	0.49	0.46	0.39	0.57	0.44	0.53	0.38	0.30	0.62	0.39	0.48
AUSTIN	0.51	0.62	0.42	0.54	0.43	0.64	0.64	0.55	0.54	0.16	0.72	0.51	0.40
BALTIM	0.22	0.63	0.58	0.33	0.70	0.52	0.54	0.61	0.55	0.56	0.49	0.56	0.56
BOSTON	0.51	0.70	0.60	0.34	0.63	0.67	0.82	0.58	0.59	0.48	0.57	0.65	0.60
CHICAG	0.59	0.77	0.73	0.49	0.78	0.80	0.76	0.68	0.68	0.51	0.68	0.56	0.57
CHRLTE	0.64	0.72	0.73	0.46	0.63	0.75	0.64	0.59	0.59	0.39	0.60	0.51	0.56
CINCIN	0.48	0.54	0.65	0.36	0.47	0.57	0.55	0.48	0.44	0.31	0.46	0.39	0.41
CLEVEL	0.56	0.69	0.54	0.38	0.52	0.65	0.57	0.62	0.58	0.28	0.60	0.49	0.62
COLUMB	0.38	0.64	0.49	0.50	0.54	0.61	0.53	0.52	0.48	0.23	0.50	0.43	0.50
COLUSC	0.36	0.60	0.45	0.48	0.42	0.39	0.52	0.41	0.40	0.15	0.47	0.51	0.53
DALLAS	0.65	0.75	0.65	0.55	0.58	0.78	0.67	0.62	0.53	0.32	0.69	0.48	0.49
DAYTON	0.04	0.20	0.26	0.21	0.51	0.34	0.25	0.30	0.38	0.21	0.30	0.37	0.42
DENVER	0.62	0.66	0.56	0.50	0.51	0.68	0.66	0.65	0.49	0.39	0.65	0.39	0.35
DETROI	0.41	0.70	0.57	0.39	0.70	0.57	0.65	0.58	0.52	0.51	0.51	0.46	0.61
EDISON	0.41	0.54	0.52	0.40	0.60	0.53	0.60	0.58	0.56	0.67	0.46	0.44	0.50
FORTLA	0.38	0.59	0.46	0.43	0.47	0.50	0.55	0.36	0.58	0.13	0.49	0.54	0.59
FORTWO	0.57	0.52	0.45	0.43	0.56	0.66	0.46	0.57	0.56	0.24	0.64	0.35	0.47
HARTFO	0.35	0.60	0.52	0.16	0.58	0.51	0.67	0.51	0.56	0.53	0.41	0.42	0.47
HONOLU	0.49	0.48	0.42	0.28	0.38	0.57	0.53	0.29	0.43	0.04	0.42	0.53	0.36
HOUSTO	0.46	0.31	0.40	0.50	0.28	0.56	0.45	0.33	0.35	0.28	0.42	0.26	0.11
INDIAN	0.31	0.54	0.44	0.27	0.45	0.44	0.38	0.53	0.33	0.17	0.43	0.32	0.41
KANSAS	0.57	0.71	0.60	0.47	0.54	0.52	0.57	0.52	0.46	0.48	0.58	0.43	0.49
LANGEL	0.53	0.61	0.74	0.31	0.76	0.75	0.80	0.55	0.66	0.46	0.54	0.65	0.60
LISLAN	0.24	0.61	0.53	0.15	0.72	0.48	0.62	0.50	0.49	0.54	0.41	0.50	0.53
MEMPHI	0.37	0.56	0.33	0.22	0.34	0.47	0.34	0.44	0.28	0.17	0.50	0.20	0.32
MIAMI	0.45	0.59	0.50	0.41	0.47	0.55	0.61	0.35	0.51	0.11	0.49	0.53	0.57
MINNEA	0.50	0.70	0.58	0.46	0.64	0.66	0.65	0.64	0.50	0.39	0.63	0.53	0.56
NASHVI	0.51	0.68	0.52	0.36	0.56	0.59	0.50	0.48	0.43	0.11	0.59	0.46	0.48
NEWARK	0.43	0.64	0.70	0.37	0.65	0.63	0.76	0.61	0.61	0.68	0.53	0.55	0.56
NEWORL	0.21	0.14	0.20	0.25	0.18	0.12	0.27	0.13	0.16	0.31	0.24	0.21	0.27
NEWYRK	0.60	0.71	0.76	0.39	0.73	0.75	0.83	0.59	0.61	0.49	0.64	0.67	0.66
OAKLAN	0.52	0.72	0.61	0.44	0.73	0.68	0.82	0.60	0.71	0.46	0.59	0.62	0.55
OMAHA	0.49	0.36	0.44	0.47	0.52	0.66	0.32	0.52	0.46	0.22	0.58	0.29	0.39
ORANGE	0.59	0.58	0.66	0.35	0.65	0.66	0.64	0.53	0.57	0.36	0.55	0.62	0.54
ORLAND	0.56	0.61	0.69	0.47	0.50	0.65	0.63	0.50	0.71	0.27	0.58	0.58	0.61
PHILAD	0.55	0.71	0.69	0.40	0.64	0.64	0.62	0.66	0.60	0.53	0.61	0.50	0.53
PHOENI	0.61	0.78	0.66	0.49	0.59	0.72	0.58	0.70	0.60	0.24	0.75	0.49	0.68
PITTSB	0.38	0.57	0.48	0.29	0.31	0.46	0.51	0.46	0.33	0.18	0.40	0.38	0.29
PORTLA	1.00	0.55	0.58	0.49	0.40	0.67	0.45	0.57	0.46	0.25	0.64	0.35	0.32
RALEIG	0.55	1.00	0.65	0.35	0.58	0.65	0.69	0.66	0.46	0.35	0.65	0.51	0.57
RICHMO	0.58	0.65	1.00	0.45	0.67	0.68	0.66	0.50	0.54	0.49	0.56	0.55	0.54
SANTON	0.49	0.35	0.45	1.00	0.34	0.48	0.27	0.46	0.52	0.05	0.67	0.33	0.45
SDIEGO	0.40	0.58	0.67	0.34	1.00	0.64	0.68	0.54	0.67	0.48	0.51	0.56	0.53
SEATTL	0.67	0.65	0.68	0.48	0.64	1.00	0.69	0.66	0.57	0.37	0.65	0.51	0.49
SFRANC	0.45	0.69	0.66	0.27	0.68	0.69	1.00	0.47	0.61	0.44	0.52	0.61	0.47
SLOUIS	0.57	0.66	0.50	0.46	0.54	0.66	0.47	1.00	0.55	0.41	0.64	0.46	0.53
TAMPA	0.46	0.46	0.54	0.52	0.67	0.57	0.61	0.55	1.00	0.40	0.63	0.60	0.59
TRENTO	0.25	0.35	0.49	0.05	0.48	0.37	0.44	0.41	0.40	1.00	0.22	0.22	0.23
TUCSON	0.64	0.65	0.56	0.67	0.51	0.65	0.52	0.64	0.63	0.22	1.00	0.52	0.55
WASHIN	0.35	0.51	0.55	0.33	0.56	0.51	0.61	0.46	0.60	0.22	0.52	1.00	0.67
WBEACH	0.32	0.57	0.54	0.45	0.53	0.49	0.47	0.53	0.59	0.23	0.55	0.67	1.00

Limited Service Correlation Matrix

	ALBANY	ALBUQU	ATLANT	AUSTIN	BALTIM	BOSTON	CHICAG	CHRLTE	CINCIN	CLEVEL	COLUMB	COLUSC	DALLAS
ALBANY	1.00	0.32	0.04	-0.03	0.36	0.28	0.23	0.03	0.20	0.15	0.16	0.00	0.21
ALBUQU	0.32	1.00	0.17	0.35	0.11	0.07	0.34	0.25	0.44	0.30	0.32	0.36	0.41
ATLANT	0.04	0.17	1.00	0.57	0.44	0.40	0.60	0.59	0.39	0.46	0.25	0.54	0.62
AUSTIN	-0.03	0.35	0.57	1.00	0.27	0.38	0.68	0.54	0.53	0.53	0.53	0.44	0.74
BALTIM	0.36	0.11	0.44	0.27	1.00	0.55	0.52	0.43	0.46	0.33	0.25	0.50	0.42
BOSTON	0.28	0.07	0.40	0.38	0.55	1.00	0.66	0.55	0.40	0.53	0.31	0.32	0.50
CHICAG	0.23	0.34	0.60	0.68	0.52	0.66	1.00	0.77	0.69	0.64	0.52	0.50	0.71
CHRLTE	0.03	0.25	0.59	0.54	0.43	0.55	0.77	1.00	0.72	0.61	0.43	0.65	0.67
CINCIN	0.20	0.44	0.39	0.53	0.46	0.40	0.69	0.72	1.00	0.55	0.45	0.54	0.63
CLEVEL	0.15	0.30	0.46	0.53	0.33	0.53	0.64	0.61	0.55	1.00	0.23	0.26	0.51
COLUMB	0.16	0.32	0.25	0.53	0.25	0.31	0.52	0.43	0.45	0.23	1.00	0.54	0.53
COLUSC	0.00	0.36	0.54	0.44	0.50	0.32	0.50	0.65	0.54	0.26	0.54	1.00	0.53
DALLAS	0.21	0.41	0.62	0.74	0.42	0.50	0.71	0.67	0.63	0.51	0.53	0.53	1.00
DAYTON	0.24	0.16	0.38	0.46	0.61	0.53	0.59	0.56	0.49	0.44	0.34	0.50	0.58
DENVER	0.16	0.34	0.53	0.63	0.33	0.50	0.72	0.60	0.51	0.44	0.39	0.49	0.71
DETROI	0.16	0.16	0.61	0.42	0.59	0.67	0.71	0.59	0.40	0.64	0.25	0.41	0.53
EDISON	0.25	0.07	0.53	0.44	0.47	0.79	0.66	0.51	0.32	0.58	0.24	0.27	0.43
FORTLA	0.11	0.12	0.37	0.31	0.33	0.35	0.32	0.36	0.36	0.20	0.33	0.49	0.42
FORTWO	0.11	0.44	0.56	0.65	0.29	0.33	0.58	0.55	0.51	0.31	0.60	0.52	0.78
HARTFO	0.38	0.11	0.37	0.14	0.54	0.71	0.51	0.56	0.41	0.52	0.26	0.40	0.45
HONOLU	-0.08	0.23	0.28	0.50	0.06	0.01	0.22	0.27	0.36	0.28	0.36	0.31	0.33
HOUSTO	0.15	0.11	0.26	0.37	0.12	-0.04	0.22	0.19	0.34	0.19	0.19	0.03	0.50
INDIAN	0.29	0.52	0.31	0.54	0.30	0.31	0.61	0.45	0.48	0.35	0.47	0.40	0.64
KANSAS	0.15	0.49	0.46	0.49	0.29	0.23	0.56	0.47	0.49	0.44	0.23	0.46	0.63
LANGEL	0.42	0.19	0.31	0.29	0.68	0.55	0.54	0.42	0.56	0.31	0.30	0.38	0.45
LISLAN	0.20	-0.10	0.41	0.10	0.53	0.49	0.34	0.25	0.13	0.17	0.23	0.22	0.21
MEMPHI	0.19	0.39	0.68	0.49	0.50	0.38	0.65	0.69	0.57	0.44	0.38	0.68	0.70
MIAMI	0.05	0.22	0.42	0.49	0.23	0.33	0.43	0.47	0.41	0.37	0.27	0.44	0.49
MINNEA	0.17	0.27	0.61	0.62	0.45	0.57	0.68	0.55	0.45	0.51	0.32	0.48	0.67
NASHVI	0.09	0.48	0.57	0.58	0.52	0.45	0.73	0.74	0.60	0.49	0.44	0.71	0.69
NEWARK	0.45	0.14	0.42	0.28	0.45	0.73	0.63	0.44	0.42	0.48	0.23	0.13	0.45
NEWORL	-0.11	0.10	0.46	0.37	0.24	0.12	0.26	0.25	0.30	0.16	0.20	0.18	0.48
NEWYRK	0.12	0.10	0.36	0.43	0.43	0.67	0.68	0.64	0.57	0.37	0.52	0.40	0.58
OAKLAN	0.21	0.14	0.34	0.61	0.44	0.70	0.67	0.51	0.50	0.42	0.52	0.29	0.60
OMAHA	0.15	0.27	0.40	0.50	0.07	0.15	0.51	0.55	0.50	0.56	0.35	0.29	0.48
ORANGE	0.09	0.16	0.51	0.46	0.55	0.48	0.52	0.53	0.47	0.37	0.26	0.47	0.50
ORLAND	0.06	0.17	0.31	0.30	0.25	0.43	0.40	0.57	0.54	0.25	0.41	0.55	0.51
PHILAD	0.12	0.17	0.48	0.40	0.52	0.57	0.54	0.53	0.38	0.33	0.46	0.63	0.42
PHOENI	0.10	0.44	0.60	0.62	0.53	0.47	0.73	0.73	0.62	0.49	0.46	0.73	0.68
PITTSB	0.12	0.37	0.10	0.35	0.01	0.17	0.33	0.34	0.43	0.19	0.32	0.19	0.47
PORTLA	0.09	0.45	0.45	0.61	0.14	0.31	0.66	0.68	0.61	0.53	0.44	0.43	0.68
RALEIG	-0.02	0.25	0.48	0.55	0.46	0.53	0.70	0.66	0.45	0.42	0.44	0.55	0.51
RICHMO	0.36	0.42	0.42	0.44	0.63	0.40	0.61	0.58	0.62	0.40	0.51	0.59	0.58
SANTON	0.37	0.44	0.38	0.43	0.16	0.07	0.44	0.30	0.50	0.29	0.16	0.20	0.51
SDIEGO	0.28	0.08	0.28	0.35	0.53	0.52	0.59	0.44	0.41	0.30	0.48	0.37	0.37
SEATTL	0.11	0.30	0.32	0.58	0.32	0.43	0.66	0.63	0.58	0.33	0.58	0.47	0.62
SFRANC	0.04	0.21	0.43	0.70	0.42	0.65	0.71	0.55	0.50	0.38	0.50	0.37	0.65
SLOUIS	0.45	0.62	0.21	0.34	0.28	0.10	0.32	0.26	0.41	0.33	0.28	0.35	0.35
TAMPA	0.15	0.23	0.44	0.43	0.48	0.34	0.51	0.54	0.57	0.34	0.42	0.64	0.54
TRENTO	0.14	-0.08	0.46	0.15	0.54	0.38	0.47	0.46	0.37	0.31	0.13	0.44	0.33
TUCSON	0.27	0.46	0.56	0.56	0.47	0.33	0.61	0.61	0.56	0.48	0.39	0.63	0.58
WASHIN	0.22	0.11	0.45	0.40	0.73	0.68	0.54	0.49	0.47	0.49	0.19	0.49	0.47
WBEACH	0.17	0.08	0.37	0.22	0.47	0.51	0.38	0.42	0.45	0.41	0.24	0.47	0.40

Limited Service Correlation Matrix (Continued)

	DAYTON	DENVER	DETROI	EDISON	FORTLA	FORTWO	HARTFO	HONOLU	HOUSTO	INDIAN	KANSAS	LANGEL	LISLAN
ALBANY	0.24	0.16	0.16	0.25	0.11	0.11	0.38	-0.08	0.15	0.29	0.15	0.42	0.20
ALBUQU	0.16	0.34	0.16	0.07	0.12	0.44	0.11	0.23	0.11	0.52	0.49	0.19	-0.10
ATLANT	0.38	0.53	0.61	0.53	0.37	0.56	0.37	0.28	0.26	0.31	0.46	0.31	0.41
AUSTIN	0.46	0.63	0.42	0.44	0.31	0.65	0.14	0.50	0.37	0.54	0.49	0.29	0.10
BALTIM	0.61	0.33	0.59	0.47	0.33	0.29	0.54	0.06	0.12	0.30	0.29	0.68	0.53
BOSTON	0.53	0.50	0.67	0.79	0.35	0.33	0.71	0.01	-0.04	0.31	0.23	0.55	0.49
CHICAG	0.59	0.72	0.71	0.66	0.32	0.58	0.51	0.22	0.22	0.61	0.56	0.54	0.34
CHRLTE	0.56	0.60	0.59	0.51	0.36	0.55	0.56	0.27	0.19	0.45	0.47	0.42	0.25
CINCIN	0.49	0.51	0.40	0.32	0.36	0.51	0.41	0.36	0.34	0.48	0.49	0.56	0.13
CLEVEL	0.44	0.44	0.64	0.58	0.20	0.31	0.52	0.28	0.19	0.35	0.44	0.31	0.17
COLUMB	0.34	0.39	0.25	0.24	0.33	0.60	0.26	0.36	0.19	0.47	0.23	0.30	0.23
COLUSC	0.50	0.49	0.41	0.27	0.49	0.52	0.40	0.31	0.03	0.40	0.46	0.38	0.22
DALLAS	0.58	0.71	0.53	0.43	0.42	0.78	0.45	0.33	0.50	0.64	0.63	0.45	0.21
DAYTON	1.00	0.45	0.51	0.43	0.31	0.33	0.56	0.09	0.23	0.39	0.37	0.47	0.28
DENVER	0.45	1.00	0.46	0.60	0.40	0.64	0.33	0.14	0.30	0.63	0.73	0.28	0.15
DETROI	0.51	0.46	1.00	0.72	0.24	0.37	0.62	0.02	0.06	0.27	0.35	0.42	0.52
EDISON	0.43	0.60	0.72	1.00	0.31	0.36	0.62	0.04	0.01	0.22	0.31	0.47	0.57
FORTLA	0.31	0.40	0.24	0.31	1.00	0.38	0.40	0.43	0.18	0.18	0.26	0.34	0.18
FORTWO	0.33	0.64	0.37	0.36	0.38	1.00	0.25	0.35	0.50	0.49	0.45	0.38	0.19
HARTFO	0.56	0.33	0.62	0.62	0.40	0.25	1.00	0.00	0.02	0.18	0.20	0.61	0.51
HONOLU	0.09	0.14	0.02	0.04	0.43	0.35	0.00	1.00	0.20	0.20	0.17	0.16	-0.07
HOUSTO	0.23	0.30	0.06	0.01	0.18	0.50	0.02	0.20	1.00	0.15	0.25	0.24	-0.03
INDIAN	0.39	0.63	0.27	0.22	0.18	0.49	0.18	0.20	0.15	1.00	0.65	0.25	0.02
KANSAS	0.37	0.73	0.35	0.31	0.26	0.45	0.20	0.17	0.25	0.65	1.00	0.21	0.01
LANGEL	0.47	0.28	0.42	0.47	0.34	0.38	0.61	0.16	0.24	0.25	0.21	1.00	0.52
LISLAN	0.28	0.15	0.52	0.57	0.18	0.19	0.51	-0.07	-0.03	0.02	0.01	0.52	1.00
MEMPHI	0.49	0.68	0.60	0.48	0.41	0.67	0.38	0.17	0.32	0.43	0.55	0.38	0.22
MIAMI	0.33	0.50	0.33	0.42	0.78	0.38	0.31	0.45	0.21	0.28	0.31	0.32	0.18
MINNEA	0.49	0.72	0.65	0.64	0.58	0.46	0.40	0.24	0.16	0.48	0.54	0.27	0.23
NASHVI	0.57	0.65	0.58	0.40	0.32	0.60	0.37	0.19	0.12	0.65	0.60	0.38	0.17
NEWARK	0.35	0.41	0.61	0.70	0.17	0.36	0.63	-0.03	0.17	0.16	0.20	0.65	0.51
NEWORL	0.25	0.29	0.31	0.18	0.39	0.55	0.10	0.27	0.55	0.08	0.25	0.23	0.11
NEWYRK	0.46	0.42	0.51	0.59	0.32	0.44	0.58	0.10	0.15	0.33	0.18	0.65	0.54
OAKLAN	0.45	0.53	0.44	0.65	0.34	0.51	0.51	0.27	0.26	0.43	0.33	0.68	0.49
OMAHA	0.25	0.40	0.30	0.20	0.23	0.35	0.22	0.44	0.31	0.45	0.45	0.13	-0.06
ORANGE	0.48	0.39	0.41	0.52	0.44	0.43	0.54	0.35	0.30	0.28	0.35	0.75	0.47
ORLAND	0.32	0.41	0.17	0.24	0.66	0.36	0.50	0.27	0.10	0.31	0.34	0.47	0.14
PHILAD	0.40	0.51	0.52	0.63	0.25	0.50	0.46	0.03	-0.01	0.29	0.28	0.54	0.52
PHOENI	0.48	0.69	0.52	0.48	0.43	0.65	0.36	0.39	0.17	0.67	0.68	0.47	0.18
PITTSB	0.27	0.35	0.07	-0.01	0.08	0.32	0.13	0.09	0.24	0.46	0.29	0.14	-0.04
PORTLA	0.39	0.61	0.31	0.28	0.23	0.66	0.28	0.31	0.45	0.54	0.55	0.32	-0.03
RALEIG	0.46	0.72	0.52	0.53	0.35	0.54	0.30	0.20	0.04	0.58	0.57	0.30	0.24
RICHMO	0.59	0.45	0.48	0.34	0.23	0.44	0.43	0.14	0.20	0.55	0.51	0.57	0.34
SANTON	0.22	0.39	0.19	0.14	0.35	0.37	0.09	0.20	0.48	0.31	0.48	0.26	-0.05
SDIEGO	0.40	0.28	0.43	0.51	0.29	0.43	0.53	0.21	0.18	0.19	0.08	0.78	0.51
SEATTL	0.45	0.66	0.23	0.39	0.57	0.51	0.36	0.39	0.31	0.57	0.50	0.51	0.21
SFRANC	0.47	0.60	0.46	0.57	0.41	0.54	0.41	0.28	0.27	0.48	0.37	0.60	0.36
SLOUIS	0.30	0.34	0.16	0.14	0.09	0.22	0.17	0.19	0.20	0.50	0.45	0.23	0.05
TAMPA	0.39	0.52	0.30	0.37	0.61	0.46	0.46	0.31	0.15	0.44	0.49	0.56	0.25
TRENTO	0.36	0.37	0.46	0.44	0.35	0.32	0.49	0.06	0.27	0.09	0.28	0.54	0.43
TUCSON	0.49	0.46	0.48	0.36	0.52	0.48	0.43	0.57	0.13	0.47	0.54	0.44	0.22
WASHIN	0.62	0.38	0.57	0.59	0.47	0.27	0.66	0.16	0.11	0.26	0.26	0.76	0.48
WBEACH	0.37	0.26	0.41	0.46	0.63	0.28	0.58	0.28	0.09	0.12	0.17	0.62	0.32

Limited Service Correlation Matrix (Continued)

	MEMPHI	MIAMI	MINNEA	NASHVI	NEWARK	NEWORL	NEWYRK	OAKLAN	OMAHA	ORANGE	ORLAND	PHILAD	PHOENI	PITTSB
ALBANY	0.19	0.05	0.17	0.09	0.45	-0.11	0.12	0.21	0.15	0.09	0.06	0.12	0.10	0.12
ALBUQU	0.39	0.22	0.27	0.48	0.14	0.10	0.10	0.14	0.27	0.16	0.17	0.17	0.44	0.37
ATLANT	0.68	0.42	0.61	0.57	0.42	0.46	0.36	0.34	0.40	0.51	0.31	0.48	0.60	0.10
AUSTIN	0.49	0.49	0.62	0.58	0.28	0.37	0.43	0.61	0.50	0.46	0.30	0.40	0.62	0.35
BALTIM	0.50	0.23	0.45	0.52	0.45	0.24	0.43	0.44	0.07	0.55	0.25	0.52	0.53	0.01
BOSTON	0.38	0.33	0.57	0.45	0.73	0.12	0.67	0.70	0.15	0.48	0.43	0.57	0.47	0.17
CHICAG	0.65	0.43	0.68	0.73	0.63	0.26	0.68	0.67	0.51	0.52	0.40	0.54	0.73	0.33
CHRLTE	0.69	0.47	0.55	0.74	0.44	0.25	0.64	0.51	0.55	0.53	0.57	0.53	0.73	0.34
CINCIN	0.57	0.41	0.45	0.60	0.42	0.30	0.57	0.50	0.50	0.47	0.54	0.38	0.62	0.43
CLEVEL	0.44	0.37	0.51	0.49	0.48	0.16	0.37	0.42	0.56	0.37	0.25	0.33	0.49	0.19
COLUMB	0.38	0.27	0.32	0.44	0.23	0.20	0.52	0.52	0.35	0.26	0.41	0.46	0.46	0.32
COLUSC	0.68	0.44	0.48	0.71	0.13	0.18	0.40	0.29	0.29	0.47	0.55	0.63	0.73	0.19
DALLAS	0.70	0.49	0.67	0.69	0.45	0.48	0.58	0.60	0.48	0.50	0.51	0.42	0.68	0.47
DAYTON	0.49	0.33	0.49	0.57	0.35	0.25	0.46	0.45	0.25	0.48	0.32	0.40	0.48	0.27
DENVER	0.68	0.50	0.72	0.65	0.41	0.29	0.42	0.53	0.40	0.39	0.41	0.51	0.69	0.35
DETROI	0.60	0.33	0.65	0.58	0.61	0.31	0.51	0.44	0.30	0.41	0.17	0.52	0.52	0.07
EDISON	0.48	0.42	0.64	0.40	0.70	0.18	0.59	0.65	0.20	0.52	0.24	0.63	0.48	-0.01
FORTLA	0.41	0.78	0.58	0.32	0.17	0.39	0.32	0.34	0.23	0.44	0.66	0.25	0.43	0.08
FORTWO	0.67	0.38	0.46	0.60	0.36	0.55	0.44	0.51	0.35	0.43	0.36	0.50	0.65	0.32
HARTFO	0.38	0.31	0.40	0.37	0.63	0.10	0.58	0.51	0.22	0.54	0.50	0.46	0.36	0.13
HONOLU	0.17	0.45	0.24	0.19	-0.03	0.27	0.10	0.27	0.44	0.35	0.27	0.03	0.39	0.09
HOUSTO	0.32	0.21	0.16	0.12	0.17	0.55	0.15	0.26	0.31	0.30	0.10	-0.01	0.17	0.24
INDIAN	0.43	0.28	0.48	0.65	0.16	0.08	0.33	0.43	0.45	0.28	0.31	0.29	0.67	0.46
KANSAS	0.55	0.31	0.54	0.60	0.20	0.25	0.18	0.33	0.45	0.35	0.34	0.28	0.68	0.29
LANGEL	0.38	0.32	0.27	0.38	0.65	0.23	0.65	0.68	0.13	0.75	0.47	0.54	0.47	0.14
LISLAN	0.22	0.18	0.23	0.17	0.51	0.11	0.54	0.49	-0.06	0.47	0.14	0.52	0.18	-0.04
MEMPHI	1.00	0.45	0.67	0.77	0.39	0.43	0.41	0.30	0.35	0.40	0.39	0.54	0.73	0.22
MIAMI	0.45	1.00	0.67	0.45	0.17	0.30	0.40	0.40	0.35	0.49	0.54	0.32	0.48	0.10
MINNEA	0.67	0.67	1.00	0.59	0.41	0.32	0.44	0.44	0.42	0.36	0.37	0.39	0.61	0.15
NASHVI	0.77	0.45	0.59	1.00	0.26	0.27	0.47	0.37	0.39	0.42	0.40	0.58	0.82	0.29
NEWARK	0.39	0.17	0.41	0.26	1.00	0.14	0.58	0.61	0.16	0.46	0.29	0.49	0.34	0.14
NEWORL	0.43	0.30	0.32	0.27	0.14	1.00	0.23	0.22	0.17	0.33	0.16	0.07	0.28	0.01
NEWYRK	0.41	0.40	0.44	0.47	0.58	0.23	1.00	0.78	0.24	0.57	0.56	0.51	0.43	0.35
OAKLAN	0.30	0.40	0.44	0.37	0.61	0.22	0.78	1.00	0.30	0.70	0.50	0.46	0.50	0.29
OMAHA	0.35	0.35	0.42	0.39	0.16	0.17	0.24	0.30	1.00	0.25	0.27	0.05	0.45	0.26
ORANGE	0.40	0.49	0.36	0.42	0.46	0.33	0.57	0.70	0.25	1.00	0.50	0.54	0.61	0.02
ORLAND	0.39	0.54	0.37	0.40	0.29	0.16	0.56	0.50	0.27	0.50	1.00	0.33	0.47	0.40
PHILAD	0.54	0.32	0.39	0.58	0.49	0.07	0.51	0.46	0.05	0.54	0.33	1.00	0.64	-0.01
PHOENI	0.73	0.48	0.61	0.82	0.34	0.28	0.43	0.50	0.45	0.61	0.47	0.64	1.00	0.14
PITTSB	0.22	0.10	0.15	0.29	0.14	0.01	0.35	0.29	0.26	0.02	0.40	-0.01	0.14	1.00
PORTLA	0.52	0.33	0.43	0.52	0.31	0.31	0.45	0.48	0.61	0.43	0.46	0.26	0.61	0.47
RALEIG	0.57	0.36	0.58	0.68	0.37	0.22	0.37	0.46	0.34	0.45	0.36	0.63	0.81	0.13
RICHMO	0.62	0.25	0.45	0.64	0.34	0.15	0.53	0.46	0.37	0.50	0.33	0.50	0.66	0.31
SANTON	0.44	0.42	0.43	0.29	0.29	0.41	0.21	0.21	0.42	0.21	0.24	-0.01	0.32	0.27
SDIEGO	0.35	0.32	0.29	0.34	0.58	0.16	0.70	0.73	0.22	0.68	0.34	0.55	0.45	0.02
SEATTL	0.42	0.62	0.51	0.50	0.31	0.27	0.60	0.69	0.41	0.62	0.67	0.40	0.62	0.34
SFRANC	0.43	0.49	0.58	0.47	0.53	0.34	0.74	0.85	0.25	0.67	0.57	0.47	0.57	0.34
SLOUIS	0.29	0.26	0.26	0.38	0.13	-0.13	0.08	0.23	0.33	0.21	0.12	0.15	0.32	0.44
TAMPA	0.52	0.52	0.47	0.57	0.26	0.17	0.46	0.52	0.36	0.58	0.72	0.53	0.67	0.21
TRENTO	0.48	0.24	0.30	0.37	0.38	0.31	0.39	0.40	0.28	0.56	0.29	0.46	0.45	-0.09
TUCSON	0.61	0.57	0.58	0.62	0.34	0.22	0.34	0.40	0.55	0.53	0.42	0.36	0.71	0.20
WASHIN	0.45	0.49	0.52	0.48	0.58	0.16	0.57	0.60	0.14	0.75	0.53	0.60	0.53	0.09
WBEACH	0.41	0.60	0.44	0.36	0.44	0.26	0.45	0.42	0.12	0.60	0.61	0.50	0.47	-0.09

Limited Service Correlation Matrix (Continued)													
	PORTLA	RALEIG	RICHMO	SANTON	SDIEGO	SEATTL	SFRANC	SLOUIS	TAMPA	TRENTO	TUCSON	WASHIN	WBEACH
ALBANY	0.09	-0.02	0.36	0.37	0.28	0.11	0.04	0.45	0.15	0.14	0.27	0.22	0.17
ALBUQU	0.45	0.25	0.42	0.44	0.08	0.30	0.21	0.62	0.23	-0.08	0.46	0.11	0.08
ATLANT	0.45	0.48	0.42	0.38	0.28	0.32	0.43	0.21	0.44	0.46	0.56	0.45	0.37
AUSTIN	0.61	0.55	0.44	0.43	0.35	0.58	0.70	0.34	0.43	0.15	0.56	0.40	0.22
BALTIM	0.14	0.46	0.63	0.16	0.53	0.32	0.42	0.28	0.48	0.54	0.47	0.73	0.47
BOSTON	0.31	0.53	0.40	0.07	0.52	0.43	0.65	0.10	0.34	0.38	0.33	0.68	0.51
CHICAG	0.66	0.70	0.61	0.44	0.59	0.66	0.71	0.32	0.51	0.47	0.61	0.54	0.38
CHRLTE	0.68	0.66	0.58	0.30	0.44	0.63	0.55	0.26	0.54	0.46	0.61	0.49	0.42
CINCIN	0.61	0.45	0.62	0.50	0.41	0.58	0.50	0.41	0.57	0.37	0.56	0.47	0.45
CLEVEL	0.53	0.42	0.40	0.29	0.30	0.33	0.38	0.33	0.34	0.31	0.48	0.49	0.41
COLUMB	0.44	0.44	0.51	0.16	0.48	0.58	0.50	0.28	0.42	0.13	0.39	0.19	0.24
COLUSC	0.43	0.55	0.59	0.20	0.37	0.47	0.37	0.35	0.64	0.44	0.63	0.49	0.47
DALLAS	0.68	0.51	0.58	0.51	0.37	0.62	0.65	0.35	0.54	0.33	0.58	0.47	0.40
DAYTON	0.39	0.46	0.59	0.22	0.40	0.45	0.47	0.30	0.39	0.36	0.49	0.62	0.37
DENVER	0.61	0.72	0.45	0.39	0.28	0.66	0.60	0.34	0.52	0.37	0.46	0.38	0.26
DETROI	0.31	0.52	0.48	0.19	0.43	0.23	0.46	0.16	0.30	0.46	0.48	0.57	0.41
EDISON	0.28	0.53	0.34	0.14	0.51	0.39	0.57	0.14	0.37	0.44	0.36	0.59	0.46
FORTLA	0.23	0.35	0.23	0.35	0.29	0.57	0.41	0.09	0.61	0.35	0.52	0.47	0.63
FORTWO	0.66	0.54	0.44	0.37	0.43	0.51	0.54	0.22	0.46	0.32	0.48	0.27	0.28
HARTFO	0.28	0.30	0.43	0.09	0.53	0.36	0.41	0.17	0.46	0.49	0.43	0.66	0.58
HONOLU	0.31	0.20	0.14	0.20	0.21	0.39	0.28	0.19	0.31	0.06	0.57	0.16	0.28
HOUSTO	0.45	0.04	0.20	0.48	0.18	0.31	0.27	0.20	0.15	0.27	0.13	0.11	0.09
INDIAN	0.54	0.58	0.55	0.31	0.19	0.57	0.48	0.50	0.44	0.09	0.47	0.26	0.12
KANSAS	0.55	0.57	0.51	0.48	0.08	0.50	0.37	0.45	0.49	0.28	0.54	0.26	0.17
LANGEL	0.32	0.30	0.57	0.26	0.78	0.51	0.60	0.23	0.56	0.54	0.44	0.76	0.62
LISLAN	-0.03	0.24	0.34	-0.05	0.51	0.21	0.36	0.05	0.25	0.43	0.22	0.48	0.32
MEMPHI	0.52	0.57	0.62	0.44	0.35	0.42	0.43	0.29	0.52	0.48	0.61	0.45	0.41
MIAMI	0.33	0.36	0.25	0.42	0.32	0.62	0.49	0.26	0.52	0.24	0.57	0.49	0.60
MINNEA	0.43	0.58	0.45	0.43	0.29	0.51	0.58	0.26	0.47	0.30	0.58	0.52	0.44
NASHVI	0.52	0.68	0.64	0.29	0.34	0.50	0.47	0.38	0.57	0.37	0.62	0.48	0.36
NEWARK	0.31	0.37	0.34	0.29	0.58	0.31	0.53	0.13	0.26	0.38	0.34	0.58	0.44
NEWORL	0.31	0.22	0.15	0.41	0.16	0.27	0.34	-0.13	0.17	0.31	0.22	0.16	0.26
NEWYRK	0.45	0.37	0.53	0.21	0.70	0.60	0.74	0.08	0.46	0.39	0.34	0.57	0.45
OAKLAN	0.48	0.46	0.46	0.21	0.73	0.69	0.85	0.23	0.52	0.40	0.40	0.60	0.42
OMAHA	0.61	0.34	0.37	0.42	0.22	0.41	0.25	0.33	0.36	0.28	0.55	0.14	0.12
ORANGE	0.43	0.45	0.50	0.21	0.68	0.62	0.67	0.21	0.58	0.56	0.53	0.75	0.60
ORLAND	0.46	0.36	0.33	0.24	0.34	0.67	0.57	0.12	0.72	0.29	0.42	0.53	0.61
PHILAD	0.26	0.63	0.50	-0.01	0.55	0.40	0.47	0.15	0.53	0.46	0.36	0.60	0.50
PHOENI	0.61	0.81	0.66	0.32	0.45	0.62	0.57	0.32	0.67	0.45	0.71	0.53	0.47
PITTSB	0.47	0.13	0.31	0.27	0.02	0.34	0.34	0.44	0.21	-0.09	0.20	0.09	-0.09
PORTLA	1.00	0.50	0.43	0.42	0.35	0.64	0.56	0.25	0.44	0.28	0.44	0.27	0.18
RALEIG	0.50	1.00	0.53	0.11	0.36	0.62	0.58	0.17	0.46	0.37	0.55	0.47	0.28
RICHMO	0.43	0.53	1.00	0.35	0.54	0.50	0.47	0.48	0.50	0.42	0.60	0.48	0.31
SANTON	0.42	0.11	0.35	1.00	0.18	0.39	0.30	0.40	0.28	0.20	0.51	0.15	0.21
SDIEGO	0.35	0.36	0.54	0.18	1.00	0.55	0.62	0.11	0.49	0.56	0.44	0.59	0.45
SEATTL	0.64	0.62	0.50	0.39	0.55	1.00	0.75	0.30	0.62	0.32	0.52	0.48	0.42
SFRANC	0.56	0.58	0.47	0.30	0.62	0.75	1.00	0.12	0.48	0.31	0.44	0.64	0.41
SLOUIS	0.25	0.17	0.48	0.40	0.11	0.30	0.12	1.00	0.26	0.02	0.50	0.22	0.02
TAMPA	0.44	0.46	0.50	0.28	0.49	0.62	0.48	0.26	1.00	0.54	0.54	0.57	0.62
TRENTO	0.28	0.37	0.42	0.20	0.56	0.32	0.31	0.02	0.54	1.00	0.34	0.47	0.41
TUCSON	0.44	0.55	0.60	0.51	0.44	0.52	0.44	0.50	0.54	0.34	1.00	0.50	0.45
WASHIN	0.27	0.47	0.48	0.15	0.59	0.48	0.64	0.22	0.57	0.47	0.50	1.00	0.70
WBEACH	0.18	0.28	0.31	0.21	0.45	0.42	0.41	0.02	0.62	0.41	0.45	0.70	1.00

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