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Determinants of Hotel Property Prices

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Keywords

Cornell, commercial real estate, hedonic model, hotel

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Commercial real estate pricing has its foundations in present value theory although improved access to transaction data heightened interest in hedonic pricing models. Heretofore, the commercial property versions of these models follow traditions for pricing non-market rent paying durable assets, principally residential housing. We present a pricing model that departs from tradition by incorporating city-specific net operating incomes and the capitalization rates into the hedonic equation. Property attributes and location characteristics serve as proxies for unobservable, asset cash flows; city incomes account for local cash flow effects; and the capitalization rate represent local and national capital market influences. Modeling commercial real estate in this way allows us to recognize the relative contributions of property, local market, and national market determinants. Empirical testing relies on a sample of hotel transactions from 2005-2010. The choice of hotels stems from the responsiveness of these properties' cash flows to market changes in the absence of lease friction and the homogeneity of the physical assets. Our model explains nearly 80 percent of the variation in hotel asset prices. We find that prices are collectively determined by property, city income, and capital market characteristics. Models only with property characteristics slightly outperform models with present value variables.

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I. *Introduction*

A hedonic pricing model for commercial real estate (CRE) is presented here that generates implicit prices from property attributes together with implicit prices of both local market net rents and capitalization rates consistent with present value theory. We estimate the model parameters without the Rosen (1984) equivalent of an underlying utility theory for investment in differentiated CRE attributes. Instead we assume that property attribute coefficients represent the marginal utilities received from additional units of these attributes offered at unique locations in line with urban economic theory. The implicit prices thus serve as proxies for unobserved property net rents. Heretofore, CRE hedonic studies closely followed the housing literature by relying on property-specific and transaction-specific characteristics for prediction. We diverge from this tradition by recognizing the contributions on financial variables that represent local market economics and capital market effects.

Because our model uses local market net rents and capitalization rates together with property attributes, we have the ability to examine the determinants of CRE transaction prices across three main effects: (1) net rental for the property (2), net rental for the local market (*i.e.*, city), (3) the city and national capital market. This approach allows us to assess the relative contributions of systematic (*i.e.*, city and national) and unsystematic (*i.e.*, property) value determinants. Our econometric approach addresses endogeneity issues that arise as the result of mixing these effects within the same model.

The various property types that comprise the investible universe of CRE share many common features. Each type is subject to the same land rent conditions that determine capital and land contributions; CRE is similarly treated in the capital markets (Gyourko, 2009). Property types also embody idiosyncratic characteristics. These unique features originate from endemic physical attributes and institutional arrangements found in specialized contracts (*i.e.,* lease provisions) - the effects of which on space market rents, property prices, and securitized asset prices have been subjects for a large number of studies.[1]

We focus on the hotel property type for estimating our model by utilizing transaction information from U.S. hotel markets. Hotels have a highly visible presence in cities despite only comprising only about ten percent of the CRE universe (Florence, Miller, Peng, and Spivey, 2010 and Prudential, 2009). Among the approximately 130 NAREIT member equity REITs, less than 20 own hotel portfolios. These facts may explain why the asset pricing and market behaviors of hotels have not been heavily researched. The scarcity of hotel real estate data is another barrier. For example, only in recent years has NCREIF maintained a hotel index; and even now the number of properties in the index is small relative to other NCREIF property-specific indexes.

Hotel real estate valuation raises some intellectually interesting questions; the answers to which have possible implications for the general case of CRE investment analysis and valuation. The absence of long-term leases to secure income streams is the most often-cited point of differentiation from other CRE. This institutional arrangement provides hotel management with the ability to reset many room rates on a daily basis and thus the opportunities to grow income in synchronization with upward movements of the market.[2] Also, this process should symmetrically operate in reverse in down markets, albeit not necessarily with the same immediacy.[3] Short-term rental raises controversial issues about cash flow risk (Quan, Li, and Sehgal 2002); franchising effects (O'Neill and Mattila 2010) and also management contributions to cash flow generation (Brady and Conlin 2004). Given

[1] One topical example is Eichholtz, Kok, and Quigley (2010) who find that office buildings with a 'green rating' sell at a three percent premium relative to identical properties, where 'identical' is determined from a hedonic specification including multiple controls.
[2] Hotels catering to business travelers may have forward contracts with corporations that establish room rate on an annual basis and sometimes for a meaningful number of room nights. Also, many hotels use online travel agents to which they pre-sell rooms. Hence the general statement that hotel management has the ability mark rents to market is compromised for some hotels.
[3] One of the issues debated in the hotel management literature involves the process of room rate 'discounting' during down markets. See Croes and Semrad (2012) for recent evidence and literature review.

the minimal contract friction, hotel markets provide a natural experimental setting for examining the sensitivity of fixed-location income streams and asset prices to changes in the local and national economic conditions.

Most importantly, a final point of differentiation comes from the fact that nearly 60 percent of the over 52,000 U.S. hotels who report their operating performance to data aggregator Smith Travel Research (STR), and an even larger share of investment quality properties, operate with recognizable brands (Smith Travel Research, 2012). Brand sponsors (*aka* franchisors) impose strict design and construction standards that introduce considerable homogeneity within the set of like-branded properties. Sponsors, such as Choice, Hilton, Hyatt, Marriott, Intercontinental, Starwood, and Wyndham, require property owners to maintain uniform quality standards during franchise contract periods. Failure to maintain these standards may result in license termination. Brand standards therefore provide 'built-in' quality controls across properties of the same brand and same market segment that are similar in nature to houses within the same neighborhood, but in contrast to other CRE property types. Brands from different sponsors tend to cluster into competitive national and local markets which results in similar physical and operational features across brands within the same market segment or 'chain scales'.[4] This clustering suggests that hotels in the same market segment, although differentiated by brand, serve as close substitutes for one another.

I.1 Rationalization for Our Approach

Location fixity, durability, and the absence of continuous trading place a greater importance on the valuation modeling of real estate relative to traded financial assets and commodities. Because so much attention has been directed to real estate valuation model development, it is not surprising that different views have emerged over the conceptual and

[4] STR defines these market segments into collections of brands know as chain scales. The six chain scales are luxury, upper-upscale, upscale, upper-midscale, midscale, and economy.

technical matters related to model construction. Importantly, an imaginary line delineates the border between relative and absolute modeling approaches for real estate valuation as it does in corporate valuation (Damodaran 2002).

Without the benefit of observable market rents, the pricing of owner-occupied housing relies on relative valuations.[5] Present value models were almost exclusively used for CRE valuation until recent decades when new and improved transaction data bases sparked an interest in hedonic and repeat-sale model set ups borrowed from residential property valuation**.** The portability of housing hedonics to CRE is far from direct. Fewer comparable transactions typically occur in the CRE markets per period than in housing markets. The homogeneity of houses is known to be greater than most types of commercial properties hence CRE hedonic valuations require additional controls to conform to the law of one price. Importantly, the conceptual foundations of buyer and seller motivations in housing compared to CRE hedonic valuations depart in an economically significant way despite sharing urban economics principles.

Hedonic theory enhanced by Rosen (1984) Epple (1987), and Lancaster (1996) from early applications by Court (1939) and Griliches (1961, 1971) assumes that the prices of differentiated consumer products, including houses, derive from the implicit prices of the attribute collections that comprise these products. No transactions occur for these attributes (*e.g.,* bedrooms), because they cannot be separated from houses themselves, so the prices of the characteristics are never independently observed. Aggregate housing demand and supply ultimately determine an attribute's marginal contribution to the prices of the properties. The demand and supply drivers for CRE (*e.g*., CBD location)

[5] Muth (1960) developed a theory of housing demand based on the service flows received by occupants. "One unit of housing service is defined as that quantity of service yielded by one unit of housing stock per unit of time. The price per unit of housing service, or rent, is the price paid by consumers for the flow of services from one standard house peer unit of time (pp. 32-33)." The value of a house then becomes the present value of the flow of services net of expenses. Given the difficulty of converting and building pro forma of housing service flows in terms of monetary rental flows paid by consuming owner occupants (*i.e.*, price time quantity of housing services), valuation models based on financial economics principles never emerged. Hedonic models serve to standardize units of housing services.

may differ in meaningful ways from the determinants of home prices (*e.g.*, proximity to good schools).

In Rosen's (1984) two-stage model, consumer demand determinants, such as income, are important for estimating implicit prices – consumers' marginal willingness to pay for each attribute. The coefficient estimates from CRE hedonic models might be similarly interpreted as the marginal utilities investors receive from additional units of attributes in much the same way as housing attribute implicit prices are interpreted by consumers. However, an investor utility theory for heterogeneous investment properties and their attributes is not well developed. The literature on heterogeneous buyer behavior (Bokhri and Geltner 2011), seller behavior (Haurin, Haurin, Nadauld, and Sanders, 2010), and investor sentiment (Clayton, Ling, and Naranjo, 2009) is emerging, but nascent at present. Because investors achieve wealth maximization objectives by obtaining rights to future net rents, it is reasonable to assume that investors achieve these objectives through ownership of CRE attributes and thus the aggregation of attribute implicit prices correspond to net rents.

Our CRE pricing model uniquely incorporates city net rent and capital market pricing linked to national net rents together with property attributes that conceptually relate to property-specific net rents. Present value and urban economic theories suggest that general levels of rents and capitalization rates of cities where properties are located, relative properties locations within cities, and the physical characteristics of the property determine the asset prices. Endogeneity arises in our hotel property hedonic model as the result of introducing city net rents so we estimate model parameters using two-stage least squares in which net rent and price are endogenous.

We find that including only property characteristics in the hedonic model in the conventional way leads to slightly better performance than only using present value variables. We conclude, however, that hotel asset prices are determined by the combination of property, city income, and capital market characteristics selected. This combination explains nearly 80 percent of the variation in hotel asset prices after controlling for transaction effects, brand/quality, and time trend.

The remainder of the paper is organized as follows. Section II contains a review of literature – its relevance and findings. In Section III we present a model that sets up the empirical research in the paper. Section IV describes the data and explains variable construction. The methodology and econometric issues also are discussed in this section. Section V presents results from the analysis of hotel transaction data. Concluding remarks appear in the final section.

II. *Related Literature*

Treating CRE as a composite asset class introduces aggregation bias - macro parameters deviating from the averages of the component micro parameters (Theil, 1954). Differences in risk and return relationships among various property types are demonstrated in diversification studies (Fisher and Liang, 2000 and Cheng and Roulac, 2007). Other studies show marked differences across property types in the ability of capitalization rates to predict future returns (Plazzi, Torous, and Valkanov, 2010), and patterns of construction cycles as well as correlations with the business cycle (Wheaton, 1999). Taken together the evidence suggests that different economic determinants of prices and returns associated with different CRE property types suggest that customized valuation model development for major property types has considerable merit. The unique characteristics of hotels noted above suggest that existing models used to price CRE do not exactly fit for hotel valuation. Our interests in this literature review lie first with the hedonic modeling approaches followed in housing and CRE studies; and secondarily with advancements in explaining variation in hotel property prices.

By comparison, the volume of hedonic pricing research in 1-4 family housing far exceeds the number of hedonic studies for CRE property types. Given the absence of both observable market rents and a wealth maximizing investment perspective, housing models usually do not blend present value and urban economic theory as we do in this study. Of the housing studies that rely on present value concepts, Meese and Wallace (1994) find that modeled values can substantially deviate from observed house prices in the short run.

Hoag (1980), in one of earliest published CRE hedonic studies, recognizes that the determinants of CRE prices come from macroeconomic and regional economic influences in addition to and independent of property fundamentals and location. Since the early 1980s, advancements occurred in hedonic pricing to the extent that models began being applied to examine a wide variety of practical issues including apartment age restrictions (Guntermann and Moon, 2002), rent concessions (Sirmans, Sirmans, and Benjamin, 1990), and technological change (Colwell and Ramsland, 2003) to cite a few. Dermisi and McDonald (2010) and Wiley and Wyman (2012) provide updated detailed reviews of this literature.

Some CRE hedonic studies incorporate economic measures, such as national employment and GDP, to control for differences in macroeconomic conditions at the times of sales. These variables enter hedonic equations without a direct link to asset pricing theory and, except for Lockwood and Rutherford (1996) who use LISREL to correct for econometric problems; they also introduce multi-colinearity brought on by mixing national and local economic determinants within the same model. We adopt a different approach by relying on the city capitalization rate. National capitalization rates embody important macroeconomic conditions through the real interest rate and inflationary expectations components. City-specific capitalization rates carry both national and city systematic risk premiums. Importantly, capitalization rates in the same model with NOIs complete the present value equation.

For hotel properties, Corgel (1997, 2007) reports hedonic results with disaggregate transaction data using similar sets of property and location characteristics and measures of local market economic strength, such as ZIP or county employment and income.[6] The semi-log regressions explain large percentages of variation in sale price. Most property and all local market economic variables are correctly signed and statistically significant. None of these equations include either city NOI or capital market effects, although local economic variables proxy with error for local area NOI.

An alternative path to understanding CRE asset market pricing is to explain variation in property capitalization rates instead of property transaction prices. Nearly all of these studies use aggregate, appraisal-based capitalization rate data. Sivitanidou and Sivitanides (1999) and Jud and Winkler (1995), for example, estimate equations with transaction-generated capitalization rates, but use periodic averages that do not allow for property-level quality controls. Only McDonald and Dermisi (2008, 2009) build a capitalization rate model with disaggregated transaction data so that local economic, national economic, and property characteristics can appear in the same model. A review in Chaney and Hoesli (2012) traces this literature from the late 1980s to present and discusses its shortcomings.

To the best of our knowledge, our study is the first to propose a hedonic model for CRE for explaining variation in asset prices based on both urban economic and present value theories while recognizing the econometric problems of estimating parameters of such a model. This approach allows us to separate the effects of property fundamentals, local markets and the macro-level capital market. In contrast to the approach we propose, Ghysels, Plazzi, and Valkanov (2007) conclude that … "commercial real estate prices are better modeled as financial assets and that the discounted rent model might be more suitable than traditional hedonic models, at least at the aggregate level (p. 472-3)," given their finding that less than one-third of the variation in capitalization rates is explained by property and local economic variables.

[6] O'Neill (2004) estimates a hedonic price equation for hotels that includes both hotel financial performance variables and local market controls, but he only reports results for financial performance variables.

III. *Model*

Discounting future net rents to generate current present values is deeply rooted in financial economic theory as adapted for CRE valuation. The basic form of the model is

$$V_0 = \sum_{t=1}^{N} \frac{NOIt}{(1+r)t} \quad (1)$$

where NOI_t is the net operating income at the end of period t and r is the risk-adjusted discount rate. Following McDonald (2005) and multiplying by (1+r), gives

$$V_0 (1+r) = NOI_1 + V_1. \quad (2)$$

Rewriting this equation gives,

$$V_0 = (NOI_1 + \Delta V) / r, \quad (3)$$

where $\Delta V = V_1 - V_0$

The period-zero capitalization rate, C_o, comes from solving Equation (3), as follows

$$C_o = NOI_1 / V_0 = r - (\Delta V / V_0). \quad (4)$$

The expression for V_0 can be written in the form below assuming the terminal capitalization rate equals the initial capitalization rate and the Gordon Growth model takes a general form with percent change in value as follows

$$V_0 = (NOI_1 + \Delta V) / [C_o + (\Delta V / V_0)]. \quad (5)$$

We present NOI_1 as the composite of systematic effects from the local market and idiosyncratic property-specific effects. Thus,

$$NOI_1 = NOI_{m1} + NOI_{i1} = (R_{m1} - E_{m1}) + (R_{i1} - E_{i1}) \quad (6)$$

where NOI_{m1} and NOI_{i1} represent the NOIs of the local market and individual property, respectively. Each NOI has endemic rent (*i.e.*, R_m and R_i) and expense (*i.e.,* E_m and E_i) components.

Unobservable property NOI^*_{i1} is estimated from location and physical property attributes, Z_i, as

$NOI^*_{i1} = f(Z_i,)$. (7)

The final expression for V_0 becomes

$$V_0 = [NOI_{m1} + NOI^*_{i1} + \Delta V] / (C_o + (\Delta V/ V_0)) \quad (8)$$

All of the parameters in Equation (8) are estimated using a hedonic specification in which the local market NOI effect is represented, the city capitalization rate captures both national capital market influences and local risk premiums, property NOI effect is included, and trend and transaction specific characteristics are controlled for through the time-series and other dummy variables, D_t, D_k.

$$\ln(P_i) = \alpha + \beta^*_1 \ln(NOI_{m1}) - \beta^*_2 \ln(C_o) + \beta_3 Z_i + f(D_t \ldots D_n, D_k) + e_i \quad (9)$$

Because the present value model embedded in Equation (9) to account for non-property related price determinants is non-linear we take the natural logs of both NOI_{m1} and C_o. That is,

$$\ln(\beta_1 NOI_{m1}/ \beta_2 C_o) = \beta^*_1 \ln(NOI_{m1}) - \beta^*_2 \ln(C_o) \quad (10)$$

Econometric issues encountered when estimating Equation (8) arise from the possibility that NOI_{m1} is correlated with e_i. We discuss this endogeneity problem in a subsequent section.

IV. *Research Design and Method*

Data

The hotel data for our research primarily come from Real Capital Analytics (RCA). This firm collects transaction prices and associated property characteristics for U.S. commercial property sales that are greater than $2.5 million. The sample period begins in January 2005 and ends in December 2010. Data from CoStar, PKF Hospitality Research, and STR augment the RCA data. The subsequent section on variable construction discusses the various uses of these supplemental databases.

Variable Construction

Hotel property characteristics appear on the right side of our hedonic equations to account for the variation in selling price. We include the effective age (EA) - calculated as the year of sale subtracted from the year of renovation, the number of rooms (RM), a landmark property dummy (DLAND) which equals one if the hotel is designated as a historical landmark and is zero otherwise. Two location dummies also enter these equations. The first of these variables captures whether the hotel is located next to water (DH2O) such as beachfront property while the second one denotes a CBD hotel location (DCBD). We also include a dummy to indicate an expected and important property renovations associated with the sale event (DRENO).

Transaction-specific effects may influence hotel sale prices so controls appear in our equations for REIT hotel buyers (DREIT), an effect suggested as meaningful in financial press reports, and if individual hotels changed ownership as part of portfolio transactions (DPORT).[7] The sign on the DPORT coefficient is ambiguous because the composition of the portfolio may result in a single property's price being greater than or less than the price if the hotel was sold independent of other assets.

Based on previous findings in the real estate asset pricing literature, we expect an inverse relationship between effective age and the transaction price of hotels. Positive relationships are presumed between selling prices and the number of rooms, landmark designation, locations near water and in the CBDs, planned hotel renovations, and REIT buyers.

To measure difficult to observe hotel attributes, a market segment dummy variable series is used for differentiation of lower from higher quality hotel features and service levels. These are: luxury LUX), upper upscale hotels (UUPS), upscale hotels (UPS), upper midscale hotels (UMID), midscale hotels (MID), and economy (ECO) hotel market segments (*i.e.*, chain scales).[8] Ex-ante, we expect the sold price to increase with hotel quality. As mentioned in the introduction of this paper, brand standards result in property homogeneity and

[7] The recorded price for a property sold as part of a portfolio is the price reported to RCA. Sometimes RCA make an allocation of the portfolio price to each property.
[8] Market segments are defined using STR classification chain scale system. This system is detailed in a subsequent section. The luxury hotel dummy is the omitted variable.

brands clustered within the chain scales also are of similar quality.

The extent of economic activity in the immediate surrounding area of the sold hotels may not be adequately controlled for by the dummies discussed above hence the daytime employment base (*i.e.,* number of employees) within a three mile radius of the hotel location was collect the from CoStar and introduced into the hedonic equation (NEMP). The higher the daytime employment base, the greater the potential demand for hotel rooms and logically a higher selling price. Also, to account for possible differences in hotel demand mix (*i.e.*, business group, and transient), we include a dummy variable (DGATE) to reflect whether the sold hotel is located in a gateway city. Cities that we define as gateway cities include Atlanta, Chicago, Dallas, Los Angeles, New York, Miami, San Francisco, and Washington DC. A dummy variables series starting in 2006 (T06) and ending in 2010 (T10) accounts for time trend.[9]

City capitalization rates come from RCA and are scaled by number of rooms in each hotel to adjust for size effects. This association serves to link the city capitalization rate to the property. A city NOI variable is constructed using PKF and STR total revenue and expense ratio data during each year. We adjust revenue by one minus the expense ratio of the property's market segment to link the city NOI to each property. The variable construction equation is as follows,

$$NOI_{it} = Rev_{City,t} * (1- OR_{Market\ Segment\ i,\ t}). \quad (11)$$

where NOI_{it} is the city NOI assigned to property i in period t, $Rev_{City,t}$ is the city total revenue in period t, and OR is the operating ratio for the applicable chain scale for property i in period t.

V. *Results*

Table 1 presents descriptive statistics for a sample of 623 hotel real estate sales that transacted in the U.S. from 2005 through 2010. As shown in Panel A, the sample includes both

[9] The 2005 dummy is the omitted variable.

large (*i.e.*, RM_{max} = 1348) and small hotels (*i.e.*, RM_{min} = 21). The capitalization rates and NOIs are for the city in which the transaction was completed. Statistics for property characteristics and transaction-specific variables appear in Panel B. Note that the transactions are spread across the six STR chain scales, all dummy variables are well distributed, and 2008-2009 financial crisis and recession lowered transaction volume.

[Insert Table 1 Here]

Hedonic Estimates

Our first set of implicit price estimates comes from running the data through the standard hedonic model with property attributes, transaction characteristics, and different treatments for NOIs and capitalization rates. Table 2 presents the results from estimating four alternative models. Models I and II include property and transaction characteristics in levels and semi-log functional form. While Model I performs well with most coefficients having the correct *ex-ante* sign and many significant, the semi-log form, as in most real estate hedonic studies, statistically dominates. This regression accounts for over 77 percent of the variation in hotel transaction prices. All variables have the expected signs and only effective age squared and two of the time dummies have coefficients that are not significant at the .10 level or better. Model III shows results from a semi-log regression of city NOIs and capitalization rates on hotel asset prices while controlling for transaction-specific effects and trend. Both variables have highly significant coefficients with expected signs. This simple present value specification explains 65 percent of the variation in hotel property prices. In Model IV, we mix the traditional hedonic variables with the financial variables. Interestingly, the coefficient vector of the traditional hedonic variables differs only slightly from Model II. The sizes and t-statistics of city NOI and capitalization rate, however, are markedly different in this specification relative to Model III. The coefficients on these variables, while remaining correctly signed, decline in size and the t-statistics are smaller. We interpret the results from estimating Model IV as confirmation of (1) our priors that hotel prices are determined by separate property-specific and market effects; and (2) potential econometric issues from mixing these variables within the same model.

[Insert Table 2 Here]

We have questions about correlations among regressors in these models, especially in Model IV. First-order correlation coefficients and variance inflation factors appear in Table 3. Multicollinearity detection and testing remain controversial. The correlations between NOI and both DGATE and NEMP appear high, yet not alarmingly so, and the variance inflation factors for EA and EA^2 approach the rule-of-thumb critical level of 10.0 (Kennedy, 2003, p.213). As a test, we remove EA and EA^2 from Model IV; this results in only very minor changes. These statistics do not raise meaningful concerns regarding the independence among the regressors, hence we conclude that our models do not violate the linear independence assumption.

Not surprisingly, the elasticity estimates presented in Panel C of Table 3 show that hotel property prices are fairly elastic with respect to the number of rooms and the capitalization rate, but inelastic with respect to city NOI and other continuous explanatory variables.

[Insert Table 3 Here]

Endogeneity Bias and 2-Stage LS Estimation

In Equation (9) restated below, hotel prices are modeled as a function of city market NOI (NOI_{m1}), property specific characteristics (Z_i), city market capitalization rate (C_o), time trend of price changes (D_t), and transaction-specific price determinants, D_k.

$$\ln(P_i) = \alpha + \beta^*_1 \ln(NOI_{m1}) - \beta^*_2 \ln(C_o) + \beta_3 Z_i + f(D_t \ldots D_n, D_k) + e_i$$

While we show that the variables representing these determinants are not highly correlated and OLS generates reasonable parameter estimates and high although not extreme R-squared, the aggregated city NOI likely will not capture all the effects of local market influences on hotel property prices. Thus, omitted regressors may be correlated with included regressors and with the error term, e_i. This observation suggests that NOI_{m1} is endogenous and its coefficient, β_1, is inconsistent. We address this potential endogeniety problem by re-estimating Equation (9) using the control-function approach which involves introducing instruments in a first-stage NOI regression. The changes in the selected instrumental variable(s) must be associated with changes in NOI but not associated with changes in regressors and P_i, except through NOI.

Three instrumental variables enter the first-stage regression after we extract the gateway city dummy, DGATE, from the hedonic model. Table 3 shows the first-order correlation coefficient between DGATE and NOI equals .45. This result is not surprising since both DGATE and NOI represent citywide effects. Given that DGATE represents a city effect, its use as an instrument in the first-stage regression conceptually makes more sense than in the second stage with an instrumented NOI.

The other two instruments are city travel spending, TSPEND, and the number of hotels, NHOTEL. Neither of these variables would logically enter a hotel asset pricing equation, but TSPEND on the demand side and NHOTEL on the supply side should explain variation in the NOI. Equation (11) presents the first-stage estimating equation.

$$NOI_{m1} = \lambda + \gamma_1 DGATE_i + \gamma_2 TSPEND_i + \gamma_3 NHOTEL_i + f(D_t \dots D_n) + u_i \qquad (12)$$

Table 4 presents the second stage results from data for the sample of 623 U.S. hotel sales. Comparing these results to those reported in Table 2 for Model IV, most coefficients are of nearly the same magnitude and significance levels. The estimated NOI coefficient of .2239 is larger from this analysis versus .1358 from OLS which is consistent with our presumption of endogeniety bias. The coefficient of NEMP becomes smaller and insignificant with the more consistent estimation of NOI. As shown in Table 3, these measures have a correlation coefficient of .46. Each of the time dummies becomes insignificant while the coefficient on EA^2 is significant in this regression. Finally, the R-squared (*i.e.*, .7975 and .7991) and root mean square error (*i.e.*, .5136 and .5132) remain virtually the same in the 2SLS run relative to OLS.

[Insert Table 4 Here]

Robustness Check - Results by Chain Scale

The universe of approximately 52,000 hotels and nearly 5,000,000 rooms assembled by data aggregator STR is widely viewed as 'the U.S. hotel industry'. This assemblage excludes properties with fewer than 20 rooms and includes most hotels with brand affiliations and many independent hotels inside the U.S. boundaries. The STR universe is organized into six chain scale divisions each consisting of branded hotels of similar quality and ADR plus a large independent hotel category. The number (percent) of hotels in each chain scale is as follows (Smith Travel Research, 2012):

Luxury – 307 (.6%), examples include Ritz-Carlton and Four Seasons.
Upper Upscale – 1,513 (2.9%), examples include Hyatt and Westin.
Upscale - 3,760 (7.2%), examples include Hilton Garden Inn and Hotel Indigo.
Upper Midscale – 8,776 (16.8%), examples include Hampton Inn and Fairfield Inn.
Midscale – 5,336 (10.2%), examples include Quality Inn and Red Lion.
Economy – 10,363 (19.9%), examples include Motel 6 and Microtel Inn.
Independent – 22,098 (42.4%).

These data reveal that the hotel industry is not an evenly distributed collection of operating businesses. Many more U.S. hotels operate in the economy segment than other chain scales. Also, a large number of independent hotels would logically fall into the economy segment if classified according to chain scales along price and quality lines. To conduct robustness checks on our results from analyzing aggregate data we disaggregate the hotels in our sample into chain scales and re-estimate the pricing equations. Because of sample size limitations we combine the six chain scales into three classifications – luxury and upper upscale (N=140), upscale and upper midscale (N=254), and midscale and economy (N=229). Independent hotels in the sample are assigned to a chain scale by examining their room size and amenities.

Results from re-estimating the hedonic pricing models (*i.e.*, single and two stages) for the three hotel market segment classifications appear in Table 5 through Table 7. Focusing on the two-stage estimates, the coefficient sizes and statistical significance appear quite similar across the four sets of equations – full sample (Table 4), luxury/upper upscale (Table 5), upscale/upper midscale (Table 6), and midscale/economy (Table 7). A bulleted summary of the differences is as follows:

Full Sample and Luxury/Upper Upscale

- The R-squared is somewhat lower for this sub-sample (*i.e.*, .6479 vs. .7991).
- Surprisingly, the number of rooms and both age variable coefficients are insignificant.
- The landmark and recently renovated variable coefficients are not significant in the sub-sample regression although the landmark coefficient is nearly identical in size.
- Not surprisingly, the portfolio variable coefficient is not significant in the sub-sample regression – higher-end hotels generally sell in one-off transactions.
- Given the relatively large coefficients on NOI and C, these higher-end hotels seem to be priced more on the basis of MSA and capital market strength than other types of hotels.

Full Sample and Upscale/Upper Midscale

- The R-squared is somewhat lower for this sub-sample (*i.e.*, .6094 vs. .7991).
- The coefficient vector in the sub-sample closely aligns with the full sample except for the number of rooms which is insignificant.

Full Sample and Midscale/Economy

- The R-squared is noticeably lower for this sub-sample (*i.e.*, .5824 vs. .7991).
- As in the other sub-sample regressions, the number of rooms is insignificant.
- Not surprisingly, variable coefficients that relate more to higher-price hotels are not significant in this regression involving lower-price hotel transaction information. These are, CBD location, landmark, and water proximity. Yet, REIT buyer is significant.

Taken together, the consistency of coefficient estimates for non-property variables – NOI and C - across chain scale regressions outweigh differences among the property variables, many of which are explained by intuition. The robustness check generally validates our model construction, and adds insights. Notably, City NOI has a larger influence on hotel pricing among the higher quality chain scales. The effect of size, albeit small in the regression with aggregate data, disappears in the chain scale regressions.

[Insert Table 5, 6, and 7 Here]

VI. *Conclusion: Property, City, and National Market Pricing Effects*

Hedonic studies of commercial real estate pricing that report the relative importance of property characteristics (*i.e.*, physical and location), local market economics, and national financial conditions have focused on accounting for variations in the capitalization rate rather than in transaction prices. These studies offer conflicting conclusions. Sivitanidou and Sivtanides (1999) and McDonald and Dermisi (2008), for example, find that property attributes and local economics are the most important drivers of capitalization rate variation. In contrast, Ghysels Plazzi, and Valkanov (2007) and Chervachidze and Wheaton (2013) place the majority of weight on macroeconomic conditions. The hotel transaction price data we analyze are suited for answering the question because of the absence of lease frictions that would impede the incorporation of local and national economic effects into prices.

Our model uses local market net rents and capitalization rates together with property attributes. This construction gives us the ability to estimate and differentiate among a diverse set of CRE transaction price determinants. Stated differently, organizing potential determinants of CRE prices along the lines of three main effects: (1) property net rental (*i.e.*, property characteristic proxies) (2), city market net rental, (3) the city and national capital market allows us to access the relative contributions of systematic (*i.e.*, city and national) and unsystematic (*i.e.*, property) value determinants. Given that the variables in our model collectively account for both numerator and denominator effects of the present value model, all of the variables are economically; and statistically important. Variation in CRE prices should be explained by systematic economic factors in the city and nation as well as property specific attributes that fundamentally relate to cash flow generation. This is analogous to modeling stock returns of a particular company as a function of an overall market effect, an industry effect, and an idiosyncratic factor associated with the firm. In this context, academic debates regarding the relative importance of property and macroeconomic forces on property values seem less meaningful.

Because we use transaction information along with incomes and interest rates in our model, this manifestation of the hedonic model reflects both comparable sales and income capitalization perspectives on property pricing in line with modern appraisal practice and ideas about price and value relationships in equilibrium dating back to Alfred Marshall in the mid 1800s.

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Table 1: Descriptive Statistics for Hotel Property Transaction Sample.

Panel A - Statistics for Selected Continuous Variables

Variable	Symbol	N	Mean	σ	Minimum	Maximum
Sale Price	P	623	$31.3 M	$55.1M	$1.6M	$575.0M
Number of Rooms	RM	623	184	158	21	1348
3M Number of Employees	NEMP	623	6013	12518	17	54402
Effective Age	EA	623	15	20	1	113
City NOI	NOIC	623	$574,535	$708,127	$30,167	$5,251,023
Capitalization Rate	C	623	8.47%	0.06%	5.60%	9.70%

Panel B - Statistics by Categorical Variables

			Sale Price			
Category	**Symbol**	**N**	**Mean**	**σ**	**Minimum**	**Maximum**
Market Segment						
Luxury	LUX	28	$105M	$111.1M	$8M	$575M
Upper Upscale	UUPS	112	$79.9M	$88.3M	$5.1M	$440M
Upscale	UPS	175	$25.4M	$21.7M	$2.9M	$123M
Upper Midscale	UMID	79	$14.8M	$19.5M	$2.8M	$130M
Midscale	MID	134	$11.1M	$11.8M	$2.5M	$73M
Economy	ECO	95	$5.5M	$4.4M	$1.6M	$34M
CBD Location= 1	DCBD	153	$70.3M	$81.7M	$2M	$440M
CBD Location = 0		470	$18.6M	$34.8M	$1.6M	$575M
REIT Buyer = 1	DREIT	156	$37.7M	$46.3M	$1.7M	$440M
REIT Buyer = 0		467	$29.2M	$57.6M	$1.6M	$575M
Landmark = 1	DLAND	27	$90.8M	$115M	$6.75M	$440M
Landmark = 0		596	$28.6M	$49.3M	$1.6M	$575M
Water Access = 1	DH2O	80	$59.3M	$91.2M	$2.5M	$575M
Water Access = 0		543	$27.2M	$46.2M	$1.6M	$440M
Gateway City = 1	DGATE	195	$44.6M	$70.9M	$2M	$440M
Gateway City = 0		428	$25.3M	$45M	$1.6M	$575M
Renovated = 1	DRENO	81	$52.6M	$57.4M	$1.6M	$300M
Renovated = 0		542	$28.1M	$54.1M	$1.7M	$575M
Portfolio Sale = 1	DPORT	146	$23M	$22.3M	$1.7M	$145M
Portfolio Sale = 0		477	$33.9M	$61.6M	$1.6M	$575M
Year of Sale						
2005	T05	115	$30.1M	$63.9M	$2.8M	$424M
2006	T06	100	$42.7M	$69.1M	$2.5M	$440M
2007	T07	179	$27.3M	$56.3M	$1.6M	$575M
2008	T08	108	$25.4M	$43.2M	$2.5M	$367M
2009	T09	37	$21.8M	$29M	$1.6M	$123M
2010	T10	84	$39.6M	$39.1M	$2M	$166M

Note: This table presents the descriptive statistics for a sample of 623 hotel real estate sales in the U.S. that occurred from 2005 through 2010.
Sources: Costar, Moody's Analytics, PKF Hospitality Research, Real capital Analytics, and Smith Travel Research.

Table 2: One-Stage OLS Results, All Hotels

Model		I		II		III		IV	
Dependent Variable		P		ln(P)		ln(P)		ln(P)	
Right-Side Variable Label	Name	Coefficient	t	Coefficient	t	Coefficient	t	Coefficient	t
ln(NOIC)	City NOI					.4653*	15.51	.1358*	4.10
ln(C)	Capitalization Rate					-.9430*	-21.33	-.5269*	-7.70
RM	Number of Rooms	186689*	16.12	.0024*	13.81			.0007*	2.43
EA	Effective Age at Date of Sale	17068	0.08	-.0084*	-2.46			-.0087*	-2.67
EA^2	Effective Age Squared	-2563	-1.02	.0001	1.19			.0001	1.56
NEMP	3M Number of Employees	34072*	7.78	.0006*	8.43			.0004*	6.47
DCBD	CBD Location	-3466718	-0.75	.2068*	2.91			.2978*	4.33
DGATE	Gateway City	8297052*	2.62	.2970*	6.10			.2149*	4.10
DLAND	Landmark Hotel	2.53e+07*	3.38	.2546*	2.20			.3278*	2.99
DH2O	Water Location	1.73e+07*	3.9	.3837*	5.62			.4088*	6.33
DRENO	Recently Renovated	-1.09e+07*	-2.36	.1198*	1.68			.0882	1.631
UUPS	Upper Upscale Chain Scale	-3.70e+07*	-4.77	-.4398*	-3.69			-.3714*	-3.24
UPS	Upscale Chain Scale	-5.30e+07*	-6.81	-.8254*	-6.89			-.6617*	-5.68
UMID	Upper Midscale Chain Scale	-6.05e+07*	-7.32	-1.2208*	-9.59			-.9675*	-7.42
MID	Midscale Chain Scale	-5.35e+07*	-6.63	-1.3579*	-10.93			-1.0042*	-7.75
ECO	Economy Chain Scale	-5.69e+07*	-6.89	-1.7908*	-14.09			-1.3911*	-10.51
DREIT	REIT Buyer	8681458*	2.20	.3847*	6.34	.4124*	5.84	.3489*	6.07
DPORT	Portfolio Sale	-1052124	-0.29	.1389*	2.46	.0769	1.15	.1268*	2.37
T06	1 = Sold in 2006	7043087	1.43	.2565*	3.37	-.0046	-.05	.1459*	1.99
T07	1 = Sold in 2007	7096943	1.62	.2600*	3.86	-.1960*	-2.40	.1335*	2.04
T08	1 = Sold in 2008	2641751	0.54	.2024*	2.71	-1398	-1.53	.1299*	1.81
T09	1 = Sold in 2009	-6480796	-0.96	.0079*	0.08	.3270*	-2.56	-.0739	-0.75
T10	1 = Sold in 2010	-5237125	-0.96	.0835	1.00	-2854	-2.75	-.1393*	-1.67
α	Constant	3.15e+07*	3.44	16.53*	117.22	15.44*	220.17	16.32*	114.42
N = 623									
R^2 Adj.		.5898		.7731		.6508		.7975	
RMSE		3.5e+07		.5437		.6746		.5136	

Notes: This table presents the results from regressing property characteristics, date-of-sale, and present value variables on hotel transaction prices with alternative functional forms. * Significant at .10 or better.
Sources: CoStar, Moody's Analytics, PKF Hospitality Research, Real Capital Analytics, and Smith Travel Research.

Table 3: Correlations and Elasticity Estimates

Panel A: Correlation Matrix – Selected Variables in All Hotels Regressions

Variable	P	NOI	C	RM	EA	NEMP	DCBD	DGATE	DREIT	DLAND	DH20	DRENO	DPORT	UUPS	UPS	UMID	MID	ECO
P	1																	
NOIC	.45	1																
C	-.35	.20	1															
RM	.66	.26	-.57	1														
EA	-.02	.07	.17	-.06	1													
NEMP	.35	.46	-.03	.09	.09	1												
DCBD	.40	.28	-.14	.32	.32	.6	1											
DGATE	.21	.45	.01	.04	.04	.37	.25	1										
DREIT	.07	.08	-.15	-.07	-.01	.03	.07	-.01	1									
DLAND	.23	.09	-.05	.13	.13	.15	.27	.14	.01	1								
DH20	.20	.06	-.03	.18	.18	-.03	.03	-.04	-.07	-.01	1							
DRENO	.14	.09	-.18	.26	.26	.01	.12	.01	-.05	.03	.12	1						
DPORT	-.08	.01	-.04	-.12	-.12	-.05	-.10	-.02	.28	-.06	-.08	-.11	1					
UUPS	.41	.27	-.36	.53	-.04	.07	.22	.09	.02	.13	.13	.34	-.05	1				
UPS	-.06	.13	-.08	-.09	-.16	-.04	-.04	-.01	.30	-.02	.06	-.10	.24	-.29	1			
UMID	-.11	-.16	-.01	-.05	.06	.02	-.07	-.04	-.19	-.01	-.04	-.05	-.18	-.18	-.23	1		
MID	-.19	-.25	.17	-.02	-.13	-.05	-.17	-.09	.02	-.11	-.12	-.17	.06	-.25	-.32	-.20	1	
ECO	-.20	-.18	.34	-.19	.19	-.05	-.05	.01	-.22	-.04	-.06	-.07	-.10	-.19	-.27	-.16	-.22	1

Panel B: Variance Inflation Factors (VIF**)**

Variable	VIF	Variable	VIF
EA	9.52	DCBD	2.05
EA^2	9.28	T10	1.91
DMID	6.57	lnC	1.90
UPS	6.43	T08	1.74
ECO	5.25	T06	1.70
lnNOIC	4.87	DREIT	1.46
UUPS	4.54	T09	1.29
RM	4.49	DRENO	1.21
UMID	4.37	DPORT	1.21
NEMP	2.14	DLAND	1.17
T07	2.07	DH20	1.10
		Mean VIF	3.47

Panel C: Hotel Asset Price Elasticity (ηP**)****

Variable	ηP
NOIC	.0045
C	-.0136
RM	.0209
EA	-.0087
NEMP	.0059

Notes: This table reports correlations and elasticity estimates among variables in the hotel property regression models from Table 2. ** Elasticity only reported for continuous variables because of interpretational difficulty.
Sources: CoStar, Moody's Analytics, PKF Hospitality Research, Real Capital Analytics, and Smith Travel Research.

Table 4: Two-Stage LS Results, All Hotels

Dependent Variable		**ln(P)**	
Right Side Variable Label	**Name**	**Coefficient**	**z**
ln(NOIC)	City NOI	.2239*	7.74
ln(C)	Capitalization Rate	-.5195*	-7.66
RM	Number of Rooms	.0006*	2.28
EA	Effective Age at Date of Sale	-.0079*	-2.46
EA^2	Effective Age Squared	.0001	1.42
NEMP	3M Number of Employees	.0001*	6.59
DCBD	CBD Location	.3222*	4.74
DLAND	Landmark Hotel	.3641*	3.36
DH2O	Water Location	.4014*	6.27
DRENO	Recently Renovated	.0801	1.20
UUPS	Upper Upscale Chain Scale	-.3321*	-2.93
UPS	Upscale Chain Scale	-.6281*	-5.45
UMID	Upper Midscale Chain Scale	-.9133*	-7.12
MID	Midscale Chain Scale	-.9454*	-7.42
ECO	Economy Chain Scale	-1.3349*	-10.26
DREIT	REIT Buyer	.3403*	5.98
DPORT	Portfolio Sale	.1205*	2.27
T06	1 = Sold in 2006	.1298*	1.79
T07	1 = Sold in 2007	.1428*	2.20
T08	1 = Sold in 2008	.1273*	1.79
T09	1 = Sold in 2009	-.0678	-0.69
T10	1 = Sold in 2010	-.1361	-1.65
α	Constant	16.27*	115.24
N	623		
R^2	.7991		
RMSE	.5112		

Notes: This table presents the results from regressing property characteristics, date-of-sale, and present value variables on hotel transaction prices with alternative functional forms. * Significant at .10 or better.
Sources: CoStar, Moody's Analytics, PKF Hospitality Research, Real Capital Analytics, and Smith Travel Research.

Table 5: One- and Two-Stage LS Results, Luxury and Upper Upscale Hotels

Stage		Single		Two	
Dependent Variable		ln(P)		ln(P)	
Right Side Variable Label	Name	Coefficient	t	Coefficient	z
ln(NOIC)	City NOI	.2452*	3.47	.3242*	5.30
ln(C)	Capitalization Rate	-.7205*	-3.90	-.7350*	-4.29
RM	Number of Rooms	.00016	0.34	.0001	0.26
EA	Effective Age at Date of Sale	-.0135	-1.66	-.0128	-1.69
EA^2	Effective Age Squared	.0001	1.16	.0001	1.09
NEMP	3M Number of Employees	.0004*	2.70	.0004*	2.92
DCBD	CBD Location	.3267*	2.35	.3349*	2.60
DGATE	Gateway City	.1503	1.14	N/A	N/A
DLAND	Landmark Hotel	.2433	1.28	.2802	1.62
DH2O	Water Location	.3426*	2.52	.3809*	2.56
DRENO	Recently Renovated	.0411	0.37	.0379	0.36
DREIT	REIT Buyer	.3241*	2.22	.3122*	2.32
DPORT	Portfolio Sale	.0045	0.03	-.0151	-0.11
T06	1 = Sold in 2006	.2038	1.14	.1940	1.16
T07	1 = Sold in 2007	.2904	1.62	.3087*	1.88
T08	1 = Sold in 2008	.2581	1.21	.2766	1.41
T09	1 = Sold in 2009	-.1939	-0.74	-.1742	-0.72
T10	1 = Sold in 2010	-.1431	-0.69	-.1097	-0.58
α	Constant	15.82*	72.33	15.73*	77.14
N = 140					
R^2	Adjusted	.6020		.6479	
RMSE	Root Mean Square Error	.6023		.5644	

Note: This table presents the results from regressing property characteristics, date-of-sale, and present value variables on luxury and upper upscale hotel transaction prices using both single- and two-stage models. * Significant at .10 or better.
Sources: CoStar, Moody's Analytics, PKF Hospitality Research, Real Capital Analytics, and Smith Travel Research.

Table 6: One- and Two-Stage LS Results, Upscale and Upper Midscale Hotels

Stage		**Single**		**Two**	
Dependent Variable		**ln(P)**		**ln(P)**	
Right Side Variable Label	**Name**	**Coefficient**	**t**	**Coefficient**	**z**
ln(NOIC)	City NOI	.2127*	4.50	3081*	7.82
ln(C)	Capitalization Rate	-.5563*	-3.60	-.5799*	-3.88
RM	Number of Rooms	.0001	0.00	-.0002	-0.27
EA	Effective Age at Date of Sale	-.0120*	-2.29	-.0118*	-2.32
EA^2	Effective Age Squared	.0001*	2.04	.0001*	2.10
NEMP	3M Number of Employees	.0003*	2.69	.0003*	2.70
DCBD	CBD Location	.4802*	4.31	.5001*	4.65
DGATE	Gateway City	.2029*	2.38	N/A	N/A
DLAND	Landmark Hotel	.3669*	1.86	.3649*	1.90
DH2O	Water Location	.6263*	6.18	.6389*	6.51
DRENO	Recently Renovated	.2232*	1.77	.2195*	1.80
DREIT	REIT Buyer	.3930*	4.64	.3812*	4.67
DPORT	Portfolio Sale	.1539*	1.93	.1403*	1.82
T06	1 = Sold in 2006	.1874	1.65	.1569	1.42
T07	1 = Sold in 2007	.1539	1.51	.1310	1.32
T08	1 = Sold in 2008	.0878	0.80	.0656	0.61
T09	1 = Sold in 2009	.1526	0.86	.1450	0.84
T10	1 = Sold in 2010	-.0454	-0.35	-.0917	-0.73
α	Constant	15.48	116.78	15.49*	121.23
N = 254					
R^2	Adjusted	.5911		.6094	
RMSE	Root Mean Square Error	.5215		.5087	

Note: This table presents the results from regressing property characteristics, date-of-sale, and present value variables on upscale and upper midscale hotel transaction prices using both single- and two-stage models. * Significant at .10 or better.
Sources: CoStar, Moody's Analytics, PKF Hospitality Research, Real Capital Analytics, and Smith Travel Research.

Table 7: One- and Two-Stage LS Results, Midscale and Economy Hotels

Stage		Single		Two	
Dependent Variable		ln(P)		ln(P)	
Right Side Variable Label	Name	Coefficient	t	Coefficient	z
ln(NOIC)	City NOI	.0424	0.66	.1750*	3.23
ln(C)	Capitalization Rate	-.5013*	-3.13	-.5185*	-3.36
RM	Number of Rooms	-.0002	-0.14	-.0005	-0.38
EA	Effective Age at Date of Sale	-.0112*	-2.29	-.0105*	-2.25
EA^2	Effective Age Squared	.00002	0.29	.00002	0.34
NEMP	3M Number of Employees	.0005*	4.40	.0005*	4.35
DCBD	CBD Location	.1665	1.23	.1987	1.53
DGATE	Gateway City	.1952*	2.33	N/A	N/A
DLAND	Landmark Hotel	-.0811	-0.23	-.0521	-0.16
DH2O	Water Location	.1361	1.03	.1329	1.04
DRENO	Recently Renovated	-.0807	-0.51	-.0940	-0.61
DREIT	REIT Buyer	.5230*	4.90	.5066*	4.92
DPORT	Portfolio Sale	.2067*	2.34	.2185*	2.56
T06	1 = Sold in 2006	.1173	0.91	.0462	0.37
T07	1 = Sold in 2007	.0012	0.01	-.0461	-0.46
T08	1 = Sold in 2008	.1278	1.13	.0611	0.56
T09	1 = Sold in 2009	-.1335	-0.92	-.1748	-1.24
T10	1 = Sold in 2010	-.1659	-1.09	-.2042	-1.39
α	Constant	15.45*	97.91	15.49*	102.28
N = 229					
R^2	Adjusted	.5607		.5824	
RMSE	Root Mean Square Error	.4734		.4606	

Note: This table presents the results from regressing property characteristics, date-of-sale, and present value variables on midscale and economy hotel transaction prices using both single- and two-stage models. * Significant at .10 or better.
Sources: CoStar, Moody's Analytics, PKF Hospitality Research, Real Capital Analytics, and Smith Travel Research.