Selling Prices/Sq. Ft. of Office Buildings in Downtown Chicago—How Much Is It Worth to Be an Old But Class A Building?

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Abstract

This paper examines office building sales in downtown Chicago for the period 1996 to 2007. Our analysis provides a conventional OLS approach and an exploration of spatial dependence. We find some evidence of spatial lag and spatial autocorrelation in our dataset but the results are similar to the OLS approach. The results indicate that high occupancy is a statistically significant factor only for Class B properties, suggesting that a low occupancy rate is a negative sign for these buildings of lower quality. Class A property receives a 44% price/sq. ft. boost due to the premium classification. This increase becomes more pronounced (90%) for floor plate efficient, neoclassical/revival façade and/or famous Class A properties built before 1972 when the comparison is with Class B properties of the same age.

The general belief among real estate academicians and practitioners is that Class A office properties transact at higher prices per square foot compared to Class B and C buildings because Class A denotes higher overall quality. This expectation is more evident among newly constructed Class A properties but the question becomes: What happens to older Class A properties? The unique aspect of this study is the investigation of the above question when accounting for office property characteristics and location. The data set consists of all known sale transactions of Class A and B office buildings that took place in downtown Chicago from 1996 through 2007. The paper offers the most detailed hedonic study of office building selling prices per square foot to date. The study shows that the classification of an older building (built before 1972) as Class A adds appreciably to the selling price/sq. ft.—even after controlling for numerous characteristics of the building. These buildings that were built before 1972 but are Class A include efficient floor plates, in some cases neoclassical/revival exterior façades (e.g., Rookery building, also a historic landmark) and three famous Chicago buildings (Hancock Place, Aon Center, and the Prudential Building).

Literature Review

The published literature on the selling prices of nonresidential real estate includes several hedonic studies of industrial real estate, surveyed by Benjamin, Zietz, and Sirmans (2003). McDonald and Yurova (2006, 2007) are more recent studies. A study by Dunse, Leishman, Orr, and Watkins (2003) focusing on office markets suggested that agent knowledge is also a significant contributing factor in office values. The most detailed hedonic study of commercial (i.e., retail) real estate selling prices is Man (1995). There are few published hedonic studies of office building selling prices in relationship with building and other location characteristics; Jones and Dunse (1998) found a statistically significant relationship between commercial values and property features; Colwell, Munneke, and Trefzger (1996) focus on the Chicago metropolitan area from 1986 to 1993 and find a similar relationship between total selling prices and building characteristics. Shilton and Zaccaria (1994) focus on mid-town Manhattan from 1980 to 1990, analyzing the effect of avenues and landmarks on increased building value. Sivitanidou (1996) focuses on the Los Angeles metropolitan area during 1993 and the relationship between assessed value per unit of land and building characteristics. Grissom, Wang, and Webb (1991) focus on four Texas cities conducting also a spatial analysis of office building rates of return. Another set of studies focuses on returns to office building investment based on the data provided by the National Council of Real Estate Investment Fiduciaries (NCREIF) (Geltner and Pollakowski, 2006). Smith, Woodward, and Schulman (2000) use Russell-NCREIF Index with the goal of analyzing the effect of the Tax Reform Act of 1986 on office property values among different regions of the U.S.

The econometric studies of office rents are more numerous. Slade (2000) analyzes rent determinants during different phases of the market cycle (considering certain property characteristics); Gat (1998) focuses on both accessibility to certain sites and quality of architecture in Tel Aviv. Doiron, Shilling, and Sirmans (1992) use a theoretical equilibrium model between developers and tenants with a practical application on office building data that included property characteristics. Four studies of office rents focus on Chicago in relationship to property characteristics: Hough and Kratz (1983), Brennan, Cannady, and Colwell (1984), Mills (1992), and McDonald (1993).

Another set of studies focus on property pricing by asset class and on property depreciation. Chen, Hudson-Wilson, and Nordby (2004) studied real estate pricing through the lens of different investment alternatives and the relationship between "property market fundamentals, pricing and capital markets." Orr, Dunse, and Martin (2003) studied the relationship between asking price rents and time-on-the-market for Scottish commercial properties accounting for property characteristics and market conditions. The studies focusing on property depreciation focus on property characteristics, their obsolescence, as well as general economic conditions (Salway, 1986; Baum, 1989, 1993, 1994; Dubben and Sayce, 1991; and Van Manen, 1993).

The studies cited above have produced some consistent results. Office building value and rent are significantly related to location, building age (negative effect), size of footprint of the building or typical floor size (positive effect), height (positive effect), and parking in the building (positive effect). Beyond the above empirical studies, a study by Lai, Vandell, Wang, and Welke (2008) develop a theoretical valuation model (replication method) for all types of real estate and compare it to the grid and regression methods. Their main goals were to ''reduce the subjectivity in the valuation process on the one hand, while accommodating the inherent data constraints present on the other.''

Description of the Data

The data set contains all the Class A and B office building transactions that occurred in downtown Chicago from 1996 through 2007 complemented by building/location characteristics and national/local economic trends (building locations shown in Exhibit 1). The transaction data were compiled by combining the sales data provided by Bob Six, Senior Vice President of Zeller Realty Group and MB Real Estate market reports. The overall office market trends and property characteristics were extracted from the CoStar Group database and the economic data (financial sector employment) were obtained from the Bureau of Labor Statistics.

The transaction portion of the data set consists of selling price per square foot[1] and sale quarter information for the 203 transactions (86 Class A and 117 Class B). The 203 transactions represent 138 unique buildings; 68 transacted only once and 70 transacted multiple times during the study period (Exhibit 2). The 203 transactions also include 192 non-portfolio and 11 portfolio transactions (Exhibit 2). The portfolio transactions usually include two properties, with the exception of the major sale of seven Blackstone Group properties (former Equity Office properties) in 2007 to Tishman Speyer. The number of transactions and the mean selling price per square foot ($2007) for each year are shown in Exhibit 3. The table reports means weighted by building rentable area and with weights for each building equal to 1.0. The average selling price per square foot for the overall data set is $190.07/sq. ft. (non-weighted by building size) and $208.77/sq. ft. (weighted). Prices/sq. ft. were generally lower in the years 1996 to 2001, and the increase that took place in 2002 was maintained through 2007 (Exhibit 3). The transaction volume also increased in recent years, with a record high of 35 recorded in 2006 (Exhibit 3). The overall condition of the downtown office market is measured by the downtown vacancy rate from CoStar Group (Exhibit 3). The vacancy rate was relatively low (under 10%) during 1996 to 2000, and then increased steadily to 16.2% in 2005. The vacancy rate declined to 12.7% in 2007 (12.0% in the third quarter of 2007).

The property-specific characteristics used in the study include: building age (Exhibit 4), footprint, parking, restaurant facilities, banking facilities, renovation (for old buildings), and other amenities. Although Exhibit 3 shows the unique

Exhibit 1 | Study Area Map with Buildings Being Transacted

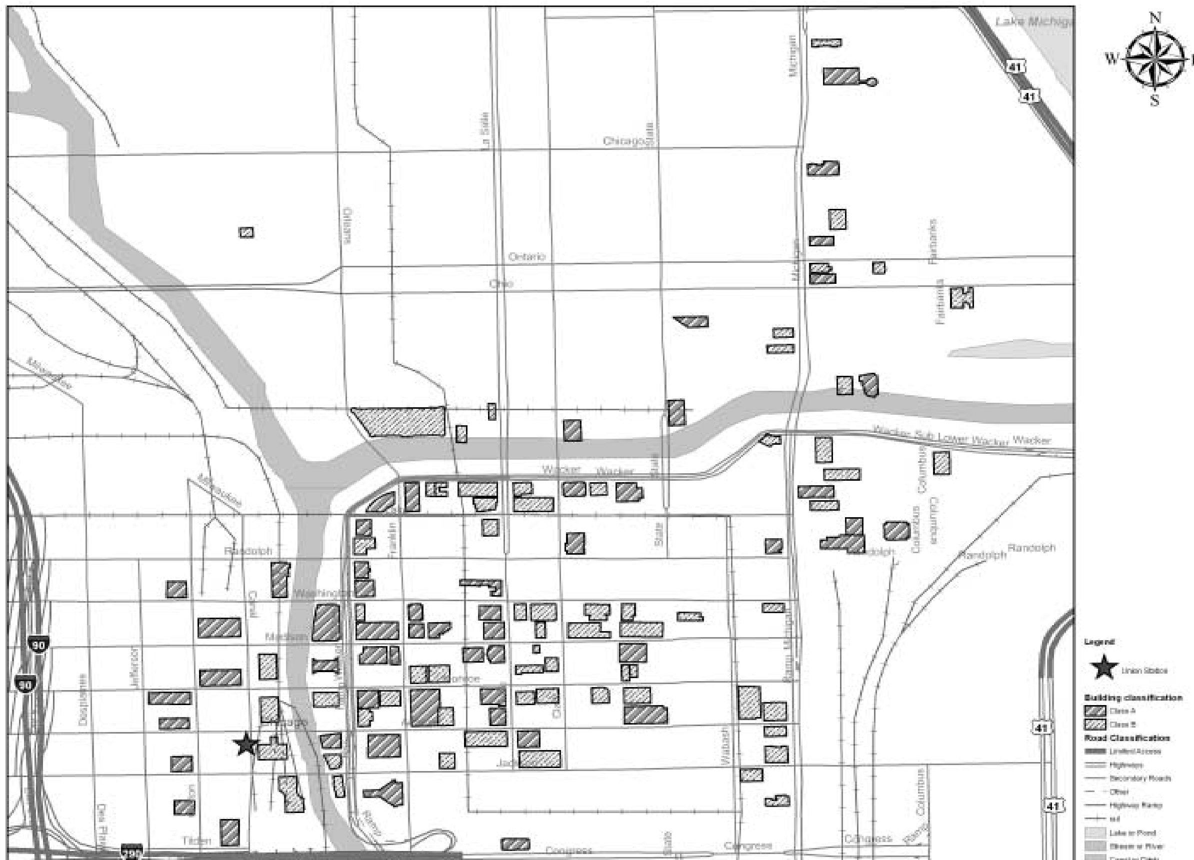


Exhibit 2 | Data Set Overview

Transaction(s)	Unique Properties	Transactions (w/o Portfolios)	Portfolio Transactions	Total Transactions
One	68	60	4	64
Two	52	75	7	82
Three	15	44	0*	44
Four	2	8	0	8
Five	1	5	0	5
Total	138	192	11	203

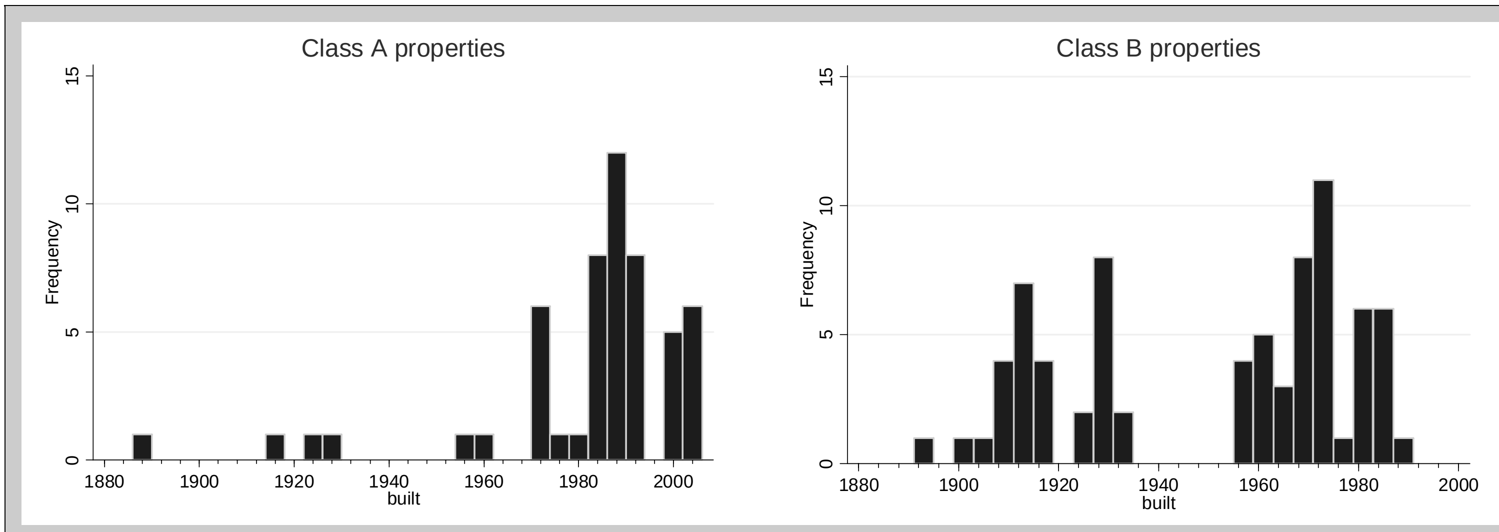
Note:
*One of the three transactions of a property was part of a large portfolio that transacted twice and was taken into accounted under that option.

Exhibit 3 | Number of Transactions and Mean Selling Prices/Sq. Ft.

Year	Transactions	Mean Selling Price Per Sq. Ft. ($2007)[a]	Mean Selling Price Per Sq. Ft. ($2007)[b]	Downtown Vacancy Rate[a]	Downtown Vacancy Rate[b]
1996	6	$146.33	$185.99	10.2%	10.2%
1997	8	$178.62	$236.87	9.3%	9.2%
1998	20	$199.75	$179.99	8.2%	8.2%
1999	10	$172.60	$191.32	8.4%	8.3%
2000	15	$155.33	$181.08	9.2%	8.8%
2001	16	$160.62	$168.49	12.7%	12.6%
2002	18	$197.83	$217.24	14.5%	14.5%
2003	17	$192.24	$210.67	15.2%	15.2%
2004	21	$191.92	$223.23	15.9%	15.9%
2005	19	$193.00	$197.10	16.3%	16.2%
2006	35	$207.20	$227.12	14.4%	14.3%
2007	18	$215.44	$237.10	13.0%	12.7%
Total	203	$190.07	$208.77	12.9%	12.7%

Note:
[a] Not weighted by rentable building area.
[b] Weighted by rentable building area.

Exhibit 4 | Age Distribution of Class A & B Properties*



* All properties were counted only once regardless of the number of transactions.

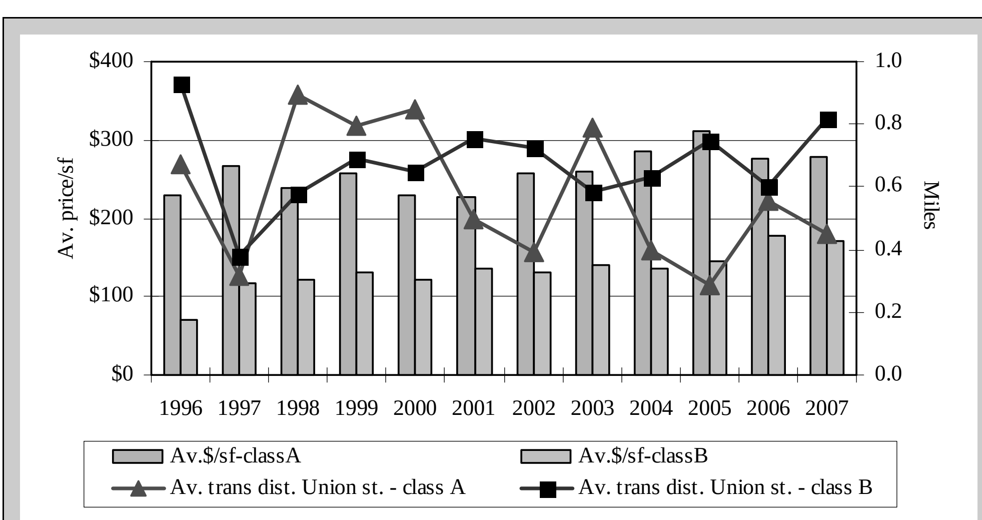
count distribution of the building ages in the data set, it clearly indicates the overlap of Class A and B properties throughout the year scale used. Considering the significance of property location in the determination of its transaction value, dummy variables were used to identify property location in the Loop area or beyond. Additionally, the distance between each property and the main commuter train station (Union Station) was determined (Exhibit 5).

Methodology

The development of a detailed data set with transaction values, property characteristics, and economic conditions allows for a holistic approach in investigating the determinants of a property's transaction price/sq. ft. In addition to the variables[2] obtained directly from the various sources, six were generated to achieve a better understanding of the determinants of sales price/sq. ft. Building age was generated as 2007 minus the year build of the building. Distance from Union Station was generated because of the thousands of workers commuting on a daily basis using the Haversine[3] Formula. Exhibit 5 shows the average price/sq. ft. distribution of buildings sold during the sample period accounting for their average distance from Union Station. On average, prices/sq. ft. appear to be higher closer to Union Station for Class A properties. Class B properties have lower prices/sq. ft. compared to Class A, and there is no apparent relationship between average price per sq. ft. and average distance to Union Station.

A dummy variable for older Class A properties was generated by identifying benchmark years based on the data set. As a next step, the relationship between

Exhibit 5 | Average Annual Transaction Price per Sq. Ft. ($2007) and Distance from Chicago's Union Station: Class A & B Properties



the dummy variables and the transaction price per square foot was investigated keeping all else constant. The testing of various benchmark years led to the selection of buildings built before 1972 and classified as A as a variable in the model because of the stability of the results. The variable included 11 buildings; four of which transacted once, six transacted twice, and one transacted three times. Some of the buildings included are among Chicago's most famous because of their exterior façade or their height (e.g., Rookery, Hancock Place, Aon Center, and the Prudential Building). Other buildings just had efficient floor plates. Ten of the 11 buildings have been renovated; the exception is Aon Center, which was built in 1972.

Another dummy variable was generated to reflect the location of a property in or out of the extended[4] Loop submarket. Two other variables were generated to test the time influence on the data. A linear ''time'' variable was generated that takes values from 1 through 12 based on the year a transaction took place (e.g., 1 = transaction year 1996, 2 = transaction year 1997 etc.). The second time-related variable generated was an interaction between time and property location (in or out of the extended Loop submarket). The time-Loop interaction variable takes values between 0 and 12, with zero representing properties with non-Loop locations.

In the regression analysis, we use two models (Equations 1 and 2). The difference between the two is the addition of the time and time-Loop interaction in the second model (Equation 2).

$$\begin{aligned}\log(psf) = {} & a + a_1 fe + a_2 CBDv + a_3 age + a_4 age^2 \\ & + a_5 cc + a_6 re + a_7 ban + a_8 ns \\ & + a_9 tfs + a_{10} p + a_{11} bo + a_{12} allren \\ & + a_{13} bc + a_{14} du + a_{15} Loop + a_{16} bA + \varepsilon.\end{aligned} \quad (1)$$

$$\begin{aligned}\log(psf) = {} & a + a_1 fe + a_2 CBDv + a_3 age + a_4 age^2 + a_5 cc \\ & + a_6 re + a_7 ban + a_8 ns + a_9 tfs \\ & + a_{10} p + a_{11} bo + a_{12} allren + a_{13} bc + a_{14} du \\ & + a_{15} Loop + a_{16} bA + a_{17} t + a_{18} tl + \varepsilon.\end{aligned} \quad (2)$$

Where *psf* is the price/sq. ft. of the transacted property in 2007 dollars (real price/sq. ft.) or the transaction price/sq. ft. at the time of sale (nominal price/sq. ft.); *fe* is the financial employment; *CBDv* is the CBD vacancy at the quarter a specific transaction took place; *age* is the building age of the building; *cc* is the a dummy variable that takes the value 1 if the building includes a conference center and 0 if it does not; *re* is a dummy variable that takes the value 1 if the building includes restaurant facilities and 0 when it does not; *ban* is the a dummy variable that takes the value 1 if the building includes banking services; *ns* is the number of stories in a building; *tfs* is the typical floor size of a building; *p* is a dummy variable that takes the value 1 if the building includes a parking facility and 0 if id does not; *bo* is the building occupancy at the time of sale; *allren* is a dummy variable that takes the value 1 if the property has been renovated in the past regardless of year built; *bc* is a dummy variable that takes the value 1 if the building is Class A or otherwise it takes the value 0; *du* is the distance of each transaction from Union Station; *Loop* is a dummy variable that equals 1 if the property is located in the extended Loop submarkets and 0 if not; *bA* is a dummy variable that equals 1 if the building was built before 1972 and is classified as Class A or otherwise it takes the value 0; *t* is a linear time variable; and *tl* is an interaction variable between time and location (Loop vs. non-Loop).

We test the significance of the variables in the two equations in multiple ways. Exhibit 6 includes the first set of models using the real prices/sq. ft. as the dependent variable and all the properties regardless of their classification (A and B). In column 1, the basic model (Equation 1) is tested for heteroscedasticity (White's test); in column 2, Equation 1 is applied with the use of robust standard errors; in column 3, Equation 1 is applied but all observations are weighted by each building's rentable building area; in column 4, Equation 2 is applied. Finally, column 5 provides the results of a multicollinearity test.

The dependent variable used in all models in Exhibit 7 is the real price/sq. ft; columns 1 and 2 include the results of Equation 1 for Class A and B properties respectively. Columns 3 and 4 include the results of Equation 2 for Class A and B properties respectively.

The dependent variable in Exhibit 8 is the nominal price/sq. ft. The goal in using the actual values at the time of sale is to identify any differences in the significance of the independent variables. Columns 1–3 include the results of Equation 1 for all buildings, Class A and B. Columns 4–6 include the results of Equation 2 for the same type of building groups.

Due to the close proximity of the properties in the transaction data set, a possibility of spatial autocorrelation exists. Although some spatial autocorrelation is expected because 70 properties transacted multiple times during the study period, additional analysis is presented in Exhibit 9. The test for residual spatial dependence is based on Anselin and Hudak (1992) and Pisati (2001) procedure. Before conducting spatial diagnostic tests, a spatial weight table was developed. This weight table is based on the total number of transactions and each property is compared to itself and every other property in the data set. If a property is in the extended Loop submarket then it takes a value 1 if not 0. In Exhibit 9, columns 1 through 3 present the results of Equation 1 (without the Loop vs. non-Loop variable) and columns 4 and 5 present the results of Equation 2. Column 1 includes five[5] spatial diagnostic tests (spatial error dependence and spatial lag dependence). The mixed diagnostic results to the inclusion of a spatial error model (columns 2) and spatial

Exhibit 6 | Regression Analysis of Selling Price per Square Foot

Independent Variable	1 Basic Model	2 Final Model[a]	3 Weighted by Building Size	4 T/L Model	5 Variance Inflation Factors (VIF)[b]
Financial employment	0.015 (4.91)	0.016 (4.80)	0.013 (5.18)	0.004 (0.71)	1.61
CBD vacancy	0.002 (0.33)	0.003 (0.39)	0.001 (0.17)	−0.013 (−1.30)	1.68
Age of building	−0.018 (−4.38)	−0.018 (−4.76)	−0.023 (−7.52)	−0.017 (−4.51)	37.71
Age squared	0.0001 (3.18)	0.0001 (3.23)	0.0001 (5.28)	0.0001 (2.98)	32.37
Conference rooms	−0.060 (−1.35)	−0.061 (−1.31)	−0.060 (−1.62)	−0.067 (−1.42)	1.39
Restaurant	0.083 (1.68)	0.083 (1.43)	0.088 (1.50)	0.077 (1.35)	1.30
Banking in building	−0.016 (−0.37)	−0.016 (−0.32)	−0.028 (−0.78)	−0.020 (−0.42)	1.41
Number of stories	0.003 (2.13)	0.003 (2.02)	0.004 (4.51)	0.002 (1.81)	1.66
Floor size—typical	4.33e-07 (0.42)	4.33e-07 (0.33)	1.91e-06 (2.87)	2.97e-07 (0.24)	1.26
Parking in building	0.107 (2.28)	0.108 (2.10)	0.124 (2.78)	0.104 (2.07)	1.62
Occupancy rate	0.780 (5.62)	0.780 (3.30)	0.957 (4.74)	0.801 (3.48)	1.27
Renovated building	0.143 (2.95)	0.143 (2.98)	0.131 (3.33)	0.132 (2.87)	1.73
Class A building	0.364 (5.49)	0.365 (5.81)	0.250 (4.32)	0.371 (5.96)	3.18
Distance to Union Station	−0.011 (−0.16)	−0.012 (−0.14)	−0.073 (−1.13)	0.021 (0.27)	2.36
Class A, built before 1972	0.280 (2.68)	0.280 (2.33)	0.235 (3.05)	0.280 (2.24)	1.95
Loop vs. non-Loop location dummy	−0.118 (−1.67)	−0.119 (−1.29)	−0.092 (−1.23)		2.08
Time				0.046 (2.48)	
Time with Loop interaction				−0.008 (−0.92)	

Exhibit 6 | (continued)

Regression Analysis of Selling Price per Square Foot

	1	2	3	4	5
Independent Variable	Basic Model	Final Model[a]	Weighted by Building Size	T/L Model	Variance Inflation Factors (VIF)[b]
Constant	−0.575	−0.575	0.229	2.980	
	(−0.56)	(−0.54)	(0.28)	(1.52)	
R^2	0.7110	0.734	0.7951	0.7388	

Notes: The dependent variable is the natural log of real price per square foot. *T*-values are in parentheses. The sample size for all models is 203. The chi square for the basic model is 182.23 and the *p*-value is .0095.

[a] Model corrected for heteroscedasticity (robust model).

[b] Variance Inflation Factors (Multicollinearity test) for final model of column 2 (values around 1 indicate absence of multicollinearity. VIF greater than 10 indicates the presence of multicollinearity (in our case this is expected between age and age squared).

lag mode (column 3). A spatial diagnostic test was also performed (spatial error dependence and spatial lag dependence) that considered a property's transaction year (variable: time − linear trend) and an interaction variable of time and the location of a transacted property (all properties were grouped by Loop vs. non-Loop) (column 4). Because the Moran's I was dropped, only the spatial lag model was run (column 5), although the results showed no spatial autocorrelation.

The underlying spatial autocorrelation model used in Exhibit 9 (Anselin and Hudak, 1992; Pisati, 2001) is as follows:

$$Y = \rho W y + X\beta + \varepsilon,$$

where $\varepsilon = \lambda W \varepsilon + \mu$. W is a symmetric $n \times n$ (203×203 in this case) weight matrix; λ denotes the spatial autoregressive parameter (spatial error model); μ denotes a vector of homoscedastic and uncorrelated errors; and ρ denotes the spatial autoregressive parameter (spatial lag model)

Empirical Results

The empirical results of the econometric modeling provide an in-depth analysis of the Chicago downtown market in the past 10 years. The first set of results (Exhibit 6) focuses on the relationship between sale prices/sq. ft. (in 2007 values)

Exhibit 7 | Regression Analysis of Selling Price per Square Foot

	1	2	3	4
	Final Model	Final Model	T/L Model	T/L Model
Variable	Class A	Class B	Class A	Class B
Financial employment	0.007 (1.89)	0.021 (5.08)	0.008 (1.35)	0.001 (0.20)
CBD vacancy	−0.001 (−0.22)	0.005 (0.54)	−0.001 (−0.10)	−0.021 (−1.46)
Age of building	−0.019 (−3.76)	−0.010 (−1.19)	−0.020 (−3.95)	−0.007 (−0.84)
Age squared	0.0001 (2.59)	0.0001 (0.71)	0.0001 (2.54)	0.00002 (0.37)
Conference rooms	−0.077 (−1.22)	−0.069 (−1.02)	−0.075 (−1.18)	−0.091 (−1.31)
Restaurant	0.060 (0.58)	0.158 (1.93)	0.067 (0.65)	0.159 (2.01)
Banking in building	0.005 (0.06)	−0.027 (−0.40)	−0.024 (−0.36)	−0.019 (−0.30)
Number of stories	0.002 (1.31)	0.006 (1.94)	0.002 (1.36)	0.007 (2.13)
Floor size—typical	8.43e-07 (0.24)	2.45e-07 (0.17)	9.41e-07 (0.27)	1.18e-07 (0.09)
Parking in building	0.070 (0.85)	0.111 (1.47)	0.042 (0.60)	0.121 (1.67)
Occupancy rate	0.324 (1.58)	0.934 (2.69)	0.326 (1.67)	0.923 (2.85)
Renovated building	0.070 (0.89)	0.116 (1.65)	0.071 (0.86)	0.104 (1.56)
Distance to Union Station	−0.087 (−0.81)	0.070 (0.55)	−0.004 (−0.04)	0.066 (0.57)
Class A, built before 1972	0.359 (2.22)		0.401 (2.63)	
Loop vs. non-Loop location dummy	−0.132 (−0.66)	−0.112 (−0.94)		
Time			−0.003 (−0.20)	0.076 (2.67)
Time with Loop interaction			0.001 (0.17)	−0.014 (−1.21)
Constant	3.222 (2.57)	−2.919 (−2.00)	2.804 (1.46)	3.167 (1.05)

Exhibit 7 | (continued)

Regression Analysis of Selling Price per Square Foot

	1	2	3	4
	Final Model	Final Model	T/L Model	T/L Model
Variable	Class A	Class B	Class A	Class B
R^2	0.4234	0.5544	0.4136	0.5840

Notes: The dependent variable is the natural log of real price per square foot. *T*-values are in parentheses. The sample size for Class A buildings is 86 and is 177 for Class B buildings.

and a number of independent variables representing building characteristics and the downtown office market. The dataset is analyzed as a whole, regardless of building classification (203 sales) and by class; Class A (86 sales) and Class B (117 sales).

Column 1 in Exhibit 6 contains results for the Basic Model, and columns 2–4 show the results for modifications of the Basic Model. The results remain consistent with only three exceptions (all in column 4) when comparing the statistical significance of all independent variables. Exhibit 6 also includes two tests: a heteroscedasticity test (column 1) and a multicollinearity test (column 5). The heteroscedasticity problems are addressed by running all regressions as robust standard errors in columns 2–4. The multicollinearity test (column 5) does not show any evidence of multicollinearity in the Final Model (column 2) with the exception of age, which is expected because the variable is also squared. Focusing on the relationships between the independent and dependent variables of Exhibit 6, the level of employment in the financial sector in the metropolitan Chicago has a strong statistically significant effect. Employment is measured in thousands, and it increased steadily from 305,000 in 1996 to 337,000 in 2007, with brief interruptions in growth in 2002 and 2004. The coefficient of 0.016 (Column 2) means that an increase in financial sector employment of 1,000 produces an increase in selling price/sq. ft. of 1.6%. However, inclusion of the time trend (column 4) eliminates the statistical significance of this employment variable. Another overall market characteristic, the CBD vacancy rate, does not have a statistically significant effect on the transaction price/sq. ft. This lack of relationship indicates that investors are more inclined to acquire properties due to their specific characteristics and occupancy levels rather than the overall market conditions. Property age is a variable expected to have a strong relationship with transaction price/sq. ft. and the results reinforce this expectation. The results indicate that selling price/sq. ft. declines with age more rapidly in the earlier years of the life of a building; −1.8% per year at age zero compared to −1.4% at age 20. A building at age 40 has declined in value by 56% compared to a new building.

Exhibit 8 | Regression Analysis of Selling Price per Square Foot

	1	2	3	4	5	6
	Final Model			T/L Model		
Variable		Class A	Class B		Class A	Class B
Financial employment	0.023 (6.97)	0.014 (3.77)	0.029 (6.93)	0.004 (0.71)	0.007 (1.29)	0.002 (0.24)
CBD vacancy	0.012 (1.70)	0.007 (0.87)	0.015 (1.55)	−0.014 (−1.40)	−0.002 (−0.24)	−0.022 (−1.49)
Age of building	−0.018 (−4.88)	−0.019 (−3.82)	−0.012 (−1.29)	−0.017 (−4.51)	−0.020 (−3.96)	−0.007 (−0.83)
Age squared	0.0001 (3.35)	0.0001 (2.76)	0.0001 (0.82)	0.0001 (2.99)	0.0001 (2.56)	0.00002 (0.35)
Conference rooms	−0.058 (−1.24)	−0.081 (−1.30)	−0.063 (−0.91)	−0.067 (−1.43)	−0.074 (−1.16)	−0.093 (−1.31)
Restaurant	0.088 (1.50)	0.069 (0.68)	0.162 (1.92)	0.080 (1.40)	0.067 (0.65)	0.164 (2.07)
Banking in building	−0.018 (−0.35)	0.008 (0.10)	−0.031 (−0.44)	−0.021 (−0.43)	−0.023 (−0.34)	−0.020 (−0.32)
Number of stories	0.003 (2.13)	0.002 (1.39)	0.006 (1.87)	0.002 (1.83)	0.002 (1.36)	0.007 (2.16)
Floor size—typical	4.19e-07 (0.30)	6.30e-07 (0.18)	2.31e-07 (0.15)	2.74e-07 (0.22)	9.72e-07 (0.28)	9.06e-08 (0.07)
Parking in building	0.103 (1.98)	0.074 (0.89)	0.103 (1.34)	0.102 (2.02)	0.043 (0.63)	0.117 (1.61)
Occupancy rate	0.763 (3.17)	0.275 (1.41)	0.934 (2.64)	0.793 (3.48)	0.323 (1.67)	0.914 (2.84)
Renovated building	0.148 (2.96)	0.074 (0.94)	0.118 (1.62)	0.132 (2.84)	0.070 (0.86)	0.103 (1.53)
Class A building	0.360 (5.60)			0.370 (5.93)		
Distance to Union Station	−0.010 (−0.13)	−0.101 (−0.93)	0.075 (0.58)	0.022 (0.27)	−0.008 (−0.07)	0.069 (0.60)
Class A, built before 1972	0.287 (2.38)	0.366 (2.28)		0.278 (2.23)	0.400 (2.64)	
Loop vs. non-Loop Location dummy	−0.121 (−1.29)	−0.144 (−0.72)	−0.112 (−0.91)			
Time				0.073 (3.90)	0.024 (1.30)	0.102 (3.59)
Time with Loop interaction				−0.009 (−0.96)	0.001 (0.14)	−0.014 (−1.24)
Constant	−3.410 (−3.10)	0.552 (0.43)	−5.832 (−3.95)	2.667 (1.36)	2.621 (1.36)	2.751 (0.92)

Exhibit 8 | (continued)

Regression Analysis of Selling Price per Square Foot

Variable	1 Final Model	2 Class A	3 Class B	4 T/L Model	5 Class A	6 Class B
R^2	0.7414	0.5548	0.5978	0.7575	0.5528	0.6455

Notes: The dependent variable is the nominal price per square foot. *T*-values are in parentheses. The sample size for the Final Model and the T/L Model is 203. The sample size for Class A buildings is 86 and is 177 for Class B buildings.

As other studies have found, the height of the building is associated with a greater selling price/sq. ft., at a level of 0.3%/sq. ft./story. However, while its coefficient is positive as expected, the size of the typical floor does not always produce a statistically significant result. Parking has a positive effect, with a sale price/sq. ft. increase of 11% [exp(0.108)−1], keeping all else constant. The occupancy rate in the building is a proxy for net operating income per square foot, and it produces a very strong effect on selling price per square foot. The results indicate a 1% increase (measured from 0–1.0) in the occupancy rate is associated with a selling price/sq. ft. increase of 0.78%. The data also indicate a positive and significant effect of renovation on sales prices/sq. ft. The renovations increase sales price/sq. ft. by 15% [exp(0.143)−1] keeping all else constant. As expected, the classification of a property as A adds in the transaction value, with the data indicating that the increase is 44% [exp(0.364)−1]. The premium for Class A is even greater for older buildings. Class A properties built before 1972 had 90% [exp(0.365[6] + 0.280)−1] greater selling prices/sq. ft. compared to Class B buildings of the same age. The time variable also shows a positive effect on the transaction prices/sq. ft. of 4.7%.

Exhibit 7 uses again the real prices/sq. ft. as the dependent variable and robust standard errors but it divides the data set by building classification (A and B). The results of column 1 and 3 (Class A properties) remain consistent, although there are differences compared to the results of Exhibit 6, which included all transactions. In Exhibit 7, columns 1 and 3, the transaction price/sq. ft. is affected in a statistically significant manner by property age and buildings built before 1972 and classified as A. The results indicate that older (built before 1972) but Class A properties accomplish price/sq. ft. increases of 36%–40% when keeping all else constant. A Class A building that is 40 years old sold for a price/sq. ft. that was 16%–20% less than a new building (−56% plus 36% or 40%). The lack of significance for other amenity variables such as conference rooms, banking, and number of stories might be caused by the presence of such facilities in almost all the properties in contrast to Class B properties. The absence of a significant

Exhibit 9 | Spatial Autocorrelation Models of Selling Price per Square Foot

Variable	1 Final Model	2 Final Spatial Error Model	3 Final Spatial Lag Model	4 T/L Model	5 Final Spatial Lag T/L Model
Financial employment	0.016 (4.82)	0.015 (5.13)	0.016 (5.20)	0.004 (0.71)	0.004 (0.72)
CBD vacancy	0.002 (0.42)	0.002 (0.35)	0.002 (0.35)	−0.013 (−1.30)	−0.013 (−1.25)
Age of building	−0.018 (−4.73)	−0.018 (−4.58)	−0.018 (−4.56)	−0.017 (−4.51)	−0.017 (−4.37)
Age squared	0.0001 (3.17)	0.0001 (3.32)	0.0001 (3.29)	0.0001 (2.98)	0.0001 (3.06)
Conference rooms	−0.065 (−1.37)	−0.061 (−1.41)	−0.062 (−1.45)	−0.067 (−1.42)	−0.067 (−1.57)
Restaurant	0.079 (1.38)	0.082 (1.74)	0.081 (1.72)	0.077 (1.35)	0.077 (1.64)
Banking in building	−0.030 (−0.60)	−0.016 (−0.40)	−0.022 (−0.54)	−0.020 (−0.42)	−0.020 (−0.50)
Number of stories	0.002 (1.97)	0.003 (2.23)	0.003 (2.21)	0.002 (1.81)	0.002 (2.07)
Floor size—typical	2.62e-07 (0.20)	4.25e-07 (0.43)	3.53e-07 (0.36)	2.97e-07 (0.24)	2.88e-07 (0.29)
Parking in building	0.095 (1.97)	0.106 (2.35)	0.102 (2.25)	0.104 (2.07)	0.104 (2.32)
Occupancy rate	0.791 (3.22)	0.780 (5.87)	0.785 (5.90)	0.801 (3.48)	0.802 (6.08)
Renovated building	0.142 (2.89)	0.143 (3.08)	0.143 (3.08)	0.132 (2.87)	0.132 (2.87)
Class A building	0.368 (5.89)	0.364 (5.73)	0.366 (5.75)	0.371 (5.96)	0.371 (5.88)
Distance to Union Station	0.067 (1.00)	−0.007 (−0.10)	0.024 (0.36)	0.021 (0.27)	0.023 (0.33)
Class A, built before 1972	0.294 (2.39)	0.281 (2.80)	0.286 (2.85)	0.280 (2.24)	0.281 (2.79)
Time				0.046 (2.48)	0.047 (2.26)
Time with Loop interaction				−0.008 (−0.92)	−0.009 (−0.62)
Constant	−0.875 (−0.62)	−0.682 (−0.70)	−4.753 (−1.14)	2.980 (1.52)	3.619 (0.42)

Exhibit 9 | (continued)

Spatial Autocorrelation Models of Selling Price per Square Foot

Variable	1 Final Model	2 Final Spatial Error Model	3 Final Spatial Lag Model	4 T/L Model	5 Final Spatial Lag T/L Model
Spatial Error					
Moran's I—Statistic	4.304				
p-value	0.000				
Lagrange mult.—Stat.	0.509			0.013	
p-value	0.475			0.909	
Rob. Lagr. mult.—Stat.	2.741			2.471	
p-value	0.098			0.116	
Spatial Lag					
Lagrange mult.—Stat.	1.135			0.217	
p-value	0.287			0.641	
Rob. Lagr. mult.—Stat.	3.367			2.675	
p-value	0.067			0.102	
Lambda		0.830 (1.90)			
Rho			0.776 (0.96)		−0.126 (−0.08)
R^2	0.7299			0.7388	
Squared corr.		0.726	0.733		0.738

Notes: The dependent variable is the natural log of real price per square foot. *T*-values are in parentheses. The sample size for all models is 203.

statistical relationship between price/sq. ft. and building occupancy might also be caused by the high occupancy of all of these properties because of their classification. For Class B buildings (columns 2 and 4), the results are more mixed with the inclusion of the time and location variables in column 4. Building occupancy is the most critical explanatory factor of transaction prices/sq. ft. Evidently, buyers of Class B buildings seek occupied buildings. Also, building height and the presence of a restaurant enhance the value of Class B buildings.

The dependent variable in Exhibit 8 is the nominal price/sq. ft., in contrast to Exhibits 6 and 7. The goal in using the nominal transaction value is the comparison of the results with those of Exhibits 6 and 7. The comparison of these tables shows that the results hold for almost all cases. Exhibit 8 includes the results of Equation 1 (columns 1 through 3) and Equation 2 (columns 4 through 6). Columns 1 and 4 include the full extent of the data set (both Class A and B).

Time trend variables are added in column 4 to the Final Model in column 1. The results in both columns (1 and 4) are consistent among each other and with those in Exhibit 6. The results for Class A properties (columns 2 and 5) are also consistent with each other and with those in Exhibit 7. The results for Class B properties (columns 3 and 6) are identical to those in Exhibit 7.

Exhibit 9 provides the results of the spatial autocorrelation tests and models using the real price/sq. ft. as the dependent variable. Columns 1 and 4 carry out five spatial autocorrelation tests. Based on the *p*-value of the reported Moran's I (column 1), the null hypothesis of zero spatial autocorrelation can be rejected but the Lagrange multiplier is giving mixed results on the error autocorrelation and the presence of a spatial autoregressive pattern. Due to these mixed results, spatial error (column 2) and lag models (columns 3 and 5) are included in Exhibit 9. The statistical significance of all the independent variables (columns 2, 3, and 5) is comparable to columns 2 and 4 of Exhibit 6, further reinforcing the initial results of Exhibit 6.

Conclusion

This study of office transactions in downtown Chicago for 1996 to 2007 shows that certain property characteristics (e.g., age, height, occupancy, parking, renovation, and so on) are important determinants of selling price per square foot. The results from the OLS modeling and the spatial autocorrelation models provide almost identical results, further reinforcing the significance of certain property characteristics. Buildings that were newer and had high occupancy rates sold for greater prices per square foot. The effect of building age was more pronounced among Class A buildings and the impact of the occupancy rate of the building had the larger effect on Class B buildings. Sales prices/sq. ft. of Class B buildings seem to be further enhanced by building height and the existence of a restaurant. Office occupancy rate seems to affect price/sq. ft. substantially only in the case of Class B properties. Apparently buyers seek Class B properties with high occupancy rates; a low occupancy rate is considered to be a negative sign for these buildings of lower quality.

A long-standing question among participants in the office market is the effect of building class on selling price/sq. ft. We found that, holding numerous other building features constant, Class A designation increased selling price/sq. ft. by 44% compared to Class B buildings. Furthermore, buildings built before 1972 and still regarded as Class A achieve selling price/sq. ft. that is 90% greater than Class B buildings of the same age and features. In effect, the Class A designation for these buildings largely overcame the negative impact of age. The majority of these buildings are clustered on prominent streets such as Michigan Avenue and LaSalle Street.

Endnotes

[1] Selling prices per square foot were converted in 2007 values using the Consumer Price Index.

[2] The inclusion of building designation as an ENERGY STAR or LEED Certified did not have any significant effect and was not included in the final exhibits. Two other variables were included in preliminary regressions. Elevators divided by the number of floors (and simply the total number of elevators) had no statistically significant effect on selling prices. Also, location within the downtown area produced no statistically significant result. In particular, it was hypothesized that location within the ''West Loop'' area might produce a higher selling price because this is regarded as the ''hot'' location by real estate professionals. However, it turns out that the other variables that measure the features of the building and the state of the market evidently eliminate the West Loop effect.

[3] The distance calculation was based on the longitude and latitude of each building in comparison to that of Union Station and was derived by the Haversine Formula (Sinnott, 1984).

[4] Extended Loop submarket includes the Central, East, and West Loop submarkets [boarders are: Wacker Drive (north), Lake Michigan (east), Congress Road (south) and Jefferson (west)].

[5] The five spatial diagnostic tests include ''three tests for spatial error dependence (Moran's $I\lambda$, simple Lagrange multiplier $LM\lambda$ and robust Lagrange multiplier $LM\lambda^*$) and two tests for spatial lag dependence (simple Lagrange multiplier $LM\rho$ and robust Lagrange multiplier $LM\rho^*$),'' (Pisati, 2001).

[6] The coefficient 0.365 is taken from the Class A dummy variable of Exhibit 6, Column 2. Adding this coefficient to the Class A built before 1972 allows us to identify the selling prices/sq. ft. relationship between Class A and B properties.

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