

Vibrancy and Property Performance of Major U.S. Employment Centers

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Since the turn of the century, the spatial pattern of real property development in the United States has changed. Many central cities across the country have attracted impressive amounts of jobs, residents, and investments compared to their weak status in the 1990s. Although suburban development dominated the metropolitan landscape after World War II, central cities and especially their downtowns have grown faster than their suburbs in numerous areas. Recently, the growth of large cities has slowed, and in some downtowns, the urban revival has begun to stall. Investment appears to be migrating from primary “Gateway cities” to secondary cities.

Often, this changing pattern of development is attributed to the “live-work-play” dynamic driven by Gen Y/Millennial preferences for large urban centers, preferences that may shift to the suburbs or to smaller cities as Gen Y ages. Analysts tracking employment growth and other socio-economic indicators have identified places where the demand for development is on the rise as well as appreciation where supply is constrained. Although such analysis is useful, this article applies the multi-dimensional concept of vibrancy to explain recent property performance. Vibrant places have crosscutting, interactive activities such as working, learning, shopping, dining, entertaining, convening, etc. The concept takes us beyond the city-suburb or



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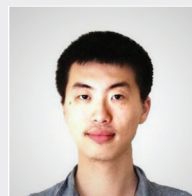
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vibrancy. Chen is also interested in the application of big data analytics in urban studies, including machine learning, computer visioning, and deep learning.

primary-secondary city distinctions with the finer-grained analysis of different types of employment centers in the U.S.

In the following sections, we analyze inventories, rents, and vacancies in 90 employment centers and draw

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conclusions relevant to real estate professionals. Based on this analysis and related previous work, the vibrancy of an employment center predicts performance better than traditional metrics of property demand. Other factors found to be important are stronger employment growth, lower crime rates, and location in the West. Yet, the most compelling take-away from this study is that real estate professionals should keep track of the vibrancy of employment centers. Attention to vibrancy metrics should lead to better-informed decisions.

FOUR CATEGORIES OF EMPLOYMENT CENTERS

Levy and Gilchrist defined 231 major employment centers in the 150 largest U.S. cities carefully delineating mutually exclusive primary downtowns and 81 other employment centers that are combinations of census tracts.¹ The 90 employment centers selected from this study fall into three major groups and two subgroups. The three major groups are primary downtowns, secondary downtowns, and suburban office parks within city jurisdictions. The secondary downtowns are either 1) centers adjacent to or near the CBD and/or anchored by educational and medical facilities or 2) the downtowns of secondary cities located within a metropolitan region that has a larger central city. The breakdown is 48 CBDs, 18 adjacent/anchored centers, 12 secondary-city downtowns and 12 suburban office centers. **Appendix A** lists the centers in each category.

These centers share three characteristics. First, public transit is better in these centers than transit in the average U.S. city.² Second, the centers have relatively high job density. Third, as the largest employment centers in the U.S., they offer advantages attractive to employers. These advantages include 1) sharing infrastructure, 2) matching in labor markets, among suppliers, and to consummate deals, and 3) learning that may increase productivity and innovation. Economists call these positive outcomes associated with size agglomeration economies.³ Real estate investors also prefer larger centers since size associates with stability and mitigates market risk to some extent.

Among the 48 cities, 14 have one adjacent or anchored employment center included in the study in addition to the CBD. LA and New York City have two others: Hollywood and Wilshire/Koreatown in LA and Brooklyn's CBD and Downtown Manhattan in addition to Midtown. Midtown Manhattan is the largest employment center in the country with more than 1.4 million jobs in 2010.

The 12 secondary cities shown in **Appendix A** are within the MSA or Consolidated MSA of one of eight larger cities: Detroit, LA (3), Miami, New York, Raleigh, Phoenix (2), Seattle (2), and Washington, D.C.

The 12 suburban office parks (SOPs) under study should perform better than typical SOPs for three reasons. First, they are located in relatively large metropolitan regions, which should result in more market stability. Second, major companies like Microsoft, Cisco Systems, and Sprint anchor one of these SOPs. Third, they are much larger than typical SOPs found in suburban jurisdictions. The Las Vegas strip is the largest of the 12 SOPs and the seventh largest center in the U.S. with over 300,000 jobs in 2010. It contains more commercial square footage than 36 of the 48 CBDs. On average, the 12 SOPs offer more jobs than the 12 downtowns of the secondary cities.

PERFORMANCE OF EMPLOYMENT CENTERS

CoStar data was used to examine performance in the 90 employment centers. CoStar's proprietary database offers very comprehensive information on property markets across the country.⁴

CoStar data was compiled for the second quarter of 2017 (2Q17) and for the second quarter of 2011 (2Q11). A circle with a radius of one mile around the central point of each center is large enough to capture all or most of the center's geography without infringing on adjacent employment centers under study. Within this area, the center's inventory was measured by aggregating the rentable building area (RBA) for the following property types: office, retail, industrial, flex, hospitality, health care, and multi-family. Data on rents

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Table 1: Total Inventory, Office Vacancy Changes & Office Rent Changes from 2Q11 to 2Q17: Statistics for 90 Employment Centers compared to All Markets

	EMPLOYMENT CENTERS	ALL MARKETS	DIFFERENCE
Inventory Growth	8.09%	3.27%	+4.82%
Office Vacancy Decline	-3.32%	-2.20%	+1.12%
Office Rent Increase	+\$5.60	+\$3.30	+\$2.30

and vacancies were also compiled for all classes of office space in the 90 centers (CoStar’s Class A, B, and C categories).

According to CoStar’s National Market Reports, total RBA in the U.S. for these seven property types was about 38 billion SF in 2Q17. From 2Q11 to 2Q17, the six-year national growth rate of this inventory was 3.27%. Within this timeframe national vacancy rates for all classes of office properties declined from 11.8% to 9.6%; average asking rents for office space increased from \$21.10 to \$24.40.

The 90 employment centers performed better than the national averages. Total inventory grew 8.09% for the six years after 2Q11, about 2 ½ times faster than the national rate. Whereas the national office vacancy rate declined by 220 bps over these six years, office vacancy declined by 332 bps in the 90 centers. Similarly, average office rents increased by \$5.60 in these centers compared to \$3.30 nationwide. These outcomes are consistent with the selection of large and relatively strong employment centers. Table 1 compares the results for the 90 employment centers to all markets.

Table 2 shows the variation in performance among the 90 employment centers by type of center. As expected, the average inventory size in the 48 CBDs is

substantially larger than average inventory size in other centers. Inventories in the downtowns of secondary cities and in SOPs are about the same size. The 18 adjacent or anchored employment centers had the lowest office vacancy rates and the highest office asking rents in 2Q17. The suburban office parks had the highest office vacancy rates in both periods.

Table 3 presents the relative performance of the centers from 2Q11 to 2Q17. The first two columns are the percent differences between 2Q11 and 2Q17 values shown in Table 2. These differences therefore represent rates of change for the six-year period. The change in asking rents is shown as the dollar increase and as the percent increase for the six-year period.

Inventory growth rates are similar across the four center types. The percentage change in centers with smaller inventories is higher, which is the expectation. The 48 CBDs in the sample registered the smallest reduction in office vacancy rates and the next to lowest increase in asking rents for office space. This relatively weak performance stems from the fact that the CBD measures are not weighted by inventory size. Adjacent or anchored secondary downtowns had the second largest reduction in office vacancies and had the greatest increase in asking rents. The downtown areas of secondary cities experienced the largest decline in

Table 2: Average Inventory, Office Vacancy Rates and Asking Rents for Employment Centers

TYPE	INVENTORY IN RBA		VACANCIES		ASKING RENTS	
	2Q17	2Q11	2Q17	2Q11	2Q17	2Q11
CBDs	70,743,041	65,561,040	9.5%	12.3%	\$27.85	\$22.57
Adjacent DTs	47,817,433	44,110,771	6.8%	10.2%	\$31.69	\$24.41
2nd City DT	22,571,803	20,699,811	7.5%	12.2%	\$29.19	\$24.77
Sub Office	24,081,554	22,190,943	13.2%	17.4%	\$28.36	\$22.86

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Table 3: Six-Year Rates of Change in Average Inventory, Office Vacancy Rates & Asking Rents

TYPE	INVENTORY	VACANCIES	ASKING RENTS	
	2Q11- 2Q17	2Q11- 2Q17	2Q11- 2Q17	
	% Increase	% Decline	\$ Increase	% Increase
CBDs	7.9%	-2.23%	\$5.28	23.4%
Adjacent DTs	8.4%	-3.31%	\$7.28	29.8%
2nd City DT	9.0%	-3.80%	\$4.42	17.8%
Sub Office	8.5%	-2.44%	\$5.50	24.1%

office vacancy rates and the smallest increase in office rents. The suburban office parks had a larger vacancy rate decline and a slightly higher rent increase than the CBDs, evidence that these SOPs are much stronger than typical SOPs.

VIBRANCY CONSIDERATIONS

One way to inform the discussion of growth and performance is to introduce the concept of vibrancy. In essence, vibrancy measures the urban form, features and amenities of a place that provide a statistically meaningful expression of the live-work-play dynamic. *The vibrancy of an employment center is a better predictor of performance in terms of rent levels, property values, cap rates, investment volumes, etc. than its recent growth, its size, its type (CBD, SOP, etc.) or its geographic location in the country.*

The four dimensions of vibrancy are a) density, which includes compactness, b) land-use diversity, c) connectivity and d) walkable urban form. Together, these physical features capture the benefits of agglomerating people and economic activity in space. Density is so fundamental that it is part of the definition of urban areas. Compactness is closely related focusing on the clustering of development in and near the urban core. Diverse land uses support different economic and social activities that occur at different times during the day and night. Density and diversity are necessary conditions for productive economic and social exchange. Connectivity provides the “glue” since high levels of interaction cannot occur without ease of access. Urban form can either promote or retard connectivity. Walkable places served by public transit

provide the highest level of connectivity in dense urban space. Previous studies have examined these vibrancy dimensions and their implications for urban areas.^{5,6,7,8,9,10,11,12,13,14,15}

Various indicators can be used to measure these four dimensions. In a previous study,¹⁶ EPA’s Smart Location Database (SLD) was used exclusively for all vibrancy measures. The SLD provides over 60 measures of density, diversity, destination accessibility, distance to transit, and design at the census block-group level for all urban areas in the U.S.¹⁷ Two connectivity measures in this analysis are drawn from the SLD: workforce accessible to the center within 45 minutes by auto or by transit. As noted, greater connectivity should lead to more interaction and exchange.

The Levy-Gilchrist study offered two attractive measures: job density and the live-work quotient. They compiled these measures for core census tracts and for census tracts in zones within one-half mile and one mile from the core. Job density accounts for the jobs per acre counts in all three zones.

In a study of 24-hour and 18-hour cities,¹⁸ the live-work quotient served as a good indicator of diversity. This measure is the percentage of people living in the core, in the half-mile zone, and in the mile zone who also work within this geography. The assumption is that land-use diversity increases as more people both live and work in the center because they spend more time and money there.

Floor-area ratio (FAR) within the core area measures compactness. Using the CoStar radius function, we

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Table 4: Vibrant Center Dimensions, Measures, and Data Sources

MEASURE	SOURCE
Density & Compactness	
Jobs per Acre	Levy & Gilchrist (L-G) 2014
Floor Area Ratio	CoStar Database
Diversity	
Live-Work Quotient	L-G 2014
Walk Score	Walk score website
Connectivity	
Workforce accessible w/in 45 minutes	
By auto	Smart Location Database
By transit	Measures
Walkable Urban Form	
Perfect Grid Measure	Smart Location Database
Average Block Size	Census data
Open space, Water & Mountains	Google Earth

drew a circle with a radius of one-half mile from the center of the employment node. This circle contains an area of almost 22 million square feet (pi times 0.5 miles squared). Then, we aggregated all existing vertical development within this circle. FAR is the square footage of vertical development divided by about 22 million square feet. Most CBDs have FARs greater than 1.0. By comparison, FARs for commercial development in suburban areas rarely exceed 0.30 primarily because of the acreage required for surface parking.

The second diversity measure is the Walk score for the employment center. To compute the walk score, which ranges from zero to 100, each of ten common destinations like banks, grocery stores, other businesses, theatres, parks, etc. within a five-minute walk or one-quarter mile receives the maximum score of 10; if these destinations require a walk of more than 30 minutes, the score is zero. The score also addresses pedestrian friendliness by including measures of population density, intersection density, and block length.¹⁹ Walk score can be considered an indicator of internal connectivity, but higher scores also indicate ease of access to common urban amenities that are present when land uses are diverse. The average Walk score for all census tracts in each center was the measure used.

Walkable urban form is primarily a function of the street pattern, how closely the pattern reflects a perfect grid²⁰ together with block size and prominence of the public realm. We used 2010 census data at the census tract level to calculate the measures. Unlike all other measures that positively associate with vibrancy, smaller blocks are better because pathways for connectivity increase as blocks get smaller. Jane Jacobs argued that these urban-form features enhance economic development in city districts.²¹

The final walkability measure combines qualitative assessments of three factors. Open space can be devoted to the public realm including parks. Water features and mountains provide boundaries and edges and add physical beauty. Water bodies also provide vistas whereas mountains offer orientation. Boundaries, aesthetics, and orientation are features that tend to associate with more walking.²² Centers receiving low scores have less open space and no bodies of water or mountains in close proximity. Centers with higher scores have more open space and at least one large body of water or several rivers near the center. Visible mountain ranges further increase the score.

The nine measures shown in Table 4 have face-validity and use publicly available data.

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The vibrancy index combines these measures giving each of the four dimensions equal weight. To calculate the index, the vibrancy measures are standardized, weighted and aggregated. The resulting standard scores are transformed such that the average score is 100 instead of zero. One standard deviation unit is assigned the value of 25. Rather than having a set of small positive and negative numbers, vibrancy scores are above or below the overall average value of 100.

The vibrancy scores for the 90 centers under study range from 9.3 for Tysons Corner to 448.6 for Midtown Manhattan. The average vibrancy score for the four types of center are CDBs 123.7, Adjacent/anchored downtowns 117.6, Secondary downtowns 85.3, and SOPs 41.0. **Appendix A** lists the scores for each center.

RESULTS OF THE ANALYSIS

The regression models analyzing inventory growth, rent change, and rent level are in **Appendix B**. The results turned out to be consistent with previous work, which found that more vibrant employment centers perform better than less vibrant ones *ceteris paribus*.²³

Vibrancy is not the only factor to influence property performance in this study. However, vibrancy is the most important factor. The most consistent and strongest result is that the vibrancy of employment centers in 2010 has significant positive relationships with inventory growth from 2011 to 2017, 2017 rent levels, and rent increases during this six-year period. Although the models are not causal, the influence of vibrancy on subsequent performance is very impressive.

IMPLICATIONS FOR PRACTICE

This final section explains the live-work-play dynamic more fully, offers applications of the vibrancy concept, and relates the findings of the study to real property valuation.

The live-work-play dynamic connects the downtown resurgence in U.S. central cities to Gen Y/Millennials (born circa 1980-1998) who have preferences that are strikingly different from the previous generation (Gen X born circa 1965-1979). Gen Y wants seamless

transitions from one activity to another and fuller integration of working, learning, convening, dining, recreating, etc. These preferences can be realized best in dense urban places like downtowns. Employers increasingly concerned about talent recruitment and retention have invested in core urban areas to capture this Gen Y talent. Thus, the location of talent is assumed to be behind the urban revival.

This explanation is partial at best. First, Gen Y/Millennials are not the dominant segment of downtown households. Many cannot afford to live downtown either because their service-industry jobs pay low wages or because they are burdened with substantial student-loan debt. More importantly, companies locating downtown or in major employment centers are not random but concentrated in specific industries related to the city's economic base. They sort and cluster to realize industry-specific agglomeration economies related to sharing, matching, and learning. As a consequence, finance types go to New York City, techies head for San Jose, engineers seek jobs with energy firms in Houston or with robotics firms near Detroit. Thus, companies moving to large employment centers to exploit agglomeration economies are largely responsible for the urban revival. Prospective workers follow them. Therefore, real estate professionals assessing employment centers should first determine how well they function as workshops and then consider their amenities and residential opportunities.

Real estate professionals are constantly assessing markets of interest trying to decipher emerging trends. They can use the quantitative measures of vibrancy, which are an improvement over qualitative and anecdotal descriptions of live-work-play. Unlike cyclical factors that can change valuations quickly, vibrancy factors tend to change very slowly over time. Some locational factors like street patterns, the public realm, water features, or mountains are rather permanent. Cities tend to improve public transit incrementally over time and at considerable expense. Substantial redevelopment is required to increase density or compactness. Although land-use diversity can change more rapidly as leases expire and uses evolve, value premiums associated with vibrancy are not likely to be arbitrated away in the near

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term. Among real estate professionals, developers play a special role because the projects they execute directly influence vibrancy for better or worse. The “container” they create is as important as its leasable contents. New projects generally add density, but the influence on other vibrancy factors is less straightforward. Compactness, land-use diversity, or connectivity may improve or suffer. Mixed-use projects can increase diversity. The creation of new links, transit stops, or pathways usually increase connectivity. Projects that improve vibrancy around them should perform well over time.

Finally, real estate professionals are very interested in valuations. Cap rate data provided by Integra Realty Resources are instructive in this regard. Before the Great Recession, cap rates for CBD office were higher than cap rates for suburban office. Similarly, urban multifamily cap rates were above suburban multifamily cap rates. In the post-recession period, the reverse is true: both CBD office cap rates and urban multifamily cap rates are *lower* than their suburban counterparts.

Several years ago, Real Capital Analytics used walk scores to produce its Commercial Property Price Indices (CPPI) that captured the value premium associated with walkable places. Counselor Hugh Kelly has demonstrated the lasting value premiums in 24-hour cities compared to 9-to-5 cities. Kelly’s updated six 24-hour cities have downtowns that also have the highest vibrancy scores with New York City leading the way.²⁴ (The others are Boston, Chicago, San Francisco, Washington, DC, and Philadelphia.)

With respect to property values, this study finds that vibrancy positively associates with inventory growth, rent levels, and rental growth. More inventory growth demonstrates that investors have favored places with greater vibrancy. Higher office rents lead to higher NOI and higher property values that reflect the greater vibrancy of the employment center in which they are located. Finally, higher rent growth in more vibrant centers portends property value increases in the future. These findings suggest that real estate professionals should add multi-dimensional vibrancy metrics to the

performance-related indicators they already track. •

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Appendix A

DOWNTOWN VIBRANCY SCORES			
Atlanta	103.3	Minneapolis	152.8
Austin	112.3	Nashville	83.5
Baltimore	151.3	New Orleans	124.3
Birmingham	59.3	New York Midtown	448.6
Charlotte	94.1	Oakland	157.7
Chicago	300.1	Oklahoma City	47.7
Cincinnati	119.1	Orlando	94.9
Cleveland	86.0	Philadelphia	211.1
Columbus	88.1	Phoenix	87.0
Dallas	134.5	Pittsburgh	134.7
Denver	152.8	Portland	158.5
Des Moines	80.3	Raleigh	50.2
Detroit	105.4	Richmond	89.1
Fort Worth	59.7	Sacramento	111.5
Grand Rapids	85.5	Salt Lake City	70.0
Hartford	82.6	San Antonio	93.6
Houston	119.1	San Diego	117.8
Indianapolis	76.0	San Francisco	230.9
Kansas City	89.9	San Jose	81.4
Las Vegas	80.3	Seattle	184.9
Los Angeles	203.0	St. Louis	106.9
Memphis	69.2	St. Paul	100.5
Miami	117.1	Tampa	72.9
Milwaukee	137.1	Washington, D.C.	222.1

ADJACENT/ANCHOR DTS			
Atlanta Midtown	63.5	NYC Downtown	329.4
Austin Medical Center	47.4	NYC Brooklyn downtown	280.3
Birmingham-UAB	70.3	Philadelphia U City	130.0
Chicago U Illinois	116.2	Phoenix North DT	63.8
Cleveland Univ Circle	41.9	Pittsburgh Oakland	98.8
Detroit Midtown	86.7	San Diego UCSD&Med Ctr	34.9
LA Hollywood	137.3	San Francisco: Civic Ctr	186.0
LA Wilshire/Koreatown	151.5	Seattle University District	111.0
Nashville Vandy Univ&Med	78.0	Washington: Georgetown	90.4

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SECONDARY CITIES	VIBRANCY SCORE
Alexandria, VA	77.6
Ann Arbor, MI	86.0
Bellevue, WA	81.1
Durham, NC	37.0
Ft. Lauderdale	93.9
Jersey City, NJ	173.9
Long Beach, CA	97.5
Pasadena, CA	114.4
Santa Ana, CA	96.2
Scottsdale, AZ	42.0
Tacoma, WA	68.0
Tempe, AZ	56.3

SOP	VIBRANCY SCORE
Bellevue I405-I520 OP	10.6
Houston Greenway Plaza	101.9
Irvine, CA SOP	75.6
Irving, TX SOP	21.1
Las Vegas Strip	79.3
Overland Park Sprint Camp	9.9
Redmond Microsoft Camp	33.7
Richardson Texas Instru	33.5
San Bernardino South OP	33.7
Santa Clara South OP	43.0
San Jose Cisco Campus	41.0
Tysons Corner, VA	9.3

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Appendix B

MODELS OF PERFORMANCE

The author and doctoral research associate Yan Chen conducted regression analysis to analyze five dependent variables, five independent variables and two dummy variables.

Dependent Variables.

Four of the five dependent variables are straightforward. We examined office asking rents and vacancy rates in 2Q17 and changes in office rents and vacancies from 2Q11 to 2Q17. The fifth dependent variable is the absolute change in the inventory of income-generating properties from 2Q11 to 2Q17, not relative inventory change. Occupancy increased over this six-year period, and the absolute amount of inventory growth represents the new supply available to absorb this amount of demand.

Independent Variables.

The variable of primary interest is the overall vibrancy score for the 90 centers shown in **Appendix A**. The size measure is what we call critical mass, which is the total number of jobs and population within the one-mile geography as compiled by Levy and Gilchrist. Critical mass is important since it should actualize the benefits of size. We intentionally double count the people who both live and work in the center since they spend considerably more time there each day compared to people who only work or only live in the center.

Employment growth is the traditional demand indicator expected to correlate with property performance outcomes. Employment growth is the ratio of employment in 2016 to employment in 2010. We measured this six-year growth rate for the 45 metropolitan areas under study. Three of the 48 urban areas contain two central cities and therefore two CBDs: Dallas-Fort Worth, Minneapolis-St. Paul and San Francisco-Oakland.

We controlled for crime and housing costs. We used the citywide murder rate per 100K population, which includes suicides, as the crime measure since the be-

havior of local police has less influence on this statistic than on other types of reported crime. We compiled data on housing affordability at the metropolitan level. The measure is the percentage of households who spent more than 30% of their annual income to rent or to own housing in 2010. We measure neither control variable nor employment growth for the same census-tract geography as the employment centers to reduce the possibility that the dependent variables could exert influence on the independent variables.

Dummy Variables.

We created two sets of dummy variables, one for region and one for type of center. We have four regional dummy variables for West, Southwest, Northeast and Southeast with Midwest as the base case. We have three dummy variables indicating secondary downtowns, downtowns in secondary cities or suburban centers treating CBDs as the base case.

RESULTS OF THE ANALYSIS

The amount of variation explained (adjusted R-squared) in three of five regression models was high enough to warrant the attention of real estate professionals. In the models for absolute change in inventory, office rent in 2017 and change in office rent since 2011, adjusted R-squared was 67%, 55% and 30%, respectively. However, the two vacancy models each explained less than 3% of the variation. The factors that explain vacancy rates appear to be market specific.²⁵ Relevant local factors such as differences in the functionality of office space, floor plate size, age and condition, time lines for new construction, conversions to other uses, etc. are not among the factors included in this analysis.

Table 5 shows the three final models that we tested for collinearity (high correlations among independent variables) and heteroscedasticity (non-random error terms). The models were heteroskedastic but not collinear according to the variance inflation test. We used robust standard errors to address heteroscedasticity. In addition, the five percent level became the threshold for significance instead of the ten percent level to establish

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	DEPENDENT VARIABLE		
	Rent 17/11	Abs.Ch.11-17	Rent 2Q17
Employment Growth	0.072*** (0.023)	142,088.8 (0.023)	1.432 (0.995)
Vibrancy Score	0.136*** (0.045)	3,235,168*** (672,136.3)	6.121*** (1.773)
Critical Mass	-0.061** (0.030)	658,514.7 (579,400)	1.251 (1.166)
Crime Rate	-0.014 (0.022)	-516,210.8** (230,916.7)	-1.044 (0.789)
House Affordability	-0.023 (0.029)	-149,689.8 (473,433.4)	1.380 (1.038)
NE Region	0.0003 (0.072)	-2,400,234*** (822,495.5)	-0.197 (2.599)
SE Region	0.065 (0.045)	878,414.8 (598,362.6)	6.703*** (2.143)
SW Region	0.039 (0.052)	949,753.2 (713,648.5)	5.898** (2.376)
W Region	0.185** (0.072)	-1,338,003 (1,243,691)	5.637** (2.743)
Secondary DT	0.082 (0.044)	-507,483.1 (556,727.5)	4.325** (1.890)
Suburban Center	0.079 (0.075)	579,411.5 (844,489.7)	4.229 (2.630)
Constant	1.139*** (0.040)	4,485,958*** (568,615.6)	23.039*** (1.498)
Observations	90	90	90
R2	0.395	0.717	0.606
Adjusted R2	0.301	0.673	0.545
Resid. Std. Error df = 77	0.176	2,335,860	6.936
F Statistic (df = 12;77)	4.195***	16.259***	9.885***

Note: **p<0.05 ***p<0.01

a higher standard. We standardized the five continuous independent variables in order to make their coefficient values comparable.

The model for change in rent from 2Q11 to 2Q17 has two significant variables beyond the 1% level: employment growth and the vibrancy score. Critical mass and the shift parameter for the West region are significant beyond the 5% level. However, critical mass has

a negative association instead of the expected positive one. Location in the west region associates with significantly greater rent increases compared to the Midwest base case.

The standardized vibrancy score has the largest coefficient (0.136) compared to the other four interval variables and almost twice the coefficient value for employment growth (0.072). Thus, vibrancy is the most

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important factor in the rent change model since one standardized unit increase in vibrancy would result in the largest increase in office rents.

The model for absolute inventory change has three significant variables: vibrancy (1% level), crime rate (5% level) and location in the northeast region (1% level). More vibrancy and less crime thus associate with higher inventory growth. The shift parameter for northeast is negative compared to the base case indicating less inventory growth in that region. Again, the vibrancy score has by far the largest standardized coefficient making vibrancy the most important factor in the model explaining absolute inventory growth.

In the third model explaining variation in 2Q17 rent levels, the vibrancy score is the only significant non-dummy variable and has the largest standardized coefficient compared to the other four interval variables. Four dummy variables are significant at either the 5% level or the 1% level. All have positive shift parameters. Rents are higher in the southeast, southwest and west compared to the Midwest. Rents are also higher in adjacent or anchored secondary downtowns compared to CBDs.

Comparing results across the three models, we find that critical mass is not significant in two of them. Critical mass has a high positive correlation with vibrancy (+0.83). This correlation suggests that vibrancy and critical mass are mutually reinforcing but that vibrancy is the more dominant factor.

Crime rate has negative coefficients in the three models and a significant one in the inventory change model. Therefore, crime has the expected negative influence on property performance.

Employment growth is positively associated with rent level and with rent increases from 2011 to 2017. One plausible explanation is that many centers adding employment have greater physical or regulatory constraints

on supply and therefore will experience upward pressure on rents. However, there is a more likely explanation in the context of vibrant centers. These larger and more vibrant employment centers have “thicker” labor markets.²⁶ Thick labor markets attract additional employers as well as more employees, generating a positive feedback cycle. In these employment centers, space demand often exceeds supply. Rents are higher and rent increases are greater as a result.

As noted, housing affordability percentages increase as households spend more than 30% of their income on housing in the metro area. Although not statistically significant, rents and inventories increased more in metropolitan areas with more affordable housing markets. On the other hand, rent levels were highest in employment centers located in metropolitan areas with less affordable housing markets.

Regional location is somewhat important. One region is significant in the first two models; three of the four regions have significant positive effects in the model for 2017 asking rents. Although type of center is not significant in the first two models, adjacent or anchored secondary downtowns have a positive influence on 2017 office rent levels.

ENDNOTES

25. Some would cite the natural office vacancy rate, which varies from market to market. See Shilling, J, Sirmans, C.F. and Corgel, J. (1992). Natural Office Vacancy Rates: Some Additional Estimates, *Journal of Urban Economics*, 31, 140-143.
26. For more discussion of thick labor markets, see Moretti E. (2013). *The New Geography of Jobs*. Boston: Mariner Books, pp. 125-131.

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