The Influence of Socioeconomic Conditions on the U.S. Internet Office Market

Sofia V. Dermisi*

Abstract

This paper focuses on the Internet as a resource in the fulfillment of companies' needs to lease or buy office space in the United States. A measure of this Internet use is introduced by two indexes that consider the companies' preferences and the office stock in states and cities. The results indicate that the Internet is utilized more for leasing than for selling office properties. Moreover, relationships are defined between the introduced indexes and local socioeconomic characteristics. Economic variables such as employment, Finance Insurance and Real Estate and high tech employment, firm size and income have significant effect on the Internet office leases and sales.

Introduction

The Internet is a medium for communication and commerce. Its adaptation by real estate companies was slow in the mid-1990s, but has grown exponentially since 1996 (Baen and Guttery, 1997). Although commercial real estate is viewed as one of the least transparent markets, its downturn increased the adoption of Internet technology among real estate brokerage companies to help fill increasingly hard to lease space (Miles, 2000; and Redbuz.com, 2001). Through this adaptation, companies use online listing services as one of the available advertisement resources to supplement their own databases (Devine, 2001). The Internet office market research, however, is limited not only because the industry is characterized as fragmented and technophobic (Hartung et al., 2000) but also because of the general absence of reliable office market time-series data (DiPasquale and Wheaton, 1996).

This paper examines the relationships between the indexes of Internet leases or sales per office stock and socioeconomic variables of states and cities in the United States, utilizing a dataset of thousands of properties. These indexes are a diachronic measure of the removed (transacted or taken off the market) Internet marketed properties for lease or sale, allowing the evaluation of the Internet as one of the resources utilized by brokers for property advertisement.

Research Context

Through time, an increasing number of real estate brokers are utilizing the Internet listing services to advertise their available properties. However, the specific means that these brokers use to advertise each property, which is also listed online, cannot be defined without their cooperation. This cooperation is impossible for the thousands

* Roosevelt University, Chicago IL 60605 or sofia_dermisi@post.harvard.edu.

of properties listed throughout the country. Thus, the assumption made is that properties listed online might also be advertised otherwise. The goal of this paper is not to investigate if the Internet removed properties were advertised only online, but to determine which portion of the available office properties for lease or sale is removed after being advertised online and its relationship with local socioeconomic variables. The removed properties were determined by adopting the assumption made in a recent study of the Internet office market by Dermisi (2002), where a property was designated as removed if it did not appear on the Internet listing service consecutively for a three-month period. Herein, the online removed properties are studied because actual transaction data are not available and the Internet user searching for an office property is interested only in the available online properties and not if the removed properties were transacted or taken off the market. After determining the removed office properties, this study proceeds in the evaluation of the socioeconomic variables' affect on the U.S. Internet office market.

In the traditional office market, the relationship between socioeconomic variables and the office market has been documented in a number of research papers. The majority of these papers focus on the impact of socioeconomic conditions on the property value (either rent or price). Only a minority of papers relates the property size with socioeconomic conditions or office property characteristics. Mourouzi-Sivitanidou (2002) found a positive effect of increasing employment on office rents conducting a time-series cross-section study of eighteen metropolitan office markets. De Wit and Van Dijk's (2003) study of major global cities indicated that increases in unemployment had a negative influence on office property prices and rents. Focusing on studies relating office property size with other variables, Rosen (1984) found a strong positive relationship between the occupied office stock space and Finance Insurance and Real Estate (F.I.R.E.) employment. Shilton and Zaccaria's (1994) study of midtown Manhattan office building sale transactions for a ten-year period, confirmed that one of the pricing function variables is property size in square feet. Bollinger, Inhlanfeldt and Bowes (1998) indicated that the average floor area is a significant variable and affects positively the rent in both linear and non-linear models. Slade (2000) found that rental rates increase at a decreasing rate with respect to average floor area.

In contrast to the traditional real estate literature, the office market lacks Internet data-driven research. Considering that the local socioeconomic conditions are among the determining factors for the selection of an office property, the questions posed are: Which socioeconomic variables have significant effect on the leases or sales per office stock index in the Internet office market of U.S. states and cities? And are these variables the same for all states and cities?

Data and Methodology

The data sets contain values of Internet REOM properties and socioeconomic variables that were aggregated either from Internet listing services or government agencies. The benefit of using the Internet property data is the inclusion of small size office properties (less than 10,000 sq. ft.). Most brokers fail to consider office buildings with

low total square footage, thus excluding them from brokerage surveys (DiPasquale and Wheaton, 1996).

Two different sets of criteria were utilized in this paper. The first set was established for the selection of reliable Internet listing services participating; and the second, for the selection of the studied U.S. states and cities. The criteria for the selection of the Internet listing services were: (1) companies should have office properties listings for lease or sale throughout the country; (2) the number of online property listings in the company's database should be more than fifty per month to qualify the company as a small Internet listing company and more than 200 per month to qualify the company as large; (4) companies should have strategic alliances with at least three financial institutions; and (4) the number of participating brokers/agencies on the Internet listing platform should be no fewer than twenty for a small listing service and at least 100 for a large listing service. Thus, office property data was gathered from six Internet listing companies: Loopnet, Propertyfirst, Commercialproperty, Comps (later bought by CoStar Group), Comro and Webrealestate. The data was downloaded from the Internet in the form of city, state, rent or price, square feet, and rent or price per square foot with the study period being from September 2000 through February 2001. Unfortunately, the time involved and the database structure constraints of the listing services did not allow the above companies to provide any aid for additional data collection. For confidentiality reasons, the data was aggregated at the state and city level.

The second set of criteria were established for the selection of U.S. states and cities participating in the research: (1) lease properties: at least 100 listed or removed properties; and (2) sale properties: (a) the number of listed properties should be at least 100 for either states or cities; and (b) the number of removed properties should be at least 100 for states and twenty-two for cities. These criteria led to the selection of thirty-five U.S. states and forty-nine cities with office properties for lease along with twenty-four states and fifteen cities with office properties for sale.

Initially, the data was "cleaned-up" from their web format. Then, the removed properties were determined. Exhibit 1 contains the number of properties for lease or

Exhibit 1
Variables and Their Corresponding Number of the Internet Listed or Removed Office Properties

Listed Office Properties	Removed[a] Office Properties
Leases	
107,541	39,168
Sales	
54,840	3,286

Note:
[a]Removed: transacted or taken off the market properties.

sale used in the study that corresponds to the variables "square feet of listed properties" and "square feet of removed properties."

The socioeconomic data (Exhibit 2) were aggregated at the state and city level to be consistent with criteria set for the Internet office market data. The data concern values of demographic, crime and economic variables (population, median age, density, online population, total violent crimes, Gross State Product (G.S.P.) of F.I.R.E. employment, income and growth rate, employment, F.I.R.E. employment, unemployment, high tech employment, number of firms and number of firm establishments). An effort was made to compile a variety of data affecting the office market and to examine their effect in the Internet era.

A general characteristic of the selected demographic variables is that their effect, if any, on the Internet office market has not been documented. Population is a basic demographic parameter with an unknown effect on the Internet office market. In this research it is also used for the standardization of economic variables avoiding cross-section bias among states or cities. Thus, income, total employment, F.I.R.E. employment, the number of firms and their establishments are expressed per capita. Density is an indicator of the willingness of people to locate in specific areas possibly because of the quality of life or job opportunities. Median age is introduced because it is assumed that younger people are usually more familiar with the Internet than the elderly. Therefore, median age and online population are related to the familiarity of Internet users to search and select an office property that is advertised online, enhancing their market insight.

Exhibit 2
Socioeconomic Variables (for U.S. States and Cities)

Variable	Source	U.S.
Population	U.S. Census	States & Cities
Median Age	U.S. Census	States & Cities
Density (persons/mile^2)	U.S. Census	States
Total Violent Crimes	U.S. Department of Justice	States
Gross State Product	Bureau of Economic Analysis	States
Per Capita Income	Bureau of Economic Analysis	States & Cities
Monthly Total Employment	Bureau of Labor Statistics	States & Cities
Monthly F.I.R.E. Employment	Bureau of Labor Statistics	States & Cities
Monthly Unemployment Rate	Bureau of Labor Statistics	States & Cities
Online Population	Progressive Policy Institute	States & Cities
High Tech Employment	Progressive Policy Institute	States & Cities
Number of Firms by Number of Employees	U.S. Census	States & Cities
Number of Firm Establishments by Number of Employees	U.S. Census	States & Cities
Growth Rate	Bureau of Economic Analysis	States & Cities

Referring to the economic variables, GSP was selected because it is directly linked to F.I.R.E. employment productivity. The Internet can enhance and expedite the selection of office properties for companies' expansions. Therefore, the additional employee inflow can improve the company's productivity. Income not only reflects local economic conditions, but it is an indication of Internet use. Medium and high income is mainly related to the familiarity of Internet use, because in both cases it is more likely to possess computer and Internet connections. Total employment represents the total labor force and F.I.R.E. employment is directly linked with the current occupied office space and possibly needs for future expansion. Unemployment allows the evaluation of employment capabilities in various areas. An increased unemployment can also indicate a reduction in need for additional office space. High tech employment is another portion of the total employment used because of high tech employees' familiarity with technology resources and Internet. The number of firms in the selected areas is crucial in establishing the needs for office space, which can be searched online. In addition, the number of firms was further grouped by number of employees. Taking into account that a firm can be comprised of more than one location, the effect of this variable was also examined by grouping the data based on the number of employees.

The measure of the Internet use is introduced by the IL and IS indexes, which express the Internet leases or sales per office stock, respectively:

$$IL = \frac{\textit{removed (for lease) office space in the Internet office market (in sq. ft.)}}{\textit{office stock (in sq. ft.)}}. \quad (1)$$

$$IS = \frac{\textit{removed (for sale) office space in the Internet office market (in sq. ft.)}}{\textit{office stock (in sq. ft.)}}. \quad (2)$$

In Equations 1 and 2, the nominators express the mean monthly Internet removed office properties space in square feet for lease or sale during the study's six-month period. The denominators express the mean office stock in square feet during the six-month period. There is absence of precise office stock data. Kimball and Bloomberg (1987) determined the square footage of office stock in Officetown, multiplying the number of office workers by the square feet of office space per worker. This office space/worker was taken from tables annually published by the Building Owners and Managers Association (BOMA). In this study, the office stock is calculated as:

$$\textit{Office stock} = 1.16 \times (\textit{office workers}) \times (\textit{office space/worker}), \quad (3)$$

in which: 1.16 = the adjustment coefficient for amenities. In an office building, according to brokers and developers, the amenities or common areas (*i.e.*, lobby, elevators, corridors, free space) are between 8% and 20% of office building area depending on building size. Therefore, an average 14% of this range is used to represent space for amenities or common areas. This leads to the conclusion that the remaining 86% of the office building space is available for workers. Therefore, 100/86 = 1/0.86 = 1.16.

The office space per worker is defined as follows:

1. For cities: the data was found in the BOMA Experience Exchange Report (2001).
2. For states: it was estimated as a weighted average value of this parameter in the studied cities of each state. These cities were determined from their online property listings and the fulfillment of the criteria set by this study. In order to calculate average square feet per worker, in states with only one city represented in the BOMA report, the assumption made was that the city's data is the same as the corresponding average for the state rather than taking the average square feet per worker in the U.S.

The office workers calculation (Equation 4) is based on the assumption that 95% of the F.I.R.E. employment is in office buildings and 40% of all office employment is in the F.I.R.E. sector (Clapp, 1993). Therefore, knowing the employees in the F.I.R.E. sector, the number of office workers can be estimated by the relationship:

$$\textit{Office workers} = (0.95/0.4) \times (\textit{F.I.R.E. employees}) = (2.38) \times (\textit{F.I.R.E. employees}). \quad (4)$$

Results and Discussion

The application of the indexes developed in this study generates Exhibits 3 through 6, which indicate that the Internet sales per office stock indexes are much lower than the corresponding indexes for leases.

Exhibit 3
Lease Listings Removed from the Internet per Office Stock in Selected U.S. States

State	Internet Lease Index (%)	State	Internet Lease Index (%)	State	Internet Lease Index (%)	State	Internet Lease Index (%)
OK[a]	17.67	CA	2.31	PA	1.71	NH	1.37
MD	6.17	NJ	2.20	FL	1.66	KY	1.10
CO	5.53	NC	2.10	MN	1.65	NY	0.95
MI	3.70	UT	2.05	IL	1.55	TN	0.91
DC	3.45	CT	2.01	OR	1.52	ME	0.83
MA	3.38	HI	1.99	VA	1.46	WI	0.81
NV	3.31	IN	1.88	KS	1.45	SC	0.57
WA	2.52	GA	1.74	MO	1.44	AL	0.52
AZ	2.51	TX	1.73	OH	1.39		

Note:
[a]OK has a significantly large index, which cannot be explained.

Exhibit 4
Lease Listings Removed from the Internet per Office Stock in Selected U.S. Cities

City	Internet Lease Index (%)	City	Internet Lease Index (%)	City	Internet Lease Index (%)
Grand Rapids, MI	7.67	Phoenix, AZ	1.75	Miami, FL	1.18
Colorado Springs, CO	6.73	Sacramento, CA	1.70	Boston, MA	1.10
Reno, NV	3.83	Pittsburgh, PA	1.70	Jacksonville, FL	1.10
Madison, WI	3.28	Las Vegas, NV	1.67	Cleveland, OH	0.99
Houston, TX	2.40	Austin, TX	1.47	San Jose, CA	0.99
Tulsa, OK	2.27	Charlotte, NC	1.43	Columbus, OH	0.96
Honolulu, HI	2.22	Dallas, TX	1.42	Chicago, IL	0.79
Omaha, NE	2.22	Fort Worth, TX	1.42	Nashville, TN	0.78
San Francisco, CA	2.14	Spokane, WA	1.40	Orlando, FL	0.75
Indianapolis, IN	2.12	Atlanta, GA	1.39	Washington, DC	0.74
Denver, CO	2.08	Seattle, WA	1.39	Boca Raton, FL	0.74
Albuquerque, NM	1.99	Greenville, SC	1.39	New York, NY	0.67
San Diego, CA	1.98	Oklahoma City, OK	1.38	Los Angeles, CA	0.54
Memphis, TN	1.91	Salt Lake, UT	1.33	Philadelphia, PA	0.52
Richmond, VA	1.89	Cincinnati, OH	1.32	St. Louis, MO	0.01
Raleigh, NC	1.88	Tampa, FL	1.21		
Fort Lauderdale, FL	1.76	Oakland, CA	1.20		

Exhibit 5
Sale Listings Removed from the Internet per Office Stock in Selected U.S. States

State	Internet Sale Index (%)	State	Internet Sale Index (%)	State	Internet Sale Index (%)
OH	1.364	PA	0.395	MO	0.194
MA	0.730	TX	0.388	DE	0.167
AZ	0.693	MD	0.383	NH	0.164
NJ	0.680	IL	0.267	FL	0.110
MI	0.581	CO	0.267	IN	0.101
GA	0.551	NC	0.266	NY	0.076
NV	0.510	KS	0.251	UT	0.073
CA	0.405	CT	0.210	KY	0.037

Exhibit 6
Sale Listings Removed from the Internet per Office Stock in Selected U.S. Cities

City	Internet Sale Index (%)	City	Internet Sale Index (%)	City	Internet Sale Index (%)
Columbus, OH	4.408	Fort Worth, TX	0.302	Charlotte, NC	0.130
Houston, TX	0.673	Cincinnati, OH	0.295	Chicago, IL	0.113
Austin, TX	0.668	Atlanta, GA	0.246	Los Angeles, CA	0.100
Raleigh, NC	0.637	Dallas, TX	0.235	Orlando, FL	0.085
Phoenix, AZ	0.625	Philadelphia, PA	0.196	New York, NY	0.079

In order to analyze further the significant differences between the indexes of leases and sales, twenty brokers and real estate professionals were contacted around the country. All of them concurred that sales per office stock are very limited compared to leases per office stock for the following reasons:

1. Commercial brokers prefer to list properties online for lease rather than for sale.
2. The majority of commercial sales are usually not listed online because commercial brokers rely on their personal networks and market insight to market these properties rather than the Internet. There are many cases in which a broker is informed about an available property before it is vacant. Thus, the deal closes immediately, even before the property is advertised online.
3. Brokers usually prefer to control for sale listing information, and marketing packages offered.
4. Although big brokerage companies now list more of their available properties online, brokers usually try to identify a buyer in their specific time frame before listing online.
5. Brokers list properties online when local real estate markets are soft (*i.e.*, high vacancy rates, low absorption rates, etc.). At such times the Internet becomes a vehicle for further property advertisement beyond local bidders.

A general observation for both the Internet leases and sales indexes are their small values. These values can be justified because the mean per month online removed office properties (in sq. ft.) is compared to the mean office stock (in sq. ft.). At any time, the monthly averaged leases or sales at the state or city level represent a small part of the corresponding to the state or city office stock.

A further investigation of Exhibits 3 and 4 of the Internet leases per office stock indicate that states with a very high value of the Internet leases per office stock index do not include cities with a similarly high value of this index. There are three exceptions (Colorado, Michigan and Nevada) out of thirty-six states (8.3%). The

differences in the Internet leases per office stock between states and cities might be explained by considering that: (1) states with a high index might include removed office properties not concentrated in specific cities, but dispersed instead in cities throughout the state; and (2) states with a high value of this index might include cities with fewer than 100 removed properties (cities should have at least 100 removed properties in order to be included in this research).

Exhibits 5 and 6 of Internet sales per office stock indicate that states with high index value of the Internet sales per office stock include cities with a high value of this index only in two cases (Ohio and Arizona) out of twenty-four states, thus 8.3%.

Additionally, socioeconomic variables such as population density, income, employment and unemployment were tested for their positive or negative effect on the value of the Internet leases or sales per office stock indexes. Regressions 1 and 2 below of states and cities, respectively, present the socioeconomic variables with significant effect on lease indexes, IL_s and IL_c. (See also robustness analysis identifying the impact of demographic, crime, economic and firm variables on the lease indexes separately and combined, in Exhibits 7 and 8.)

$$\begin{aligned}\text{Log}(IL_s) = {} & -2.528 + 0.001(OP)^2 - 0.657\log(DEN) + 0.390\log(VC) \\ & (-0.55)\ (-4.22) \qquad (3.15) \qquad (-3.95) \\ & + 1.85{*}10^{4}\ (PCI) - 6.86{*}10^{-6}\ (GSPF) - 17.069(ME) \\ & \quad (-4.57) \qquad (2.79) \qquad (2.87) \\ & - 0.800\log(MFIRE) + 1.959(MU) - 0.304(MU)^2 - 1.90(GR) \\ & \quad (1.93) \qquad (-2.21) \qquad (2.61) \qquad (2.07) \\ & R^2 = 0.54 \\ & N = 37 \end{aligned} \tag{1}$$

$$\begin{aligned} IL_c = {} & 27.463 - 0.001(OP)^2 - 0.305(MA) + 1.88{*}10^{-9}\ (PCI)^2 + 0.453(ME)^2 \\ & \quad (3.5) \quad (2.22) \qquad (2.53) \qquad (-3.03) \qquad (-2.59) \\ & - 16.187(MFIRE) - 0.103(MU)^2 - 0.277(HTE) + 3.121\log(F100\text{–}500) \\ & \quad (2.74) \qquad (3.59) \qquad (2.07) \qquad (-3.32) \\ & + 619.685(F500) - 465.35(FE500)\ R^2 = 0.67 \\ & \quad (-2.71) \qquad (2.75) \qquad N = 33 \end{aligned} \tag{2}$$

The *t*-Statistics are in parentheses below the coefficients. In these equations: IL_s and IL_c = the lease indexes for states and cities, respectively; *OP* = online population; *DEN* = density population; *MA* = median age; *VC* = violent crime; *PCI* = per capita income; *GSPF* = Gross State Product of Finance Insurance and Real Estate (F.I.R.E.) employment; *ME* = mean employment per capita; MFIRE = mean F.I.R.E. employment per capita; *MU* = mean unemployment; *GR* = growth rate; *HTE* = high tech employment; *F100–500* = number of firms/capita with 100–500 employees; and *FE500* = number of firm establishment/capita with more than 500 employees.

Exhibit 7
Robustness Analysis of Lease Listings Removed from the Internet per Office Stock of U.S. States

	Regression Models							
Independent Variables	1	2	3	4	5	6	7	8
REOM								
Mean rent of removed properties	−3.14E-08	−2.02E-08	−5.53E-08	−4.11E-08	−9.46E-08	−1.94E-08		
	−0.67	−0.39	−1.19	0.69	−1.42	−0.32		
Demographic								
Population	1.07E-08				−6.16E-08			
	0.38				−0.62			
Online population	0.018				0.050	−0.250	−1.52E-01	
	0.67				1.16	−1.84	1.17	
Square of online population						0.004	0.003	0.001
						2.25	−1.57	−4.22
Median age	−0.063				−0.066			
	−1.03				−0.52			
Density	0.001				−0.001			
	0.56				−1.46			
Log of density						−0.898	−0.655	−0.657
						−2.73	3.24	3.15
Crime								
Violent crimes				−0.694	2.13E-05	5.89E-06		
				−1.43E+05	1.66	0.70		
Log of violent crimes							0.378	0.390
							−3.83	−3.95
Economic								
Per capita income		0.000			0.000	0.000	0.000	1.85E-04
		1.54			0.97	4.64	−4.62	−4.57

Exhibit 7 (continued)

Robustness Analysis of Lease Listings Removed from the Internet per Office Stock of U.S. States

	Regression Models							
Independent Variables	1	2	3	4	5	6	7	8
GSP of F.I.R.E.		−1.84E-06 −0.54			−9.76E-06 −1.34	−1.05E-06 −2.47	−6.53E-06 2.37	−6.86E-06 2.79
Mean employment per capita		−10.804 −1.58			−34.721 −1.78	−22.807 −3.04	−16.546 2.80	−17.069 2.87
Mean F.I.R.E. employment per capita		−43.860 −1.09			−80.988 −1.44			
Log of mean F.I.R.E. employment per capita						−1.772 −1.89	−0.679 1.60	−0.880 1.93
Mean unemployment		−0.115 −0.43			−0.575 −1.43	2.776 2.57	1.810 −1.97	1.959 −2.21
Square of mean unemployment						−0.431 −2.81	−0.282 2.30	−0.304 2.61
High tech employment		0.084 0.67			−0.099 −0.50			
Growth rate		−0.008 −0.01			−0.132 −0.08	−1.634 −1.81	−1.863 2.07	−1.900 2.07
Economic/Firms								
Number of firms/capita with 0–99 empl.			−3722.073 −1.78		−5557.441 −1.45			
Number of firms/capita with 100–500 empl.			2322.702 1.81		5638.438 1.55			
Number of firms/capita with 500+ empl.			−374.914 −0.35		−3752.753 −1.38	−3030.765 −2.48		

Exhibit 7 (continued)

Robustness Analysis of Lease Listings Removed from the Internet per Office Stock of U.S. States

	Regression Models							
Independent Variables	1	2	3	4	5	6	7	8
Number of firms establishments/ capita with 0–99 empl.			3643.879 1.64		3733.160 1.19			
Number of firms establishments/ capita with 100–500 empl.			−2165.136 −1.88		−1921.578 −1.10			
Number of firms establishments/ capita with 500+ empl.			−316.133 −0.81		−859.483 −1.44			
Constant	2.102	5.126	2.965	0.545	0.529	3.225	0.635	−2.528
R^2	0.108	0.167	0.158	0.014	0.529	0.617	0.559	0.544

Note: The types of variables used in the models are in italic type. The dependent variable is log of lease listings removed from the Internet per office stock of U.S. states. The *t*-Statistics appear beneath the coefficients. For regression Models 1–6, the number of observations = 34; for Models 7–8, the number of observations = 37.

Exhibit 8
Robustness Analysis of Lease Listings Removed from the Internet per Office Stock of U.S. States

	Regression Models							
Independent Variables	1	2	3	4	5	6	7	8
REOM								
Mean rent of removed properties	−7.93E-08	1.78E-07	−1.17E-07	−2.09E-08				
	−1.04	0.82	−1.01	−0.17				
Demographic								
Population	−9.91E-08			2.36E-08				
	−2.81			0.24				
Online population	0.026			2.40E-02	−0.101	−0.295		
	1.36			0.93	2.17	1.56		
Square of online population						0.002	−0.001	−0.001
						−1.05	2.22	2.22
Median age	0.040			−4.21E-02	−0.432	−0.414	−0.336	−0.305
	0.80			−0.26	2.65	2.79	2.51	2.53
Economic								
Per capita income		6.27E-06		6.96E-05	1.82E-04	1.57E-04	−2.47E-04	
		1.18		0.91	−2.85	−2.70	0.97	
Square of per capita income							5.36E-09	1.88E-09
							−1.49	−3.03
Mean employment per capita		4.79E-02		0.241				
		0.14		0.19				
Square of mean employment per capita					0.234	2.59E-01	4.27E-01	0.453
					−1.58	−1.62	−2.36	−2.59
Mean F.I.R.E. employment per capita		−2.263		−8.527	−21.948	−21.484	−16.939	−16.187
		−0.38		−1.39	2.75	2.99	2.74	2.74
Mean unemployment		0.037		−0.618	−0.845	0.804		
		0.09		−2.10	3.52	−0.57		

Exhibit 8 (continued)
Robustness Analysis of Lease Listings Removed from the Internet per Office Stock of U.S. States

	Regression Models							
Independent Variables	1	2	3	4	5	6	7	8
Square of mean unemployment						−0.235	−0.104	−0.103
						1.19	3.43	3.59
High tech employment		0.017		−0.294	−0.411	−0.344	−0.242	−0.277
		0.13		−1.45	2.40	2.01	0.64	2.07
Square of high tech employment							−0.004	
							0.12	
Growth rate		−0.001						
		−0.10						
Economic/Firms								
Number of firms/capita with 0–99 empl.			10.145	−636.360				
			0.05	−1.40				
Number of firms/capita with 100–500 empl.			1.418	103.579	61.717	65.406		
			0.02	0.30	−3.13	−3.37		
Log of number of firms/capita with 100–500 empl.							3.177	3.121
							−3.25	−3.32
Number of firms/capita with 500+ empl.			444.737	99.705	592.058	573.541	522.497	619.685
			2.08	0.59	−2.31	−2.30	−2.30	−2.71
Number of firms establishments/ capita with 0–99 empl.			−10.455	673.429				
			−0.04	1.54				

Exhibit 8 (continued)

Robustness Analysis of Lease Listings Removed from the Internet per Office Stock of U.S. States

	Regression Models							
Independent Variables	1	2	3	4	5	6	7	8
Number of firms establishments/ capita with 100–500 empl.			−2.728 −0.06	−153.451 −0.75				
Number of firms establishments/ capita with 500+ empl.			−103.055 −1.63	−107.631 −1.01	−409.190 2.41	−447.454 2.50	−428.897 2.38	−465.355 2.75
Constant	−0.855	−0.358	1.986	2.578	19.682	21.277	32.930	27.463
R^2	0.203	0.345	0.236	0.567	0.667	0.692	0.680	0.673

Note: The types of variables used in the models are in italic type. The dependent variable is log of lease listings removed from the Internet per office stock of U.S. states. The *t*-Statistics appear beneath the coefficients. For regression Model 1 and 4, the number of observations = 28; for Model 2, the number of observations = 16; for Model 3, the number of observations = 37; for Models 5–8, the number of observations = 33.

The results from the regression analysis (Regressions 1 and 2) are:

- An increase in the percentage of the online population has a positive effect on the lease index of the states studied in contrast to the cities where the effect is negative (unexpected result).
- On the lease indexes for both states and cities: (1) an increase in income has a positive effect; and (2) an increase in mean F.I.R.E. employment has a negative effect (unexpected result).
- An increase in mean employment has a negative effect on the lease index in states (unexpected result) but a positive effect on the lease index in the cities studied.
- An increase in high tech employment has a negative effect on the lease index in the cities studied (unexpected result).

The positive coefficient of the online population for the states studied is expected in contrast to the negative coefficient at the city level. The negative effect at the city level can be associated with the city office market, which might be more relationships rather than Internet driven. However, companies outside a city and without any broker help are more likely to utilize the Internet as a search engine.

The positive coefficient of income is consistent with expectations because an increase in the income of employees indicates that companies are profitable. Therefore, they can expand by leasing additional office space. One of the rapid and free-of-cost space search resources is the Internet.

The analysis of total, F.I.R.E. and high tech employment variables presents interesting results. An increase in employment should increase demand for space. Companies can easily search the Internet listings for available properties based on their particular criteria. Thus, if an online listing satisfies a company's additional space need they can then lease it. Instead, the data show that an increase in mean employment has a negative coefficient at the state level and a positive one at the city level. An explanation of the negative coefficient at the state level is that employment might be distributed in areas of a state outside of cities with the Internet listings, where the number of the Internet removed properties is very low, or properties are not attractive to lessees.

F.I.R.E. employment has an unexpected negative effect on the Internet leases per office stock for both states and cities. However, based on the Internet leases per office stock index (Equation 1), this effect should be expected because F.I.R.E. employment is in the denominator. This indicates that an increase in F.I.R.E. employment is associated with a decrease in the index when the nominator remains constant. Also, in the short-run, an increase in F.I.R.E. employment might be accommodated in available office space rather than by buying other properties.

Further analyzing the high tech employment coefficient, one explanation for the negative sign is that this type of employment might require a more intensive use of

office space especially within cities. This indicates that an increase in high tech employment might be accommodated in existing company office space and thus it can be associated with a decrease in the lease index in cities.

The previous analysis of the lease indexes concentrated on the common socioeconomic variables of the regressions between states and cities. In the following, the effect of the remaining variables (in Regressions 1 and 2) on the lease indexes at the state level, IL_s, and the city level, IL_c, are examined.

State Level

The increase in population presents a positive effect on IL_s, which was expected. Similar expected effect is presented by unemployment. The positive effect of the increase of violent crimes on IL_s is unexpected. A possible explanation might be the need of companies to remain in specific states regardless of crime increase (*i.e.*, California). However, they relocate within the state in a safer area as soon as a property meets their criteria. The negative effect of the increase of G.S.P. on IL_s can be possibly justified in relation to the negative relationship that the F.I.R.E. employment has with the lease indexes. The negative effect of growth rate on IL_s can be justified based on the assumption that either the increase in population is not related to employees who work in offices or the additional number of office workers can be accommodated in the existing companies office spaces or telecommuting. Finally, negative effect of density's increase on IL_s can be justified either by the unwillingness of companies to expand by leasing other properties or the limited number of office workers triggering this density increase.

City Level

The negative effect of both median age and unemployment and the positive effect of firm size on IL_c were expected. High median age can be associated with limited use of the Internet, even for property search. The negative effect of unemployment increase on IL_c is expected. An increase in unemployment is an indication of bad economic conditions, which constrain the expansion of companies in additional office spaces, thus, creating higher vacancy rates. The positive effect of the number of firms on the IL_c is expected because these companies are in search of office space, which the Internet listings provide. The increase of both online population and firm establishments has an unexpected negative effect on IL_c. A possible explanation of online population's effect is that relationship rather than Internet might drive the city's office market. Additionally, only a segment of the total population in a city is employed in office buildings, thus, an increase of population might not lead to an increase in IL_c. The firm establishments with more than 500 employees present a negative effect on IL_c. These large-sized companies may rely more on the traditional office market brokers rather than the Internet to find additional space.

Regressions 3 and 4 below of states and cities, respectively, present the socioeconomic variables with significant effect on sale indexes, IS_s and IS_c. (See also robustness analysis in Exhibits 9 and 10.)

Exhibit 9
Robustness Analysis of Sale Listings Removed from the Internet per Office Stock of U.S. States

	Regression Models							
Independent Variables	1	2	3	4	5	6	7	8
REOM								
Mean price of removed properties	−2.32E-08 0.76	−7.46E-08 −1.20	1.19E-08	−3.45E-08 −1.27	2.76E-07 0.90	3.49E-07 −4.28	3.46E-07 −5.63	3.40E-07 −7.13
Demographic								
Population	−2.93E-09 −0.49				1.57E-08 0.19			
Online population	−0.003 −0.34				−0.008 −0.16			
Median age	−0.057 −1.70				0.194 1.31			0.191 −5.05
Log of median age						8.462 −2.33	6.981 −4.22	
Density	0.000 3.28				0.002 2.23	−0.001 0.56		
Square of density						1.63E-06 −1.27	1.38E-06 −10.62	1.36E-06 −8.72
Crime								
Violent crimes				−3.43E-07 −0.38	−2.46E-06 −0.35			
Economic								
Per capita income		0.000 0.89			0.000 −1.42	0.000 3.68	0.000 0.25	
Square of per capita income							−4.17E-09 1.35	−4.93E-09 7.12

Exhibit 9 (continued)

Robustness Analysis of Sale Listings Removed from the Internet per Office Stock of U.S. States

	Regression Models							
Independent Variables	1	2	3	4	5	6	7	8
GSP of F.I.R.E.		7.40E-07 0.42			−2.14E-06 −0.17			
Mean employment per capita		3.196 0.34			9.813 0.88	9.330 −1.16		
Log of mean employment per capita							5.323 −2.66	4.883 −3.99
Mean F.I.R.E. employment per capita		15.085 0.36			−22.843 −0.40	−22.557 0.79		
Square of mean F.I.R.E. employment per capita						−1.66E-12 3.19	−2.08E-12 5.65	−2.09E-12 7.08
Mean unemployment		0.055 0.29			−0.279 −0.86	−0.416 2.79	−0.227 2.99	
Square of mean unemployment								−0.030 4.02
High tech employment		−0.097 −0.94			0.200 0.43	0.309 −3.73	−0.171 2.39	−0.184 2.86
Square of high tech employment							0.052 −4.71	0.053 −5.07
Growth rate		0.676 1.18			1.619 0.67			
Economic/Firms								
Number of firms/capita with 0–99 empl.			−441.839 −0.56		−3507.533 −1.78	−2708.804 4.06	−2340.676 6.01	−2320.27 7.78
Number of firms/capita with 100–500 empl.			1655.449 1.62		5852.587 1.53	6693.612 −4.12	5851.437 −5.34	5753.380 −7.16

Exhibit 9 (continued)

Robustness Analysis of Sale Listings Removed from the Internet per Office Stock of U.S. States

	Regression Models							
Independent Variables	1	2	3	4	5	6	7	8
Number of firms/capita with 500+ empl.			−1561.367 −1.40		−6295.069 −1.28	−7873.587 4.38	−7546.266 6.21	−7420.463 8.42
Number of firms establishments/ capita with 0–99 empl.			−353.064 −0.61		1289.904 0.54			
Number of firms establishments/ capita with 100–500 empl.			−127.412 −0.34		−1582.495 −1.59	1489.378 −4.03	−1375.881 3.84	−1316.373 5.31
Number of firms establishments/ capita with 500+ empl.			312.993 1.18		38.488 0.07			
Constant	2.463	−2.532	−1.118	0.496	−5.363	−25.204	−13.876	2.416
R^2	0.186	0.171	0.397	0.062	0.881	0.857	0.940	0.944

Note: The types of variables used in the models are in italic type. The dependent variable is sale listings removed from the Internet per office stock of U.S. states. The *t*-Statistics appear beneath the coefficients. The number of observations = 22.

Exhibit 10
Robustness Analysis of Sale Listings Removed from the Internet per Office Stock of U.S. States

	Regression Models							
Independent Variables	1	2	3	4	5	6	7	8
REOM								
Mean price of removed properties	2.52E-07 1.13	6.02E-07 0.58	3.45E-08 0.37	−1.19E-07 −1.47	6.03E-07 1.40	1.20E-07 −1.09	1.68E-07 −1.09	
Demographic								
Population	−2.80E-07 −1.19				−8.20E-07 −0.97			
Online population	−0.051 −0.58				0.163 0.30	−0.017 0.45	0.005 −0.07	−0.097 2.27
Median age	−0.599 −1.27				0.053 0.15			
Economic								
Per capita income		1.44E-04 0.32	4.01E-05 0.46		1.09E-04 0.38	9.64E-05 −1.01		
Log of per capita income							3.45E+00 −1.44	5.428 −2.21
Mean employment per capita		−7.21E-01 −0.60	−0.200 −0.25		3.58E+00 0.98	5.162 −2.22	5.629 −2.14	5.085 −2.54
Mean F.I.R.E. employment per capita		3.80E+00 0.18	−5.092 −0.43		2.71E+01 0.29	1.11E+00 −0.009		
Log of mean F.I.R.E. employment per capita							0.637 −0.27	−2.052 3.24
Mean unemployment		−2.390 −1.29	−1.269 −3.30		−2.031 −1.05	−2.102 4.04	−2.101 4.03	−2.129 4.29
High tech employment		−0.514 −0.77	−0.310 −2.23		−1.013 −0.61	−0.626 3.34	−1.55E+00 1.10	

Exhibit 10 (continued)

Robustness Analysis of Sale Listings Removed from the Internet per Office Stock of U.S. States

	Regression Models							
Independent Variables	1	2	3	4	5	6	7	8
Square of high tech employment							0.080	−0.056
							−0.67	3.26
Growth rate		0.003						
		0.10						
Economic/Firms								
Number of firms/capita with 0–99 empl.				−3612.589	50.330			
				−3.34	0.41			
Number of firms/capita with 100–500 empl.				−1692.790				
				−1.47				
Number of firms/capita with 500+ empl.				−349.400	725.324			
				−2.04	0.24			
Number of firms establishments/ capita with 0–99 empl.				4929.858				
				4.01				
Number of firms establishments/ capita with 100–500 empl.				−920.105				
				−1.50				
Number of firms establishments/ capita with 500+ empl.				786.847	−1140.424	−611.881	−669.804	−533.190
				2.94	−0.55	2.31	2.12	2.49
Constant	19.903	3.201	3.972	0.639	−3.946	5.578	−24.386	−50.595
R^2	0.534	0.868	0.724	0.792	0.929	0.889	0.918	0.878

Note: The variables in the models are in italic type. The dependent variable is sale listings removed from the Internet per office stock of U.S. states. The *t*-Statistics appear beneath the coefficients. For Models 1, 3, 5–8, the number of observations = 22; for Model 2, the number of observations = 9; for Model 4, the number of observations = 15.

$$IS_s = \underset{(2.8)}{2.416} + \underset{(-7.13)}{3.4*10^{-7}(MP)} + \underset{(-5.05)}{0.191(MA)} + \underset{(-8.72)}{1.36*10^{-6}(DEN)^2} - \underset{(7.12)}{4.93*10^{-9}\,(PCI)^2}$$
$$+ \underset{(-3.99)}{4.883\log(ME)} - \underset{(7.08)}{2.09*10^{-12}\,(MFIRE)^2} - \underset{(4.02)}{0.030(MU)} - \underset{(2.86)}{0.184(HTE)}$$
$$+ \underset{(-5.07)}{0.053(HTE)^2} - \underset{(7.78)}{2320.03(F0\text{–}99)} + \underset{(-7.16)}{5753.38(F100\text{–}500)} - \underset{(8.42)}{7420.463(F\text{-}500)}$$
$$- \underset{(5.31)}{1316.37(FE100\text{–}500)} \quad R^2 = 0.944 \quad N = 22 \tag{3}$$

$$\log(IS_c) = \underset{(-2.1)}{-50.59} - \underset{(2.27)}{0.097(OP)} + \underset{(-2.21)}{5.428\log(PCI)} + \underset{(-2.54)}{5.085\log(ME)}$$
$$- \underset{(3.24)}{2.052\log(MFIRE)} - \underset{(4.29)}{2.129(MU)} - \underset{(3.26)}{0.056(HTE)^2} - \underset{(2.49)}{533.19(FE500)}$$
$$R^2 = 0.88 \quad N = 14 \tag{4}$$

The *t*-Statistics are in parentheses below the coefficients. In these equations: IS_s and IS_c = the sales indexes for states and cities, respectively; *MP* = mean price of removed properties; *F0–99* = number of firms/capita with 0–99 employees; *F-500* = number of firms/capita with more than 500 employees and *FE100–500* = number of firm establishment/capita with 100–500 employees. The other parameters have been defined in Regressions 1 and 2.

The results from the regression analysis (Regressions 3 and 4) are:

- An increase in income has a negative effect on the sales index at the state level and a positive effect at the city level (unexpected result).
- An increase in mean employment has a positive effect on the sales index in both states and cities studied.
- An increase in both mean F.I.R.E. employment and mean unemployment has a negative effect on the sales index in both states and cities studied (unexpected result).

An increase in income has an unexpected negative effect on sales index in states, but not in cities. In states, an income increase might be distributed in areas with a limited number of online office listings or the listed properties might not be attractive to buyers. Thus, this income increase might be related to the sales index decrease. Moreover, high income is usually concentrated in cities where company offices locate. In these cities, an increase in income is an indication of good economic conditions that can enhance companies' physical expansion leading to an increase in the sales index in cities.

Similar to properties for lease, total, F.I.R.E. and high tech employment present interesting relationships with the sales index. The positive coefficient of mean

employment: (1) is consistent with expectations because increase in employment has a positive effect on demand for space; and (2) indicates that the Internet office properties seem to fill part of the demand generated by an increase in employment.

F.I.R.E. employment presents a negative effect on the sales index for both states and cities. This result can be explained similarly as in the case of lease properties.

At the state level, an increase in high tech employment initially has a negative effect on the sales index. However, as high tech employment continues to rise, the negative effect is minimized. One reason for this is that high tech employees might not require a large amount of office space due to telecommuting. Therefore, an increase in high tech employment might be accommodated in existing facilities until an expansion of office space takes place. Moreover, medium and large high tech companies might have only a small part of their facilities located in cities. This in combination with a high tech company's requirement for a small amount of office space has a negative effect on the sales index in cities.

The relationship between mean unemployment and the sales index is expected, since an increase in unemployment leads to an increase in vacant space, an indication of a soft economy and a reduction of interest in property buying.

The previous analysis of the sale indexes concentrated on the common socioeconomic variables of the regressions between states and cities. In the following, the effect of the remaining variables (in Regressions 3 and 4) on the sales indexes at the state level, IS_s, and the city level, IS_c, are examined.

State Level

At the state level, seven socioeconomic variables were not common with those at the city level. The effect of these variables on the sales index IS_s is examined next. The increase of the removed properties mean price has a positive effect on IS_s. This can be justified only if better quality properties, thus with higher prices are more likely to be removed because this is a long-term investment. The increase in median age also has a positive effect on IS_s, which is unexpected because of the lower exposure of the elderly to the Internet. However, the purchase of an office property is a significant investment and the elderly might be more willing to investigate market conditions and properties on the Internet. The positive effect of the density increase on IS_s is expected because it is an indicator of additional space needs, which can be met by the available online listings. However, this result contradicts that of the lease regression. An increase in the number of firms with 100–500 employees presents an expected positive effect on IS_s. The remaining variables have an unexpected effect on IS_s. Finally, the number of firms with employees between 0–99, more than 500 and establishments with 100–500 employees presents a negative effect on IS_s. This effect can be caused by firms that do not expand their office facilities.

City Level

At the city level there were only two variables not common with those at the state level. The negative effect of population and firm establishments' increase on IS_c can be explained similarly to the city leases.

Conclusion

This paper provides a measure through time of the lease and sale listings removed from the Internet per office stock. The results indicate that Internet is used more in leasing rather than buying an office property, a result also confirmed by broker's professional experience. Although none of the transactions occur without physical evaluation of the property, the Internet allows a rapid search and identification of a property meeting the criteria of a lessee or buyer. By determining a measure of the Internet leases (or sales), the relationship with socioeconomic variables could also be investigated through econometric relationships. The robustness analysis allowed the evaluation of the significance of the selected socioeconomic variables and the determination of the strongest relationships.

The data analysis indicates that the economic rather than the social conditions are those that impact significantly the Internet leases or sales indexes, IL and IS, at the state or city level. This study also highlights differences among the significance of the studied variables in the two levels. Particularly, the index of office properties for lease (IL) is positively affected by an increase in: (1) in online population and income per capita for states and (2) income per capita and mean employment for cities. On the other hand, IL is negatively affected by an increase in: (1) online population, mean F.I.R.E. employment, mean employment and growth rate for states and (2) mean F.I.R.E. employment, high tech employment and unemployment for cities. Likewise, the index of office properties for sale (IS) is positively affected by an increase in: (1) mean employment for states and (2) income per capita and mean employment for cities. The IS index is negatively affected by an increase in: (1) income per capita and mean F.I.R.E. employment for states and (2) mean F.I.R.E. employment for cities.

This study is the first research conducted with a significant office property data set in an effort to investigate the Internet office market trends, based on reliable data sources. Unfortunately, the Internet listing services were not able to provide any useful assistance at the time the research was conducted. However, the hope is that in the future companies will have more readily available data for analysis. Internet listing services could also require additional information from brokers when a property is listed, such as where else is the property listed, as well as when a property is removed from the listing, if the broker was contacted after an online office property search or not. Future research could benefit substantially from information provided by the listing services.

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The author thanks the anonymous referees for their detailed comments and suggestions from which the paper benefited significantly. She also thanks Grant Thrall for his encouragement to revise this paper.