

A DESCRIPTIVE ANALYSIS OF THE RETAIL REAL ESTATE MARKETS AT THE METROPOLITAN LEVEL

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Overview

Gross Leasable Area (GLA) per capita is a commonly used measure to compare the retail market potential across different retail real estate markets. This paper uses GLA per capita to assess the supply of retail space across 58 metropolitan areas in the United States. After a detailed descriptive analysis of the supply of retail space, we estimate GLA per capita for each metropolitan area using a modified version of the stock adjustment model. Initial findings indicate that the retail construction boom of the 1980s was not a boom at all and that GLA per capita can be predicted using a multi-factor model.



■ Introduction

The purpose of this paper is to provide a descriptive picture of retail real estate markets and test the viability of the GLA per capita index. Building on several inquiries made by Wheaton and Torto (1995), we explore

one of the perceived “contradictions” common in the retail real estate markets. Using both time-series and cross-sectional data on retail real estate markets, this paper tracks 58 retail markets over 27 years. Retail sales is then used to predict GLA per capita to assess which metropolitan areas are over-/undersupplied with retail space. Our findings are two-fold. First, we reveal that the retail construction “boom” of the 1980s was not a boom at all and that retail construction in the 1970s and 1990s matched that of the 1980s. Second, GLA per capita presents a fairly efficient market indicator for retail space across metropolitan areas.

The remainder of the paper is as follows: In the next section, we provide a brief overview of the GLA per capita as an index measure that is followed by a discussion of the data for each of 58 metropolitan areas using several different definitions of retail space. We then test the viability of the GLA per capita measure using a variant of the stock adjustment model and close the paper with market level estimates of retail supply per capita.

■ The Gross Leasable Area per Capita Index

For an index to be helpful to retail real estate decision-makers, it must present a meaningful comparison of alternative retail investments/development opportunities across markets. However, a majority of current retail real estate research is focused on explaining the locational and tenant mix factors of retail real estate, where site and tenancy differences make indexing retail real estate difficult if not impossible.¹ Highlighting the importance of location, some researchers use gravity models to measure the success of a retail location, suggesting that retail sales are a function of center size and travel distance to the center.²

Other advanced theoretical models of retail sales allow for the more complex decision-making of today's consumer, but these models often require a set of empirical inputs that are either not observable or are not collected.³ The use of Geographic Information Systems (GIS) epitomizes the locational importance of a shopping center by modeling the spatial relationships between and among consumers and retailers.⁴ However, GIS modeling has revealed that shopping center developers efficiently locate centers across a metropolitan area, making retail space a commodity when compared across similar center types, which in turn, should make retail real estate eminently indexable.

Gross Leasable Area (GLA) per capita is one method of comparing retail investment potential across markets. This method measures the

potential success of a retail location by standardizing retail supply by population, which is described as

$$GLAPC_i = \frac{GLA_i}{POP_i} \quad (1)$$

where

$GLAPC_i$ = gross leasable area per capita in market area i ,

GLA_i = total retail space in market area i , and

POP_i = total population in market area i .

The GLA per capita measure has been the industry's darling when discussing the over-building of retail space in the mid-1980s, because it standardizes the growth in supply of retail space across metropolitan areas and is easy to use.

■ A Descriptive Discussion of the Retail Market Data

A. Retail Real Estate Data, an Overview

One possible reason for the contradictory evidence on retail real estate may be attributable to retail market data. Retail real estate data problems and limitations are many. For instance, retail properties classified as neighborhood centers in one market are not necessarily classified as neighborhood centers in another market; retail vacancy and rental rates, if reported, are usually composite statistics that include all retail sub-property types and retail tenant types (i.e., anchor and nonanchor tenants); time-series retail data are frequently not consistent across markets and when available are usually for short durations of three to five years, which is not adequate to develop time-series models of supply; and changes in retail supply formats, i.e., power centers, urban malls, and discount retail outlets, result in a retail supply that is not easily classified into standard categories.

Industry associations, including the Urban Land Institute (ULI) and the International Council of Shopping Centers (ICSC), have promoted standard definitions and classifications of retail properties which has resulted in improved data collection and reporting. Adherence to industry standards will eventually provide the research community with a rich database of retail market data by retail property type. Until such time, our understanding of retail property markets will lag the body of knowledge found in office and industrial markets.

B. FW Dodge Retail Market Data

A special request to FW Dodge is the source of the retail supply data in this paper. Annual supply data in square feet were produced for 58 markets for 1970 through 1996. Retail supply (i.e., construction starts) is divided into two categories—*freestanding retail* and *shopping centers*. Each of these two categories is further subdivided into seven shopping center size classifications. Freestanding retail includes non-attached retail construction and freestanding construction in shopping centers (i.e., outpad buildings); the shopping center category includes all retail space that is contiguous. Single restaurant retail sites and food stores such as bakeries, butcher shops, and dairy stores are not included in either the freestanding retail or the shopping center data. Other sources of information used in this paper include the U.S. Department of Commerce, Bureau of Economic Analysis, Bureau of the Census, and Woods & Poole. Exhibit 1 illustrates the data provided by each source.

Data provided by FW Dodge have their benefits and limitations. The benefits include consistency of data gathering, time-series data, and metropolitan-level supply statistics. Limitations come in the quality control of the data collected. Classifying FW Dodge's supply statistics by retail classifications (freestanding stores and shopping centers) involves some human judgment. Also, FW Dodge retail supply data do not account for actual space removals or a change from a retail use to another use. To reduce the possibility of data categorization error we combine freestanding and shopping center retail categories into a total retail category when estimating retail supply.

EXHIBIT 1. DATA SOURCES AND VARIABLE DESCRIPTIONS

Source	Variable Description
FW Dodge	<ul style="list-style-type: none"> • Annual retail supply (construction starts) for 58 Metropolitan Statistical Areas (MSAs), 1970–1996 • Retail absorption and vacancy rates for 58 MSAs, 1991–1996
US Department of Commerce, Bureau of Economic Analysis, Census Bureau	<ul style="list-style-type: none"> • Annual population, per capita income, retail sales, retail sales excluding automotive expenditures, and number of households, 1969–1996
Woods & Poole	<ul style="list-style-type: none"> • Annual population, number of households, retail sales, and per capita income, 1970–1996

C. *The Stock of Retail Space*

The stock of retail space is a critical input to the GLA per capita measure. To have a meaningful GLA per capita index, an accurate assessment of the supply of retail space is imperative. One of the primary weaknesses of the retail supply data is the accounting for the removal of space. Retail space removals as estimated by FW Dodge for the period 1991–1996 for 58 MSAs averaged 0.70% per annum. Discussions with researchers at FW Dodge indicate that they use a non-linear stock removal function with an assumed 90-year economic life for retail space. Similarly, Wheaton and Torto (1995) estimate the growth in national retail space without considering any space removals and later use a removal of 1% of the retail stock per annum.

Different from FW Dodge and Wheaton and Torto, a 1973 study by Touche Ross and Company for the International Council of Shopping Centers found that the economic life of most shopping centers is between 22 and 29 years with an average life of 27 years. The study used panel data on 535 shopping centers across the United States. The Touche Ross research found that 69% of major center alterations for centers 15 years of age or older were needed to avoid economic obsolescence. Economic obsolescence was measured using factors such as competition, business expansion, changes in merchandising trends, changes in income trends, changes in population density, and changes in driving patterns. Physical decay of the facilities, outdated design, and other unidentified factors accounted for only 31% of alterations necessary to avoid physical obsolescence. While the Touche Ross and Company research is based on survey data, the “big six” accounting firm presents evidence that the economic obsolescence of a retail center may come much sooner than the physical obsolescence.

While the physical structures that house retail real estate may have a life that approaches 90 or 100 years, the structure itself may undergo a change in use before the end of its life. A good example of the change in use in retail properties today is culled from the time-series data supplied in the ULI's *Dollars and Cents of Shopping Centers*. Using the ULI's 1969 and 1995 survey results, the percent of shopping center space dedicated to services, which includes financial, offices, and personal services, increased 5.6% (to 16.6% of space) for neighborhood centers, 4.1% (to 9.6% of space) for community centers, 2.0% (to 5.1% of space) for regional centers, and 1.7% (3.9% of space) for super-regional centers. The anecdotal evidence of the ULI survey data supports the findings of the Touche Ross and Company study suggesting that the economic life of a retail center as a retail center may be much shorter than a center's structural life.

EXHIBIT 2. GROSS LEASABLE AREA PER CAPITA FOR FREESTANDING RETAIL SPACE BY CENTER SIZE AND METROPOLITAN AREA, 1996*

Metro area	10,000 to 25,000 s.f.						25,000 to 100,000 s.f.		100,000 to 200,000 s.f.		200,000 to 400,000 s.f.		400,000 to 800,000 s.f.		800,000 s.f. to >800,000 s.f.		Total s.f.
	<10,000 s.f.	10,000 to 25,000 s.f.	25,000 to 100,000 s.f.	100,000 to 200,000 s.f.	200,000 to 400,000 s.f.	400,000 to 800,000 s.f.	800,000 s.f. to >800,000 s.f.	>800,000 s.f.	>800,000 s.f.	>800,000 s.f.	>800,000 s.f.	>800,000 s.f.	>800,000 s.f.	>800,000 s.f.	>800,000 s.f.	>800,000 s.f.	
Atlanta	2.58	1.78	4.91	3.64	0.86	0.17	1.05	15.00									
Austin	2.18	2.13	7.40	3.69	0.41	0.00	0.00	15.80									
Baltimore	1.48	1.25	3.13	2.66	0.79	0.00	0.00	9.31									
Birmingham	2.27	1.04	4.68	2.20	1.13	0.00	0.00	11.33									
Boston	1.16	0.95	2.53	1.23	0.28	0.09	0.00	6.25									
Charlotte	2.99	2.24	4.75	3.89	1.42	0.00	0.00	15.29									
Chicago	1.70	1.55	3.82	3.01	0.80	0.00	0.00	10.89									
Cincinnati	2.45	1.99	4.74	3.24	0.82	0.00	0.66	13.91									
Cleveland	2.41	1.73	4.46	3.64	0.10	0.32	0.00	12.65									
Columbus	2.92	2.08	5.66	3.19	0.32	0.00	0.00	14.17									
Dallas	2.75	2.18	8.02	4.25	0.77	0.19	0.34	18.50									
Denver	2.10	3.28	9.31	4.01	1.12	0.60	0.00	20.42									
Detroit	2.47	1.63	3.86	2.30	1.11	0.00	0.00	11.37									
Ft. Lauderdale	3.22	2.50	6.19	3.33	0.88	0.34	0.00	16.46									
Ft. Worth	3.50	2.51	7.60	3.93	0.14	0.00	0.00	17.68									
Greensboro	3.26	2.40	5.83	3.26	1.75	0.00	0.89	17.39									
Greenville	2.92	1.81	5.88	2.66	0.25	0.00	0.00	13.51									
Hartford	1.62	1.63	3.90	2.67	0.60	0.00	0.00	10.42									
Honolulu	2.14	2.21	4.25	3.32	3.43	0.00	1.01	16.36									
Houston	3.13	1.75	5.78	3.59	0.90	0.30	0.00	15.45									
Indianapolis	3.38	2.35	5.58	4.33	1.31	0.00	0.00	16.96									
Jacksonville	3.66	2.57	6.10	3.39	0.49	0.00	0.00	16.20									
Kansas City	2.56	2.17	5.75	3.80	0.60	0.58	0.00	15.47									

Las Vegas	4.32	2.88	8.64	2.80	0.84	0.00	0.00	19.48
Los Angeles	2.53	1.90	3.69	2.06	0.53	0.30	0.19	11.20
Miami	2.40	1.75	3.42	2.23	0.77	0.00	0.00	10.57
Milwaukee	2.30	2.21	4.24	1.62	0.37	0.00	0.00	10.74
Minneapolis	1.57	1.31	4.07	3.05	0.52	0.00	0.00	10.51
Nashville	4.00	2.40	6.14	3.47	1.26	0.00	0.00	17.27
Nassau-Suffolk	1.39	0.68	1.90	1.04	0.71	0.00	0.00	5.71
New Haven	1.81	1.41	2.69	2.22	0.35	0.00	0.00	8.48
New Orleans	2.57	1.41	5.13	2.67	1.04	0.00	0.00	12.82
New York City	0.49	0.28	0.55	0.38	0.23	0.00	0.00	1.92
Newark	1.22	0.87	1.46	1.21	0.58	0.00	0.00	5.33
Norfolk	2.30	1.76	3.88	1.79	0.57	0.00	0.00	10.30
Oakland	1.45	2.33	5.16	2.83	0.44	0.00	0.00	12.21
Oklahoma City	2.38	1.84	5.38	3.63	0.20	0.00	0.00	13.44
Orange County	2.95	3.17	6.63	3.29	0.33	0.31	0.00	16.68
Orlando	3.31	2.47	6.69	2.96	0.49	0.00	0.00	15.92
Philadelphia	1.15	0.79	2.44	1.91	0.49	0.13	0.00	6.92
Phoenix	3.55	2.88	8.74	3.01	0.44	0.00	0.00	18.62
Pittsburgh	1.43	1.02	3.33	1.52	0.54	0.00	0.00	7.85
Portland	1.93	2.73	5.89	4.53	0.78	0.00	0.00	15.86
Raleigh	1.91	1.54	5.34	2.58	0.32	0.00	0.00	11.69
Richmond	2.59	1.51	4.90	3.51	0.45	0.00	0.00	12.97
Riverside	2.50	2.88	7.32	2.70	0.41	0.00	0.00	15.80
Sacramento	2.02	3.57	7.52	2.51	0.14	0.00	0.00	15.76
St. Louis	1.17	1.34	4.26	3.32	0.38	0.00	0.00	10.47
Salt Lake City	2.28	3.16	9.21	4.27	0.31	0.00	0.00	19.22
San Antonio	2.30	1.84	5.81	3.09	0.40	0.00	0.00	13.45
San Diego	2.91	2.79	6.57	3.77	0.37	0.00	0.00	16.40
San Francisco	1.41	1.69	2.99	1.93	1.78	1.23	0.00	11.02

EXHIBIT 2. Continued

Metro area	10,000 to 400,000 to								Total s.f.
	<10,000 s.f.	10,000 to 25,000 s.f.	25,000 to 100,000 s.f.	100,000 to 200,000 s.f.	200,000 s.f. to 400,000 s.f.	400,000 s.f. to 800,000 s.f.	800,000 s.f. to >800,000 s.f.	>800,000 s.f.	
San Jose	1.77	3.12	6.06	2.73	1.02	0.77	0.00	0.00	15.46
Seattle	1.88	2.88	5.79	3.61	0.47	0.00	0.00	0.00	14.63
Tampa	3.30	2.30	6.03	3.09	0.64	0.00	0.00	0.00	15.56
Tulsa	2.95	2.00	7.80	2.38	0.91	0.00	0.00	0.00	16.03
Washington	1.00	0.86	3.73	2.29	0.54	0.00	0.00	0.00	8.41
West Palm Beach	3.21	2.40	4.89	2.69	1.46	0.00	0.00	0.00	14.66
Average	2.11	1.78	4.58	2.64	0.64	0.10	0.07	0.07	11.91

*The supply of space is defined as all construction starts for the period 1970-1996.

Based on the ULI data and the Touche Ross and company report, retail supply data used in this analysis only include space that was constructed in the past 27 years, the estimated economic life of a shopping center. While this may have some limiting consequences on the analysis of retail real estate supply, especially for cities with older, viable downtown retail areas, the stock of space is consistently determined for each market based on actual (not estimated) retail construction data. It should also be noted that the 27-year average life of a shopping center conveniently matches the time-series of the FW Dodge retail supply data.

D. GLA per Capita as a Retail Market Benchmark

The GLA per capita is reported for freestanding retail space, shopping center space, and total retail space in exhibits 2–4. Total freestanding retail space per capita (exhibit 2) maintains a mean of 11.91 with a range of approximately 10 to 17 square feet per capita with a few notable outliers. All observations of GLA per capita that were less than 10 were recorded for established East Coast cities which include Baltimore, Boston, New York City and its sub-jurisdictions, Philadelphia, Pittsburgh, and Washington. Cities that maintained a high GLA per capita (over 18) were all younger, high-growth cities and include Dallas, Denver, Las Vegas, Phoenix, and Salt Lake City.

Results of both the shopping center GLA per capita and total retail (combined freestanding and shopping center) GLA per capita analyses are similar to freestanding GLA per capita. Shopping center and total retail GLA per capita maintain a mean of 9.92 and 21.84, respectively. Most MSAs maintain a total retail GLA per capita of 17 to 26 (see exhibit 4). The clear outlier is New York City with 3.89 square feet of total retail per capita (recall that this analysis only includes retail space constructed between 1970 and 1996). Several of the rapidly growing or tourist destination MSAs maintain the highest total retail GLA per capita with Fort Lauderdale at 41.39, West Palm Beach at 39.99, Orlando at 38.74, and Las Vegas at 35.94. As tourist destinations, all of these MSAs are able to draw retail dollars from visiting tourists, and therefore have a justifiably higher GLA per capita.

E. The Supply of Retail Space over the Last 27 Years

The over-building of the 1980s has been well documented in the popular press and in the academic real estate literature, which generally states

EXHIBIT 3. GROSS LEASABLE AREA PER CAPITA FOR SHOPPING CENTER SPACE BY CENTER SIZE AND METROPOLITAN AREA, 1996*

Metro area	10,000 to 25,000 s.f.		25,000 to 100,000 s.f.		100,000 to 200,000 s.f.		200,000 to 400,000 s.f.		400,000 s.f. to 800,000 s.f.		800,000 s.f. to >800,000 s.f.		Total s.f.
	<10,000 s.f.	10,000 to 25,000 s.f.	25,000 to 100,000 s.f.	100,000 to 200,000 s.f.	200,000 to 400,000 s.f.	400,000 s.f. to 800,000 s.f.	800,000 s.f. to >800,000 s.f.	>800,000 s.f.					
Atlanta	0.32	1.04	7.75	4.17	2.24	1.05	0.00	16.57					
Austin	0.18	0.60	5.04	2.49	1.71	0.67	1.40	12.09					
Baltimore	0.24	0.52	2.60	1.96	1.62	0.72	1.39	9.05					
Birmingham	0.21	0.60	3.75	3.59	2.50	1.65	0.00	12.30					
Boston	0.10	0.37	1.18	1.77	1.10	0.76	0.38	5.66					
Charlotte	0.24	0.96	6.85	2.46	2.59	2.03	2.09	17.22					
Chicago	0.31	0.87	2.54	1.82	2.05	1.09	1.03	9.71					
Cincinnati	0.39	0.87	2.63	2.23	2.50	0.57	0.63	9.82					
Cleveland	0.24	0.77	2.36	1.75	1.01	0.84	0.67	7.64					
Columbus	0.45	1.23	4.43	2.83	1.03	0.76	0.85	11.58					
Dallas	0.43	1.26	5.63	2.44	1.71	1.12	1.41	14.00					
Denver	0.13	0.75	3.82	2.71	2.21	1.10	1.37	12.09					
Detroit	0.48	1.14	3.15	1.80	0.93	0.73	0.30	8.53					
Ft. Lauderdale	0.45	1.88	8.24	6.62	3.76	0.87	3.11	24.93					
Ft. Worth	0.75	1.53	5.11	2.24	2.95	1.47	1.07	15.12					
Greensboro	0.31	0.61	5.58	2.40	0.72	1.51	1.65	12.78					
Greenville	0.23	0.79	6.63	2.66	1.33	1.64	2.34	15.62					
Hartford	0.07	0.45	2.50	1.45	1.32	0.90	0.00	6.69					
Honolulu	0.03	0.15	0.35	0.54	0.39	0.00	0.00	1.46					
Houston	0.48	1.37	5.81	2.84	1.70	0.72	0.00	12.92					
Indianapolis	0.36	1.01	4.70	1.92	1.16	0.00	1.50	10.65					
Jacksonville	0.43	1.09	6.73	3.52	2.98	0.00	2.35	17.10					

Kansas City	0.34	0.72	4.31	2.51	0.89	1.28	2.16	12.21
Las Vegas	0.42	1.71	5.97	3.70	2.82	1.85	0.00	16.47
Los Angeles	0.47	0.86	1.88	1.10	0.81	0.72	0.31	6.15
Miami	0.58	1.49	4.91	3.49	2.14	2.64	0.59	15.84
Milwaukee	0.38	0.89	2.27	1.56	0.72	0.41	0.00	6.23
Minneapolis	0.21	0.79	3.17	2.02	1.68	0.63	1.51	10.01
Nashville	0.44	1.14	5.55	3.65	2.99	1.39	0.00	15.16
Nassau-Suffolk	0.10	0.36	1.46	1.80	0.89	1.16	0.00	5.77
New Haven	0.21	0.67	1.82	3.53	0.79	0.40	1.52	8.94
New Orleans	0.42	1.09	3.50	2.51	0.69	0.84	0.76	9.81
New York City	0.04	0.10	0.50	0.25	0.32	0.28	0.48	1.97
Newark	0.12	0.44	1.23	1.20	0.89	1.81	0.00	5.69
Norfolk	0.26	0.89	3.48	3.01	0.66	3.00	0.71	12.01
Oakland	0.09	0.50	2.60	1.79	0.41	0.77	0.59	6.75
Oklahoma City	0.37	1.49	4.73	3.47	1.47	1.70	2.71	15.94
Orange County	0.32	0.82	3.78	2.43	1.56	1.13	0.00	10.04
Orlando	0.30	1.20	8.17	5.28	1.91	1.77	4.19	22.82
Philadelphia	0.16	0.51	2.49	2.21	1.76	0.88	0.97	8.98
Phoenix	0.32	1.19	6.06	3.85	1.59	2.42	0.51	15.94
Pittsburgh	0.10	0.29	2.08	1.75	2.13	1.68	0.58	8.61
Portland	0.07	0.40	2.42	2.12	1.05	0.43	0.00	6.49
Raleigh	0.19	0.67	7.55	4.06	2.01	1.47	0.85	16.80
Richmond	0.22	0.86	5.45	2.75	2.12	0.48	0.95	12.83
Riverside	0.18	0.82	3.77	2.18	1.61	0.70	0.68	9.94
Sacramento	0.13	1.04	3.38	2.98	0.29	0.51	0.00	8.33
St. Louis	0.15	0.59	2.11	1.18	1.14	0.24	0.00	5.41
Salt Lake City	0.16	0.39	2.34	1.81	0.82	0.37	2.30	8.19
San Antonio	0.31	0.75	4.22	1.89	0.88	0.62	2.33	11.00
San Diego	0.21	0.93	3.49	1.97	0.93	0.39	0.51	8.43

EXHIBIT 3. *Continued*

Metro area	<10,000 s.f.	10,000 to 25,000 s.f.	25,000 to 100,000 s.f.	100,000 to 200,000 s.f.	200,000 to 400,000 s.f.	400,000 to 800,000 s.f.	>800,000 s.f.	Total s.f.
San Francisco	0.04	0.17	0.75	1.15	0.30	0.27	0.00	2.68
San Jose	0.15	0.55	1.60	1.43	0.98	0.65	0.00	5.36
Seattle	0.10	0.55	2.64	1.58	0.62	0.57	0.73	6.79
Tampa	0.44	1.48	6.59	4.16	2.07	0.53	3.03	18.30
Tulsa	0.34	1.24	4.73	4.38	1.25	0.83	2.01	14.78
Washington	0.19	0.65	3.66	2.63	1.94	2.15	2.21	13.43
West Palm Beach	0.42	1.79	8.70	10.40	2.81	1.21	0.00	25.33
Average	0.27	0.79	3.40	2.26	1.40	0.96	0.84	9.92

*The supply of space is defined as all construction starts for the period 1970-1996.

that the lack of discipline among all players in the real estate industry created a glut of office, industrial, hotel, and retail space. In exhibits 5–7 we catalog the additions to retail supply for the combined 58 MSAs over the past 27 years for freestanding retail, shopping center, and total retail space. The increase in retail stock is standardized by the total space added for the period 1970 to 1996. For instance, exhibit 5 reveals that additions to total square feet of freestanding retail for 1994 was greater than any other year with 5.48% of the stock added to the 27-year total. During an average year 3.7% of the total freestanding retail space was added to the stock of freestanding space. The boom in freestanding construction in the 1990s can be explained by the increase in stand-alone, “big box” discount retailers over the past several years. It should also be noted that in intermittent years space was added in the 400,000 to 800,000 and greater than 800,000 square feet categories. We suggest that these observations are attributable to the incorrect coding of shopping center data as freestanding retail data for we can cite no examples of freestanding retail facilities greater than 400,000 square feet.

Exhibit 6 presents the increases to the supply of shopping centers for the period 1970 to 1996, standardized by total shopping center space added, 1970 to 1996. The mid to late 1980s represented a period of great expansion for shopping centers smaller than 800,000 square feet. Super-regional mall construction, as represented by the greater than 800,000 square feet category, underwent its growth cycle in the 1970s. Overall, shopping center supply additions expanded most rapidly during the 1984–1989 period, confirming the anecdotal evidence of the 1980s construction boom. The combined freestanding and shopping center supply additions are presented in exhibit 7 which reveals a much more muted development boom in the 1980s.

In exhibit 8, we analyze the decade-by-decade additions to supply of retail space for all 58 MSAs standardized by the average construction for the period 1970 to 1996. Any decade with an index number of greater than 100% indicates that a greater proportion of construction occurred in that decade than in other decades. For the category of total square feet of freestanding retail space constructed, the 1970s maintained 103% of an average year, while the 1980s saw little construction of freestanding retail at only 83% of an average year and the 1990s reveal an increase in freestanding retail space constructed to 120% of the average year. Shopping center supply additions reveal the converse, with 91%, 126% and 75% of the average for the 1970s, 1980s, and 1990s, respectively.

Of particular interest in exhibit 8 is the decade-by-decade increase in total retail space. The results show that total retail space added during the 1970s was 97% of the 27-year average, and during the 1980s and

EXHIBIT 4. GROSS LEASABLE AREA PER CAPITA FOR ALL RETAIL SPACE BY CENTER SIZE AND METROPOLITAN AREA, 1996*

Metro area	10,000 to 25,000 s.f.		25,000 to 100,000 s.f.		100,000 to 200,000 s.f.		200,000 to 400,000 s.f.		400,000 to 800,000 s.f.		800,000 s.f. >800,000 s.f.		Total s.f.
	<10,000 s.f.	10,000 to 25,000 s.f.	25,000 to 100,000 s.f.	100,000 to 200,000 s.f.	200,000 to 400,000 s.f.	400,000 to 800,000 s.f.	800,000 s.f. >800,000 s.f.	>800,000 s.f.	>800,000 s.f.	>800,000 s.f.	>800,000 s.f.		
Atlanta	2.90	2.82	12.66	7.82	3.10	1.22	1.05	31.57					
Austin	2.36	2.72	12.44	6.19	2.11	0.67	1.40	27.89					
Baltimore	1.72	1.76	5.73	4.63	2.41	0.72	1.39	18.36					
Birmingham	2.49	1.64	8.43	5.79	3.64	1.65	0.00	23.64					
Boston	1.26	1.32	3.71	3.00	1.38	0.85	0.38	11.90					
Charlotte	3.23	3.20	11.60	6.34	4.02	2.03	2.09	32.51					
Chicago	2.01	2.43	6.36	4.83	2.85	1.09	1.03	20.60					
Cincinnati	2.84	2.86	7.37	5.47	3.33	0.57	1.29	23.73					
Cleveland	2.65	2.49	6.82	5.39	1.10	1.16	0.67	20.28					
Columbus	3.37	3.30	10.09	6.03	1.35	0.76	0.85	25.75					
Dallas	3.17	3.45	13.65	6.69	2.48	1.32	1.75	32.51					
Denver	2.23	4.04	13.13	6.71	3.33	1.70	1.37	32.51					
Detroit	2.95	2.76	7.01	4.10	2.04	0.73	0.30	19.89					
Ft. Lauderdale	3.68	4.37	14.43	9.95	4.64	1.21	3.11	41.39					
Ft. Worth	4.25	4.05	12.71	6.18	3.08	1.47	1.07	32.81					
Greensboro	3.57	3.01	11.41	5.66	2.46	1.51	2.54	30.16					
Greenville	3.15	2.60	12.51	5.32	1.58	1.64	2.34	29.14					
Hartford	1.70	2.08	6.40	4.12	1.92	0.09	0.00	17.12					
Honolulu	2.17	2.36	4.60	3.86	3.82	0.00	1.01	17.82					
Houston	3.61	3.13	11.59	6.43	2.61	1.01	0.00	28.38					
Indianapolis	3.74	3.36	10.28	6.26	2.46	0.00	1.50	27.60					
Jacksonville	4.08	3.65	12.83	6.91	3.47	0.00	2.35	33.29					

Kansas City	2.91	2.89	10.06	6.31	1.49	1.85	2.16	27.67
Las Vegas	4.74	4.59	14.60	6.50	3.66	1.85	0.00	35.94
Los Angeles	3.00	2.76	5.57	3.16	1.35	1.02	0.49	17.35
Miami	2.98	3.24	8.33	5.72	2.91	2.64	0.59	26.41
Milwaukee	2.69	3.09	6.51	3.19	1.09	0.41	0.00	16.98
Minneapolis	1.78	2.10	7.24	5.07	2.20	0.63	1.51	20.53
Nashville	4.44	3.54	11.70	7.12	4.25	1.39	0.00	32.44
Nassau-Suffolk	1.49	1.03	3.36	2.83	1.61	1.16	0.00	11.48
New Haven	2.02	2.08	4.51	5.74	1.14	0.40	1.52	17.41
New Orleans	2.99	2.50	8.63	5.18	1.73	0.84	0.76	22.63
New York City	0.53	0.38	1.04	0.63	0.55	0.28	0.48	3.89
Newark	1.34	1.30	2.69	2.41	1.46	1.81	0.00	11.01
Norfolk	2.56	2.66	7.36	4.80	1.24	3.00	0.71	22.33
Oakland	1.54	2.83	7.77	4.62	0.84	0.77	0.59	18.96
Oklahoma City	2.75	3.33	10.12	7.10	1.67	1.70	2.71	29.38
Orange County	3.27	4.00	10.40	5.72	1.90	1.44	0.00	26.73
Orlando	3.60	3.67	14.86	8.24	2.41	1.77	4.19	38.74
Philadelphia	1.31	1.31	4.93	4.12	2.25	1.01	0.97	15.90
Phoenix	3.87	4.07	14.80	6.86	2.03	2.42	0.51	34.56
Pittsburgh	1.54	1.31	5.42	3.27	2.66	1.68	0.58	16.46
Portland	1.99	3.13	8.31	6.65	1.83	0.43	0.00	22.34
Raleigh	2.10	2.21	12.89	6.64	2.33	1.47	0.85	28.49
Richmond	2.81	2.37	10.35	6.26	2.57	0.48	0.95	25.79
Riverside	2.68	3.70	11.09	4.87	2.02	0.70	0.68	25.74
Sacramento	2.15	4.61	10.89	5.49	0.44	0.51	0.00	24.09
St. Louis	1.32	1.94	6.37	4.50	1.51	0.24	0.00	15.88
Salt Lake City	2.43	3.55	11.55	6.08	1.13	0.37	2.30	27.41
San Antonio	2.61	2.60	10.03	4.98	1.28	0.62	2.33	24.45

EXHIBIT 4. Continued

Metro area	<10,000 s.f.	10,000 to 25,000 s.f.	25,000 to 100,000 s.f.	100,000 to 200,000 s.f.	200,000 to 400,000 s.f.	400,000 to 800,000 s.f.	>800,000 s.f.	Total s.f.
San Diego	3.12	3.71	10.05	5.74	1.30	0.39	0.51	24.82
San Francisco	1.45	1.85	3.74	3.08	2.08	1.50	0.00	13.70
San Jose	1.92	3.66	7.65	4.16	2.00	1.42	0.00	20.81
Seattle	1.97	3.44	8.43	5.19	1.08	0.57	0.73	21.41
Tampa	3.74	3.78	12.62	7.26	2.70	0.73	3.03	33.86
Tulsa	3.29	3.24	12.52	6.76	2.15	0.83	2.01	30.80
Washington	1.19	1.51	7.39	4.92	2.48	2.15	2.21	21.85
West Palm Beach	3.64	4.19	13.59	13.09	4.27	1.21	0.00	39.99
Average	2.38	2.57	7.98	4.90	2.04	1.06	0.91	21.84

*The supply of space is defined as all construction starts for the period 1970-1996.

1990s the construction was 103% and 100% of the 27-year average. The total retail space summary statistics reveal that retail construction on a decade-by-decade basis has been flat.⁵ Additionally, if these decade-by-decade numbers were adjusted for the increase in population over time, they would show that retail construction has decreased over time on a per capita basis. This decade-by-decade descriptive analysis dispels one retail contradiction—that retail supply grew at a more rapid pace in the 1980s.

■ Testing the GLA per Capita Rule Using a Modified Stock Adjustment Model

A. The Stock Adjustment Model

To examine the demand for retail space we adopt a special case of the stock adjustment model that is modified for cross-sectional estimation. There are two reasons for introducing a time-series model that will be tested cross-sectionally. First, stock adjustment models have been the preferred means of modeling additions to the supply of real estate. Other real estate research that has used a version of the stock adjustment model include: Benjamin, Jud, and Okoruwa (1993); Benjamin, Jud, and Winkler (1996); Eppli and Shilling (1995); Eppli, Shilling, and Vandell (forthcoming); Voith and Crone (1988); and Wheaton and Torto (1990). Second, we are attempting to estimate the change in the stock of retail space for the period 1970–1996, which follows the theoretical constructs of a stock adjustment model.

A stock adjustment model for retail real estate assumes that the desired level of demand for retail space is dependent on retail sales, that is,

$$K_{it}^* = \frac{S_{it}}{\Phi_i} \quad (2)$$

or

$$K_{it}^* = \beta_{i0} + \beta_{i1} S_{it} + \varepsilon_{it} \quad (3)$$

where

K_{it}^* = the desired level retail stock of space in market i at time t ,

S_{it} = retail expenditures in market i at time t ,

Φ_i = equilibrium retail sales per square foot in market i , and

ε_{it} = random error term.

**EXHIBIT 5. FREESTANDING RETAIL CONSTRUCTION SPACE AS A PERCENT OF TOTAL FREESTANDING
RETAIL SUPPLY (1970-1996) BY CENTER SIZE AND YEAR OF COMPLETION**

Year	10,000 to 25,000 s.f.		25,000 to 100,000 s.f.		100,000 to 200,000 s.f.		200,000 to 400,000 s.f.		400,000 to 800,000 s.f.		>800,000 s.f.		Total s.f.
	<10,000 s.f.	10,000 to 25,000 s.f.	25,000 to 100,000 s.f.	100,000 to 200,000 s.f.	200,000 to 400,000 s.f.	400,000 to 800,000 s.f.	800,000 to 400,000 s.f.	400,000 to 800,000 s.f.	>800,000 s.f.	>800,000 s.f.	>800,000 s.f.	Total s.f.	
1970	3.57%	4.14%	2.86%	4.78%	6.94%	12.40%	29.24%	4.06%					4.06%
1971	4.01	4.56	2.86	5.43	5.76	3.24	0.00	4.03					4.03
1972	4.72	5.38	3.80	5.04	5.46	0.00	10.83	4.57					4.57
1973	4.92	5.90	3.79	4.37	6.75	8.95	0.00	4.62					4.62
1974	3.97	3.92	3.23	3.81	5.08	8.31	0.00	3.72					3.72
1975	3.63	3.09	2.03	3.59	4.92	9.63	0.00	3.02					3.02
1976	4.52	3.84	2.53	2.58	1.96	0.00	0.00	3.02					3.02
1977	4.91	4.47	3.48	2.76	1.03	0.00	11.37	3.61					3.61
1978	5.03	4.26	3.58	3.25	3.75	4.47	14.08	3.94					3.94
1979	3.67	3.47	3.70	3.65	3.62	0.00	0.00	3.59					3.59
1980	3.00	2.38	3.19	3.06	2.45	4.69	0.00	2.96					2.96
1981	2.73	2.04	2.52	2.08	0.54	0.00	0.00	2.24					2.24
1982	2.44	1.84	2.32	1.33	1.87	0.00	0.00	1.99					1.99
1983	3.17	2.53	2.44	0.73	0.56	4.11	0.00	2.11					2.11
1984	3.85	3.29	3.08	1.35	1.97	11.18	0.00	2.86					2.86
1985	4.62	4.45	4.18	2.54	3.64	0.00	0.00	3.84					3.84
1986	4.57	4.30	4.31	1.77	3.90	4.25	9.75	3.80					3.80

EXHIBIT 6. SHOPPING CENTER RETAIL CONSTRUCTION SPACE AS A PERCENT OF TOTAL SHOPPING CENTER RETAIL SUPPLY (1970-1996) BY CENTER SIZE AND YEAR OF COMPLETION

Year	10,000 to 25,000 s.f.		25,000 to 100,000 s.f.		100,000 to 200,000 s.f.		200,000 to 400,000 s.f.		400,000 to 800,000 s.f.		>800,000 s.f.		Total s.f.
	<10,000 s.f.	10,000 to 25,000 s.f.	25,000 to 100,000 s.f.	100,000 to 200,000 s.f.	200,000 to 400,000 s.f.	400,000 to 800,000 s.f.	800,000 to 1,000,000 s.f.	1,000,000 to 2,000,000 s.f.	2,000,000 to 4,000,000 s.f.	4,000,000 to 8,000,000 s.f.	>8,000,000 s.f.		
1970	1.52%	1.09	1.34	2.96	3.34	4.00	1.92	2.28					2.28
1971	2.04	2.08	2.21	3.51	2.71	4.83	5.30	3.08					3.08
1972	3.00	2.71	3.09	4.91	3.80	3.46	9.35	4.14					4.14
1973	3.39	2.85	4.35	4.03	5.30	3.28	8.85	4.54					4.54
1974	2.03	2.45	3.15	2.77	2.68	4.44	9.39	3.56					3.56
1975	1.98	1.65	1.75	1.82	1.40	2.59	5.07	2.08					2.08
1976	3.04	2.92	2.70	1.62	1.55	1.79	0.00	2.00					2.00
1977	4.04	3.78	3.50	2.76	2.39	1.96	0.89	2.84					2.84
1978	4.81	5.40	4.93	3.71	2.75	3.88	3.02	4.11					4.11
1979	3.93	4.41	5.11	4.82	4.01	6.15	6.11	4.99					4.99
1980	2.98	3.10	3.78	3.39	0.97	4.73	4.86	3.40					3.40
1981	2.77	2.67	2.80	2.62	2.01	2.56	1.07	2.47					2.47
1982	3.02	2.49	2.43	1.31	2.09	2.28	0.00	1.93					1.93
1983	4.88	4.75	4.58	2.91	3.11	0.98	2.61	3.50					3.50
1984	6.55	8.05	6.72	4.99	2.94	3.45	0.00	5.01					5.01
1985	9.01	8.88	7.71	7.26	7.01	4.38	2.59	6.88					6.88
1986	8.55	8.28	7.40	6.72	6.01	4.81	2.80	6.51					6.51

EXHIBIT 7. TOTAL RETAIL CONSTRUCTION AS A PERCENT OF TOTAL RETAIL SUPPLY (1970-1996) BY CENTER SIZE AND YEAR OF COMPLETION

Year	10,000 to 25,000 s.f.		25,000 to 100,000 s.f.		100,000 to 200,000 s.f.		200,000 to 400,000 s.f.		400,000 to 800,000 s.f.		800,000 s.f. >800,000 s.f.		Total s.f.
	<10,000 s.f.	10,000 to 25,000 s.f.	25,000 to 100,000 s.f.	100,000 to 200,000 s.f.	200,000 to 400,000 s.f.	400,000 to 800,000 s.f.	800,000 s.f. >800,000 s.f.	>800,000 s.f.	>800,000 s.f.	>800,000 s.f.	>800,000 s.f.		
1970	3.34	3.20	2.21	3.94	4.46	4.82	3.99	3.25					
1971	3.79	3.79	2.58	4.55	3.66	4.67	4.90	3.60					
1972	4.52	4.55	3.50	4.98	4.32	3.12	9.46	4.37					
1973	4.75	4.96	4.03	4.21	5.75	3.83	8.17	4.58					
1974	3.75	3.47	3.19	3.33	3.43	4.81	8.68	3.65					
1975	3.44	2.65	1.91	2.77	2.50	3.28	4.69	2.59					
1976	4.36	3.55	2.60	2.14	1.68	1.61	0.00	2.56					
1977	4.82	4.26	3.49	2.76	1.97	1.77	1.68	3.26					
1978	5.00	4.61	4.15	3.46	3.06	3.93	3.86	4.02					
1979	3.70	3.76	4.30	4.19	3.89	5.55	5.64	4.22					
1980	3.00	2.58	3.44	3.21	1.43	4.73	4.49	3.16					
1981	2.73	2.23	2.64	2.33	1.55	2.31	0.99	2.34					
1982	2.51	2.04	2.37	1.32	2.02	2.05	0.00	1.96					
1983	3.36	3.22	3.35	1.73	2.31	1.29	2.41	2.74					
1984	4.15	4.76	4.63	3.03	2.64	4.21	2.39	3.84					
1985	5.11	5.82	5.68	4.72	5.96	3.95	3.33	5.22					
1986	5.01	5.53	5.63	4.06	5.36	4.75	4.37	5.03					

EXHIBIT 8. ADDITIONS TO THE SUPPLY OF TOTAL RETAIL SPACE BY DECADE AS A PERCENT OF TOTAL RETAIL SUPPLY (1970-1996)

Type of Retail Space	<10,000 s.f.	10,000 to 25,000 s.f.	25,000 to 100,000 s.f.	100,000 to 200,000 s.f.	200,000 s.f. to 400,000 s.f.	400,000 s.f. to 800,000 s.f.	800,000 s.f. to >800,000 s.f.	Total s.f.
Freestanding retail space								
1970s	1.16	1.16	0.86	1.06	1.22	1.27	1.77	1.03
1980s	0.96	0.86	0.93	0.53	0.74	1.23	0.26	0.83
1990s	0.83	0.97	1.29	1.58	1.05	0.29	0.95	1.20
Shopping center retail space								
1970s	0.80	0.79	0.87	0.89	0.81	0.98	1.35	0.91
1980s	1.53	1.57	1.41	1.28	1.15	1.04	0.69	1.26
1990s	0.52	0.48	0.60	0.76	1.06	0.97	0.94	0.75
Total retail space								
1970s	1.12	1.05	0.86	0.98	0.94	1.01	1.38	0.97
1980s	1.03	1.08	1.14	0.88	1.02	1.06	0.66	1.03
1990s	0.79	0.82	0.99	1.20	1.06	0.90	0.94	1.00

Φ_i could also be defined as the number of persons (or fraction of a person) necessary to justify another square foot of retail space. The subscript i refers to each of the 58 metropolitan areas for which we have data. From Pindyck and Rubinfeld (1991) we propose the following stock adjustment model:

$$K_{it} - K_{it-1} = \delta_i(K_{it}^* - K_{it-1}) \quad (4)$$

where

K_{it} = the actual stock of retail space in market i at time t , and
 δ_i = the speed of adjustment parameter.

In any given period, the actual value of K may not adjust completely to the desired level of supply. Thus the speed of adjustment factor, δ , is responsible for the partial adjustment and its value is constrained to the range $0 < \delta < 1$. If the value of δ approaches 0, the time it takes for the market to adjust to additions in supply is large. Conversely, if $\delta = 1$, the market can completely absorb all new space in the period that it is constructed. Substituting equation 3 for K_{it}^* in equation 4 returns

$$K_{it} = \delta_i \beta_{i0} + \delta_i \beta_{i1} S_{it} + (1 - \delta_i) K_{it-1} + \delta_i \eta_{it} \quad (5)$$

Data limitations pose direct limitations on our ability to test each metropolitan area for its speed in absorbing new space using equation 5. The time-series data for each market is available for 27 periods. Additionally, to test for the speed of adjustment, several lag periods are necessary, further decreasing the number of time-series observations. To address these limitations, we assume that all space is absorbed in the

EXHIBIT 9. SUMMARY STATISTICS FOR THE 58 METROPOLITAN AREAS

Characteristic	Standard			
	Mean	Deviation	Minimum	Maximum
Change in square feet of retail space 1970-96*	50,350	30,757	15,634	159,179
Change in occupied square feet of retail space, 1970-96*	46,332	28,571	14,258	150,868
Change in retail sales, 1970-96**	8,304	5,027	(2,006)	20,144
Total retail sales in 1996**	19,888	13,697	6,455	69,225
Population in 1996*	2,305	1,804	747	9,138
Tourism as a percent of gross regional product in 1996	4.71%	3.03%	2.22%	23.9%

* = 000

** = 000,000

EXHIBIT 10. EXPLANATORY POWER OF RETAIL SALES VARIABLES ON TOTAL AND OCCUPIED RETAIL SPACE ACROSS 58 METROPOLITAN AREAS, 1996* (T-RATIOS IN PARENTHESES)

Dependent Variable	Constant	Change in Retail Sales, 1970-96	Total Retail Sales, 1996	R-Squared
Total retail space	7,120 (1.71)	5.21 (12.12)	—	72.4%
Total retail space	13,824 (3.33)	—	1.84 (10.64)	66.9
Total retail space	1,032 (0.33)	3.41 (8.60)	1.06 (7.25)	85.9
Occupied retail space	6,447 (1.64)	4.80 (11.83)	—	71.4
Occupied retail space	11,829 (3.17)	—	1.73 (11.21)	69.2
Occupied retail space	449 (0.16)	3.04 (8.45)	1.04 (7.89)	86.6

*Total retail space is defined as all construction starts for the period 1970-1996. Occupied space is the product of total retail space and the quantity (1 minus vacancy rate).

EXHIBIT 11. EXPLANATORY POWER OF RETAIL SALES VARIABLES ON DEPRECIATED STOCK OF TOTAL AND OCCUPIED RETAIL SPACE ACROSS 58 METROPOLITAN AREAS, 1996* (T-RATIOS IN PARENTHESES)

Dependent Variable	Constant	Change in Retail Sales, 1970-96	Total Retail Sales, 1996	R-Squared
Total retail space	3,926 (1.83)	2.78 (12.48)	—	73.6%
Total retail space	8,264 (3.56)	—	0.93 (9.67)	62.5
Total retail space	1,076 (0.62)	1.92 (8.71)	0.494 (6.12)	84.3
Occupied retail space	3,562 (1.77)	2.54 (12.22)	—	72.2
Occupied retail space	7,147 (3.43)	—	0.88 (10.17)	64.9
Occupied retail space	736 (0.47)	1.71 (8.57)	0.49 (6.69)	85.0

*Total retail space is defined as all construction starts for the period 1970-1996. Occupied space is the product of total retail space and the quantity (1 minus vacancy rate).

current period by constraining δ to 1, and we use a single period model such that K_{it} is the amount of additional supply added during the 1970–1996 period.

Constraining δ to 1 is a significant assumption that reduces the time-series stock adjustment model to a cross-sectional model, which is necessary given the data restrictions.⁶ The primary purpose of stock-adjustment models in real estate has been to estimate time lags between when space is delivered and when it is absorbed. However, this research does not focus on the stock operands and instead focuses on the non-

**EXHIBIT 12. EXPLANATORY POWER OF MODELS
STANDARDIZED BY TOTAL POPULATION ACROSS TOTAL AND
OCCUPIED RETAIL SPACE IN 58 METROPOLITAN AREAS,
1996* (T-RATIOS IN PARENTHESES)**

Dependent Variable	Change in Total Retail Sales per Capita, 1970–1996			R-Squared
	Constant	1970–1996	1996	
GLA per Capita without Depreciation				
Total GLA per Capita	9.66 (6.02)	3.55 (10.06)	—	64.4%
Total GLA per Capita	-8.105 (-1.01)	—	3.66 (4.11)	23.2
Total GLA per Capita	20.39 (3.21)	4.17 (8.37)	-1.50 (-1.75)	66.2
Occupied GLA per Capita	9.23 (6.49)	3.17 (10.14)	—	64.7
Occupied GLA per Capita	-7.37 (-1.05)	—	3.35 (4.27)	24.6
Occupied GLA per Capita	17.53 (3.10)	3.65 (8.22)	-1.15 (-1.52)	66.1
GLA per Capita with Depreciation				
Total GLA per Capita	4.27 (4.38)	2.13 (9.93)	—	63.1%
Total GLA per Capita	-5.19 (-1.06)	—	2.06 (3.77)	20.3
Total GLA per Capita	12.69 (3.35)	2.62 (8.81)	-1.17 (-2.30)	66.9
Occupied GLA per Capita	4.10 (4.64)	1.91 (9.83)	—	63.3
Occupied GLA per Capita	-4.75 (-1.08)	—	1.89 (3.86)	21.0
Occupied GLA per Capita	11.05 (3.20)	2.31 (8.53)	-0.97 (-2.08)	66.0

*Total retail space is all construction starts for the period 1970–1996. Depreciated assuming a 27-year straight-line economic life per Touche Ross and Company (1973).

EXHIBIT 13. ESTIMATES OF TOTAL GLA PER CAPITA AND MARKET SUPPLY OF RETAIL SPACE BY METROPOLITAN AREA, 1996

Metro Area	Estimates Using Change in Sales per Capita		
	Actual GLA per Capita	Estimated GLA per Capita	Market Over/ (Under) Supply
Atlanta	31.57	29.70	1.87
Austin	27.89	34.08	-6.19
Baltimore	18.37	19.27	-0.90
Birmingham	23.63	22.00	1.63
Boston	11.91	20.35	-8.44
Charlotte	32.52	25.70	6.82
Chicago	20.61	17.11	3.50
Cincinnati	23.71	21.15	2.56
Cleveland	20.30	13.78	6.52
Columbus	25.75	25.46	0.29
Dallas	32.50	29.37	3.13
Denver	32.50	27.59	4.91
Detroit	19.89	15.94	3.95
Ft. Lauderdale	41.39	39.54	1.85
Ft. Worth	32.81	28.82	3.99
Greensboro	30.16	24.74	5.42
Greenville	29.14	23.77	5.37
Hartford	17.12	19.68	-2.56
Honolulu	17.82	30.80	-12.98
Houston	28.38	27.79	0.59
Indianapolis	27.61	22.83	4.78
Jacksonville	33.30	26.26	7.04
Kansas City	27.67	20.30	7.37
Las Vegas	35.95	36.34	-0.39
Los Angeles	17.34	17.49	-0.15
Miami	26.41	26.37	0.04
Milwaukee	16.98	19.23	-2.25
Minneapolis	20.52	26.01	-5.49
Nashville	32.43	29.18	3.25
Nassau-Suffolk	11.48	20.47	-8.99
New Haven	17.42	21.55	-4.13
New Orleans	22.62	18.88	3.74
New York City	3.89	8.83	-4.94
Newark	11.01	14.79	-3.78
Norfolk	22.33	23.00	-0.67
Oakland	18.95	21.92	-2.97
Oklahoma City	29.38	22.25	7.13
Orange County	26.72	28.88	-2.16
Orlando	38.73	37.44	1.29
Philadelphia	15.90	18.14	-2.24
Phoenix	34.56	31.23	3.33

EXHIBIT 13. *Continued*

Metro Area	Estimates Using Change in Sales per Capita		
	Actual GLA per Capita	Estimated GLA per Capita	Market Over/ (Under) Supply
Pittsburgh	16.47	14.88	1.59
Portland	22.35	27.42	-5.07
Raleigh	28.48	28.90	-0.42
Richmond	25.79	22.36	3.43
Riverside	25.73	26.22	-0.49
Sacramento	24.09	27.37	-3.28
St. Louis	15.87	18.45	-2.58
Salt Lake City	27.41	26.10	1.31
San Antonio	24.46	25.40	-0.94
San Diego	24.83	27.17	-2.34
San Francisco	13.71	21.14	-7.43
San Jose	20.82	26.41	-5.59
Seattle	21.41	29.35	-7.94
Tampa	33.86	31.02	2.84
Tulsa	30.81	23.84	6.97
Washington	21.84	24.28	-2.44
West Palm Beach	39.99	38.54	1.45

stock operands to test the effectiveness of the GLA per capita rule.⁷ Replacing δ with 1, equation 6 becomes

$$K_{it} = \beta_{i0} + \beta_{i1}S_{it} + \eta_{it} \quad (6)$$

In our estimates of the net supply of space using a single period model, we let K_{it} represent the change in supply over the past 27 years, which follows the finding of Touche Ross and Company of a 27-year shopping center economic life.

B. The Data and Empirical Analyses

Summary statistics for the data used to test equation 6 are provided in exhibit 9. For the average metropolitan area, more than 50 million square feet of retail space was added between 1970 and 1996. The amount of retail space added varied between 15 and 159 million square feet. The change in nominal retail sales between 1970 and 1996 was positive for all metropolitan areas except New York City (not inclusive of its sub-jurisdictions). The average metropolitan area had total retail sales of \$19.9 billion and a population of 2.3 million. Tourism as a percent of gross regional product maintained a mean value of 4.71%, with Las Vegas realizing 23.9% of its gross regional product from tourism in 1996.

Using the modified stock adjustment model presented in equation 6, we estimate numerous OLS models. The dependent variable is the change in the stock of retail space from 1970 to 1996 across 58 metropolitan areas. K_{it} is estimated using both the total square feet and the occupied square feet.⁸ Two independent variables are used to estimate the stock of space: the change in retail sales (1970–1996) and total retail sales in 1996. Exhibit 10 reveals that the change in retail sales and total retail sales explains a majority of the variance in the stock of retail space. Combining the change in retail sales and total retail sales variables in a single model, approximately 86% of the variation in supply additions is explained. Exhibit 11 uses the same dependent and independent variables as exhibit 10, but adjusts the stock of space for depreciation using the Touche Ross and Company findings.⁹ Generally speaking, the results show little change using depreciated versus undepreciated stock numbers.

To test the GLA per capita model directly, we standardize equation 6 by the population for each metropolitan area which returns the GLA per capita as the dependent variable. Equation 6 is reestimated and the results are presented in exhibit 12.¹⁰ The estimates of GLA per capita show that approximately two-thirds of the variance can be explained by the change in retail sales per capita and total retail sales per capita across both depreciated and undepreciated supply models.

C. Estimates of GLA per Capita

Using the results from exhibit 12 we estimate the desired level of GLA per capita. Exhibit 13 presents these results for each market.¹¹ Exhibit 13 reveals that the difference between the predicted GLA per capita and actual per capita results are relatively small, indicating that the retail real estate market is relatively efficient. Comparing actual GLA per capita to estimated GLA per capita gives us a benchmark to measure which markets are over-/under-supplied with retail real estate on a relative basis. This analysis can also be completed for each of the market classifications (free-standing retail and shopping centers) and by retail size. For both of the estimated models the over-/under-supply of retail real estate is small, with the exception of Honolulu and New York, which are both unique retail markets. Finally, if the existing stock of retail real estate can be more accurately measured (especially for the older East Coast cities), the predictive power the GLA per capita index could be improved.

■ Conclusion

This paper reveals that the retail real estate markets may be more efficient than many pundits suggest. First, the often discussed over-building

of the retail product in the 1980s is a fallacy. The additions to the supply of space in the 1980s were virtually identical across the decades of the 1970s, 1980s, and 1990s. The only difference among decades is the type of retail space constructed (i.e., freestanding or shopping center). Second, the GLA per capita appears to be a viable means of assessing the balance of retail supply and demand across markets. However, direct comparisons across markets need to be adjusted for the supply of retail space built prior to 1970 that is still used as retail space.

■ Notes

1. See Craig, Ghosh and McLafferty (1984); Eppli and Benjamin (1994); Ingene (1984); Ingene and Lusch (1981); and Ingene and Yu (1981).
2. See Eppli and Shilling (1996) and Okoruwa, Nourse and Terza (1994).
3. The complex decision-making by consumers and retailers are partially captured using the Multiplicative Competitive Interaction (MCI) models that are reviewed by Craig, Ghosh and McLafferty (1984).
4. See Ling and Smersh (1996).
5. These findings are confirmed by Matzer (1985).
6. In many ways converting a time-varying model to a cross-sectional model is not satisfying. In an attempt to address this issue, additional analyses were completed using the pooling of cross-section and time-series data (see Pindyck and Rubinfeld [1991]). The result of this estimation procedure, which assigns binary variables to each metropolitan area and each year of analysis was equally unsatisfying. While the predictive power of the model is respectable at 68%, by adding approximately 78 binary variables (the number of binary variables is dependent on the number of lags in each model) much of the subtlety of the speed of adjustment parameter is lost.
7. We are grateful to an anonymous reviewer for this helpful clarification.
8. The generalized definition of the desired stock level incorporates the possibility of a non-zero vacancy rate. We are thankful to an anonymous reviewer's comments for this insight.
9. Based on the Touche Ross and Company findings, retail centers depreciate on a straight-line basis over a 27-year economic life.
10. In addition to the linear OLS estimates shown in Exhibit 12, other tested forms include quadratic, logarithm, exponential, a number of Box-Cox transformations—and the linear form plus binary variables. Additionally, several estimations included an independent variable for tourism as a percent of gross regional product, which generally maintained a negative and insignificant parameter estimate. Our a priori expectations were that this variable would be positive and significant, however, our results may have been skewed by the fact that tourism is 23% of gross regional product for Las Vegas, relative to an average tourism as a percent of gross regional product average of 4.71%. When a binary variable for Las Vegas is included, the

tourism as a percent of the gross regional product parameter estimate was positive, but remained insignificant.

11. Using Goldfeld-Quandt (see Pindyck and Rubinfeld [1991], p. 133) we do not detect the existence of heteroskedasticity. While the empirical test reveals a homoskedastic relationship, there are several outlier observations including Honolulu and several established East Coast cities.

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