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Fear of Overbuilding in the Office Sector: How Real is the Risk and Can We Predict It?

*Mark Gallagher**
*Antony P. Wood***

Abstract. **After a prolonged hiatus following the boom of the 1980s, the pace of office construction has begun to increase, raising the specter of overbuilding in several metropolitan areas (MSAs). Research has shown that commercial property markets are prone to overbuilding, however, there is a dearth of research on construction cycles at the MSA level. This article examines three techniques that can be used to examine the probability of overbuilding within the office sector. Based on quarterly data from 1977–1997, this research concludes that both base employment and the Space Market Index provide the most practical methods for assessing the risk of overbuilding. There is considerable variation across MSAs in terms of the risk of overbuilding. This has important implications for real estate investors from a tactical asset allocation viewpoint.**

Introduction

Following a period of extensive construction in the 1980s, office construction fell to a record low in the early 1990s. Meanwhile, office vacancies plummeted from double-digit levels, rents have been rapidly increasing and returns to private investors over the past two years have been very strong. However, after a prolonged hiatus following the building boom of the 1980s, the pace of office construction has begun to increase, raising the specter of overbuilding in several metropolitan statistical areas (MSAs). While the gains in appreciation from privately held office real estate finally turned positive in 1996, this follows ten years of losses in value, primarily due to overbuilding. Yet, given the importance of overbuilding and its role in explaining the poor performance of the office sector over the last real estate cycle, research on commercial construction cycles remains relatively sparse.

Several articles in the real estate literature have identified the causes and consequences of periods of overbuilding in office markets. The factors that cause real estate markets to overreact to underlying economic trends include: the long-term nature of real estate investment, the long time lags required to deliver real estate product to market, demand uncertainty, adjustment costs and the unbridled optimism of developers

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*F.W. Dodge/The McGraw-Hill Companies, Lexington, MA 02173 or *mark_gallagher@mcgraw-hill.com*.
**John Hancock Real Estate Investment Group, Boston, MA 02117 or *awood@jhancock.com.*

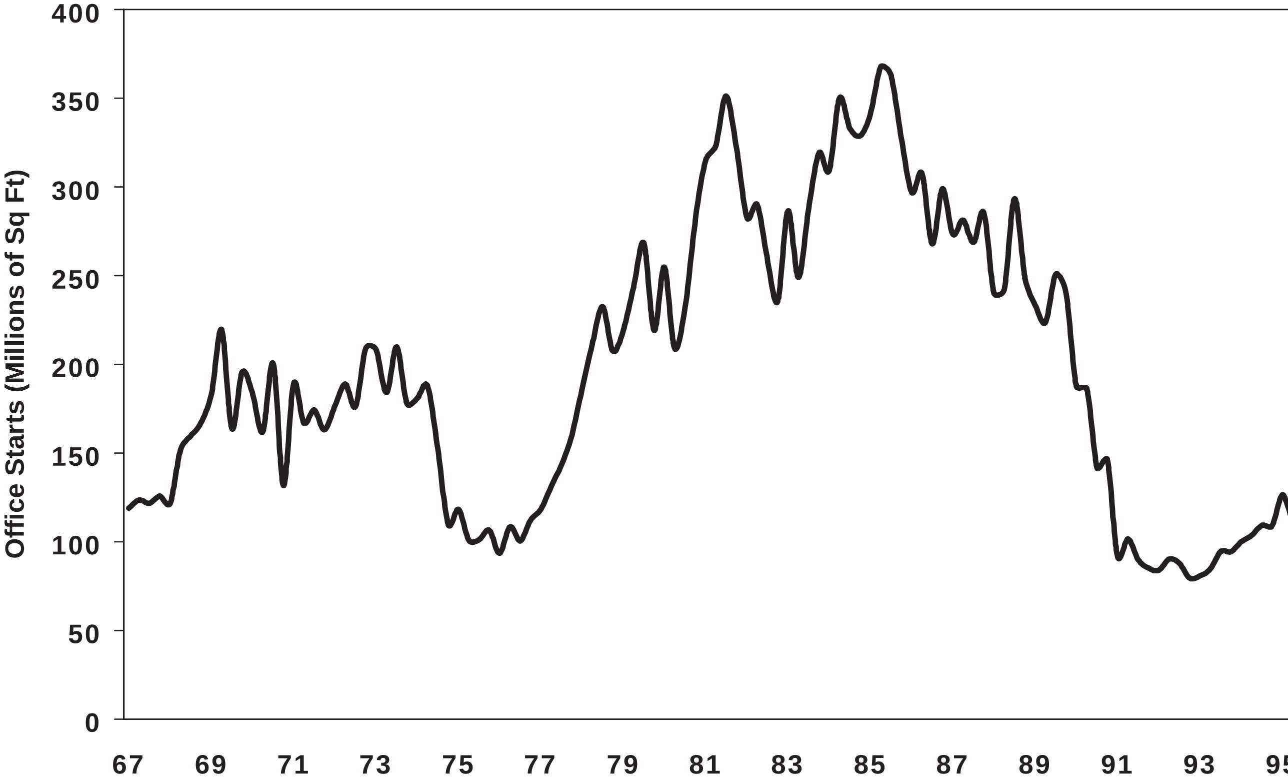
(Gardner, 1993; and Grenadier, 1995). In particular, long construction lags increase the likelihood of overbuilding and help explain the persistence of real estate cycles, whereas shorter lags lead to less volatile property markets. Voith and Crone (1988) find that the supply of office space tends to be quite elastic, while demand may be relatively inelastic, which can lead to prolonged periods of oversupply, with changes in space demand providing strong signals to developers to build. Other studies have attempted to link changes in demand or economic fundamentals to the office market cycle (Gordon, Mosbaugh and Canter, 1996).

Previous research on the office sector has focused primarily on factors that impact the demand for office space and how changes in space demand impacts vacancies and rents (Wheaton, 1988; and Shilton, 1998). This research has demonstrated that the cyclical change in rents and vacancies in the office sector are not closely correlated with the changes in the national economy (Voith and Crone, 1988; Wheaton, 1988; and Grenadier, 1995). Wheaton and Rossoff (1998) found similar results in the hotel sector in which long supply cycles and shorter demand cycles may be the result of slow adjustments in rents and the long construction lags. Research has also shown that the adjustment process in retail construction is slow to respond to changes in market conditions (Eppli and Shilling, 1995; and Benjamin, Jud and Winkler, 1998). In contrast, cyclical change in other property sectors such as the housing market (both single-family and multifamily) and the industrial sector tend to be much more closely aligned with changes in the national economy (Grebler and Burns, 1982; Wheaton and Torto, 1990; and Kling and McCue, 1991).

Torto and Wheaton (1999) suggest that the real estate cycle varies across property types and MSAs with cyclical change in supply in some property types, such as the industrial and multifamily sectors, responding closely to changes in demand. As a result, changes in supply in these sectors tend to be highly correlated with changes in the business cycle. Meanwhile, other property types, such as office, hotel and regional malls, have much longer supply cycles that appear to be somewhat endogenous. In these sectors, cyclical changes in supply have a very low correlation with changes in underlying demand. These long-run supply cycles, they suggest, are caused by a more elastic supply relative to demand, long construction lags, a high rate of physical or economic obsolescence and a high rate of growth in space demand. Thus, the risk of investing in property types with long supply cycles, such as the office and hotel sectors, appears to have more to do with the intrinsic risk of overbuilding inherent in their supply cycles rather than from the risk due to changes in demand. This suggests that investors in the office sector need to focus on the differential risk of overbuilding across markets.

The fact that the office sector is prone to overbuilding can be seen in Exhibit 1. Over the past thirty years, the office sector has experienced two distinct building booms. Yet over the same time period, the economy in the United States has experienced five recessions, with little or no relation between changes in demand from the broader economy and changes in office supply. Similar graphs for the multifamily and industrial construction would show a much higher degree of correlation with changes in the national economy.

Exhibit 1
U.S. Office Construction—1967–1997



Source F.W. Dodge

Given the increase in the pace of office construction over the past two years, there are renewed fears about overbuilding. Numerous observers have argued that the current real estate cycle is different from the boom and bust cycle of the 1980s and early 1990s. Many have argued that the last real estate recession was a ‘‘100 year flood’’ caused by a confluence of factors that are unlikely to recur in the future. Furthermore, many believe that the increasing securitization of real estate will bring increased discipline and disclosure to real estate that heretofore has been relatively weak. Supporting this notion of lower volatility, Shilton (1998) found evidence that suggests that the office space demand cycles across MSAs are dampening.

The integration of real estate into the public capital markets will potentially lessen the risk of overbuilding and ultimately lead to both shorter and shallower real estate cycles (Wood and Gallagher, 1998; and Han, 1999). However, this integration will result in more volatile real estate prices. Thus, at times real estate prices may not reflect the underlying real estate fundamentals as was witnessed in the latter half of 1998 when turmoil in the global financial markets led to a 10%–15% repricing of real estate. If indeed we have entered a ‘‘new era’’ for real estate investing with lower credit risk, Riddiough (1998) suggests that real estate returns may eventually fall since they currently contain an embedded premium for the risk of overbuilding.

Commercial construction may well become more responsive to market fundamentals in the future, thereby reducing the risk of overbuilding. However, it is still too early to see whether this theory will hold true. Furthermore, the integration of real estate does not mean that overbuilding will not occur in the future. Rather, overbuilding and real estate cycles will persist in certain property sectors like office, in part because of their inherent supply cycles, but at potentially lower amplitudes. Despite the ‘‘new era’’ of real estate, office construction has picked up markedly in response to declining vacancies and accelerating rents in several markets such as Atlanta and Dallas, raising concern that these markets may soon become overbuilt.

One of the unique features of our research is its focus on the supply of office space at the MSA level, which has received little attention from researchers other than a recent paper by Sivitanides and Sivitanidou (1999). In this article, we examine office supply for thirty-four MSAs from 1977 through 1997. The objective of the research is to see: (1) if there is a differential risk of overbuilding in the office sector across MSAs; and (2) whether the risk of overbuilding can be predicted using techniques that could be generalized for smaller MSAs as well as for other property types. We examine three different indicators using a logit model framework, across thirty-four MSAs, to determine their effectiveness in predicting periods of overbuilding. The indicators include: (1) a metropolitan area leading economic indicator index; (2) a new index proposed by Miles (1997) that relates changes in office demand to changes in office supply; and (3) growth in economic base, or export-oriented industries. The results indicate that there is a significant differential in the risk of overbuilding in the office sector across MSAs.

Characterizing Office Overbuilding—1977–1997

Several criteria have been used in the past to define periods of weakness in the office real estate, including changes in office construction, financial performance, office vacancies and rent changes. Mueller (1995) establishes terminology for real estate's physical and financial market cycles, noting that the financial performance of real estate is closely tied to the sector's physical building cycle.

For the purposes of this analysis, overbuilding is defined as periods in which a metropolitan area's quarterly growth in office inventory is one standard deviation or more above the long-term average growth in office inventory over the past twenty years. There are obvious limitations to a definition of overbuilding that is solely based on changes in supply. Under this definition, MSAs experiencing low construction activity and possibly low vacancy rates, which then experience an increase in construction, will be defined as overbuilt, yet such new supply may be warranted. Meanwhile, markets that have high levels of office supply growth, such as Las Vegas, may experience even more rapid growth in demand, keeping the overall demand/supply balance positive. In such a situation, the financial performance of the office sector is likely to improve despite an indicator of overbuilding because of above average inventory growth. Despite these shortcomings, our definition of overbuilding is useful. It allows analysts to identify possible periods of *increased supply risk* that could negatively affect the financial performance of the office property market. Furthermore, office construction appears to follow long cycles that may not be closely linked to changes in demand (Torto and Wheaton, 1999).

Exhibit 2 provides summary statistics of the growth in office inventory and employment growth for 34 metropolitan areas over the 1977 to 1997 period.[1] The simple descriptive statistics provide intuitive insights into the quarterly distribution of office construction activity over the past 20 years. In all MSAs examined, the distribution of growth in office stock is positively skewed. This implies that office construction in these MSAs is highlighted by periods of extremely high levels of completions. Exhibit 2 also shows that the distribution of growth in office employment is positively skewed in most MSAs, but to a lesser degree than the growth in office inventory.[2] There are a few exceptions—namely Houston, Salt Lake City, Los Angeles, Boston, Cleveland, Milwaukee and New York—where office employment growth is negatively skewed. Each of these economies experienced sharp cyclical growth followed by a recession or periods of very weak economic activity, which contributed to the negatively skewed growth in office employment. Exhibit 2 also shows the number of periods of overbuilding, defined as growth in office stock that is at least one standard deviation above the long-term average growth in office stock. Under this definition, the number of periods in which overbuilding takes place ranges from a low of two periods in New York to a high of eighteen in Riverside.[3]

Index Construction

Metropolitan Area Leading Economic Indicator Index

Leading economic indicator indexes have been used extensively at the national and local levels to predict changes in the overall level of economic activity. At the state

Exhibit 2
Summary Indicators for Office Markets Quarterly—1977–1997

Metropolitan Area	Stock (msf) 1997	Vacancy Rate 1997	Growth in Stock (annualized)			Growth in Office Employment (annualized)		
			Mean	Std. Dev.	Skewness	Mean	Std. Dev.	Skewness
Los Angeles, CA	442.8	17.2	2.1	2.0	0.6	1.4	3.5	−0.1
New York, NY	427.4	10.5	0.2	1.1	1.5	0.9	2.4	−0.9
Chicago, IL	411.1	13.5	1.5	1.6	1.0	1.9	2.6	0.1
Washington, DC	390.3	9.0	4.1	2.8	0.2	2.8	3.5	1.2
Boston, MA	240.0	6.6	1.0	1.7	1.0	1.7	3.0	−0.4
Dallas, TX	230.4	13.8	5.1	6.4	1.4	3.9	3.1	0.3
Houston, TX	225.6	15.2	5.7	7.1	1.1	3.1	4.4	−0.5
Philadelphia, PA	209.2	11.2	0.9	1.5	1.8	1.4	2.4	0.6
Atlanta, GA	183.0	12.9	4.1	3.7	1.0	4.6	3.7	2.2
Minneapolis, MN	139.8	5.7	2.0	2.2	1.2	3.0	2.8	0.6
Denver, CO	122.0	11.5	4.2	5.6	1.6	3.2	3.1	0.8
Seattle, WA	121.2	5.7	3.2	3.3	1.7	4.0	4.0	1.0
San Francisco, CA	120.8	5.0	2.0	2.9	2.5	1.3	2.9	0.3
St. Louis, MO	107.4	12.0	0.9	1.8	2.8	1.9	2.9	0.0
San Diego, CA	107.1	10.5	3.7	3.1	0.7	3.6	3.6	0.6
Baltimore, MD	106.7	11.4	1.3	1.9	1.0	1.8	3.2	0.3
Phoenix, AZ	105.7	10.9	4.1	3.4	1.0	5.6	4.3	0.2
Cleveland, OH	104.1	12.7	0.7	1.4	1.9	1.3	2.9	−0.5
Pittsburgh, PA	96.2	13.9	0.7	2.6	7.3	0.9	3.0	0.2
Kansas City, MO	92.6	9.9	2.0	2.2	1.2	2.5	3.3	0.7
Columbus, OH	76.7	6.7	2.6	2.9	2.4	2.8	2.9	0.7
Cincinnati, OH	72.7	9.1	1.6	2.1	1.9	2.4	3.0	0.0

Exhibit 2 (continued)
Summary Indicators for Office Markets Quarterly—1977–1997

Metropolitan Area	Stock (msf) 1997	Vacancy Rate 1997	Growth in Stock (annualized)			Growth in Office Employment (annualized)		
			Mean	Std. Dev.	Skewness	Mean	Std. Dev.	Skewness
Milwaukee, WI	70.7	15.0	0.9	1.3	1.3	2.0	2.8	−0.4
Sacramento, CA	62.3	9.4	3.9	3.2	1.7	3.5	3.1	0.0
Charlotte, NC	60.5	9.6	2.6	2.6	1.0	3.5	3.2	0.4
Riverside, CA	59.7	24.3	2.8	2.4	1.3	4.4	3.8	0.3
New Orleans, LA	58.4	16.2	1.3	3.4	3.1	1.5	3.1	0.7
San Antonio, TX	55.3	10.6	2.5	3.6	1.4	3.5	2.5	1.0
Nashville, TN	52.3	5.4	2.7	3.2	2.0	3.5	3.6	0.1
Salt Lake, UT	51.1	4.8	2.8	2.4	1.2	3.6	2.7	−1.1
Birmingham, AL	43.3	8.6	2.6	3.9	3.7	2.2	3.1	0.1
Oklahoma City, OK	42.5	15.8	1.5	2.5	1.8	2.4	4.0	0.3
Richmond, VA	39.9	10.9	3.4	4.3	1.9	2.5	3.1	0.7
Tulsa, OK	33.6	11.8	2.5	5.7	4.5	2.6	3.9	0.1
Mean	140.1	11.1	2.4	3.0	1.8	2.7	3.2	0.3

and regional level, leading economic indexes have been implemented to predict turning points in the economic cycle and to provide an assessment of the probability of recession in local areas (S&P/DRI, 1985; and Horst, 1997). Kozlowski (1987) in a review of several local area leading indexes, finds that in spite of markedly different methods of construction, leading indexes do provide useful information on cyclical movements in the local economy and hold promise in forecasting aggregate measures such as employment. However, the leading indexes are far from perfect, and their predictive ability can vary substantially due to subjective component and index weight selection.

The rationale for developing a leading economic indicator index for real estate market analysis stems from the predictive value of the index in determining periods of accelerating or waning economic activity. Positive changes in the index level can be used to identify future levels of output and employment levels. In turn, higher levels of output and employment will increase space demand and ultimately rental rates, which will encourage developers to undertake new projects. While the leading indicator index methodology ignores the rental adjustment process and the role of the capital markets in determining growth in office space, it identifies periods in which local economies may be prone to overheating, raising the likelihood of excessive building activity. Therefore, one would assume that high values of the index are associated with subsequent periods of rapid construction activity.

Although the construction of leading economic indexes is relatively straightforward, the choice of available economic indicators and the weighting method used to develop the aggregate leading index present two major obstacles. The choice of variables in a metropolitan leading index is quite limited compared with the numerous indicators such as factory orders, purchasing trends and consumer confidence that are available at the national level. The choices are often limited to housing permits, help wanted advertising, initial unemployment claims or information on weekly hours worked. In many cases, local information may not adequately describe the key linkages between the performance of the local economy and national or international economy activity. Some theoretical attention must be paid to finding relevant leading indicators for metro area economic performance. In many cases, national or regional indicators become important leading indicators for the metro area index. Often, however, the ad hoc selection of such economic indicators can lead to erroneous conclusions about the future state of the metropolitan area economy.

In addition, the choice of weighting schemes for the leading index components presents challenges. Several methods have been proposed, ranging from proportional component weights to functions that generate weights based on the minimization of the leading index's predictive errors.[4] One widely-used approach involves a variance-weighting scheme, which is implemented in the Conference Board's National Index of Leading Economic Indicators.[5] Under this method, each of the index components are normalized by their variance in an effort to neutralize the leading index's potential for generating ‘‘false signals'' about the direction of economic activity based on movements in one or more of the volatile index components.

The leading index constructed for this analysis utilizes a standard set of local and national component series across the thirty-four MSAs. Three local area components comprise the metro area leading index: (1) residential housing starts; (2)average weekly hours worked in manufacturing; and (3) a help wanted advertising index. Two national indicators are included: (1) a yield curve measure using the spread between the ten-year Treasury and the Federal Funds rate; and (2) a trade-weighted international currency exchange rate. The yield curve measure is included to capture the influence of national interest rates and monetary policy on metro area performance. An inverted yield curve, where the long-term rate is less than the Federal Funds rate, is often associated with an increased risk of recession. The trade-weighted exchange rate measures the relative international competitiveness of metropolitan areas. Favorable international exchange rates stimulate export activity, thus enhancing growth prospects. These five indicators were rolled into a leading index using a variance-based weighting method, which normalizes the weights based on each component's measure of historical volatility. The calculation of variance-based weights follows the Bureau of Economic Analysis (1996) and Conference Board techniques for the National Index of Leading Economic Indicators. The index base is set to its 1992 average value.[6]

The Space Market Index

Miles (1997) proposes an indicator that can be used to assess the commercial real estate supply/demand balance in MSAs and identify stages of their real estate market cycles. Vacancy rates are not a reliable indicator of real estate market conditions, due to the numerous conceptual problems associated with their determination and measurement. For instance, vacancy rates often overlook issues associated with subleasing and ''partially built'' space in industrial parks, where large infrastructure commitments have been made. Furthermore, Gentile (1992) shows that the ''natural,'' or equilibrium vacancy rate can differ substantially across markets, making an unadjusted vacancy measure difficult to compare across markets. In addition, the Space Market Index (SMI) can be generalized to help identify the risk of overbuilding across smaller MSAs. Since vacancy rates are not readily available for smaller MSAs, this precludes their use in our analysis.

Rather than rely on vacancy rates to indicate the state of supply/demand balance, Miles constructs indexes for each of the commercial property types based on the long-run trend in employment changes relative to building stock changes. The index is constructed by taking the quarter-by-quarter first difference in nonfarm employment and office stock. Miles uses a three year moving average of these changes, using two years of historical data and one year of forecasted data.[7] The moving average of changes in employment is then divided by the moving average of changes in stock, providing a long-run ratio of demand relative to supply. The SMI is defined by dividing this ratio by its long-run (1977 to 1997) average. The SMI can be represented algebraically as a function of office employment (*OFFEMP*) and stock (*STOCK*) over *n* time periods:

$$RATIO_{i,t} = (OFFEMP_{i,t} - OFFEMP_{i,t-1})/STOCK_{i,t} - STOCK_{i,t-1}) \tag{1}$$

$$SMI_{i,t} = \sum_{t-7}^{t+4} (RATIO_{i,t}/(\sum_{t=1}^{n} RATIO_{i,t})/n)/12.$$

Therefore, an SMI in excess of one indicates a positive jobs-to-space balance, while a value less than one indicates deteriorating jobs-to-space balance. Miles notes that the index has a positive association with the financial performance of property sectors, including NCREIF returns. Miles and Guilkey (1998), in a follow-up article, compute the index for metropolitan areas and devise a real estate buy/sell tactical allocation strategy based on the upper and lower quartiles of the index.

For the purposes of this article, the SMI was computed for the thirty-four MSAs. However, unlike Miles' formulation, which uses total nonfarm jobs, our version of the SMI uses office employment, since we believe that this provides a more appropriate measure of demand in the office sector. Exhibit 3 plots the SMI based on office employment and stock aggregated for the thirty-four MSAs, against the annualized growth in office stock. Exhibit 4 provides a summary of the SMI calculations. Of the thirty-four markets included in our research, twenty had an SMI value greater than one during the fourth quarter of 1997, indicating a positive demand-to-supply balance. San Francisco, Los Angeles and Boston ranked highest in terms of their demand-to-supply balance, while Richmond, Salt Lake City and Atlanta ranked lowest. Twelve markets demonstrated an improvement in the SMI for the year ended in the fourth quarter 1997, with Baltimore, New York and Washington showing the most improvement. Meanwhile, Dallas, Phoenix and Atlanta showed the most deterioration in the SMI over this period, as their markets experienced rapid increases in office construction activity.

As Miles and Guilkey (1998) note, phases in the SMI are associated with changes in market rents at various phases in the office market cycle. As the index reaches a peak above one, the demand for space outstrips supply, leading to rapid rent growth. As supply responds to the changes in demand, the index falls back down towards a value of one. This particular phase of the index is useful for analysts, since it provides a possible signal of overbuilding and deteriorating markets. Negative first differences of the index, which mark its downward slope, are likely to occur when supply growth is increasing. However, this may not always be the case, as downward index movements may occur when demand growth is slowing amid an absence of stock growth.

An Economic Base Indicator

Economic base measures are used extensively for characterizing local economic structure and economic modeling purposes (Treyz, 1993). Specifically, the economic base refers to the collection of industries that drive local income and employment levels through their ability to export, or sell outside of the local area. Manufacturing and mining sectors, for instance, are often associated with base activity since a large

Exhibit 3
Space Market Index vs. Growth in Office Stock
(Aggregated across Thirty-Four MSAs)

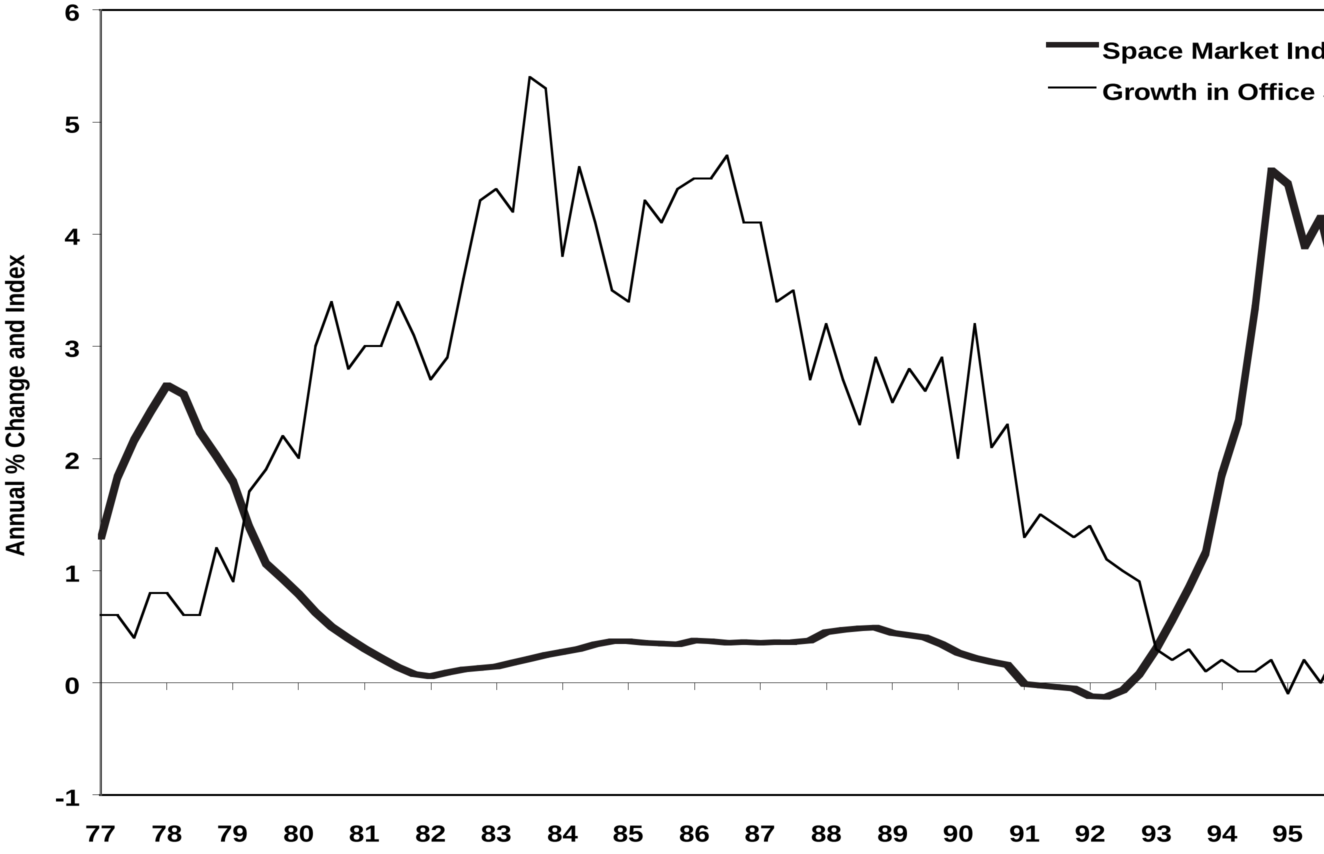


Exhibit 4
Office Space Market Index

Metropolitan Area	SMI 1997:4	Change 1996:4 to 1997:4	Rank
San Francisco, CA	2.82	−0.28	24
Los Angeles, CA	2.67	0.04	10
Boston, MA	2.08	0.09	8
Chicago, IL	1.97	−0.37	28
San Diego, CA	1.93	−0.26	22
New York, NY	1.89	0.56	2
Riverside, CA	1.85	0.16	7
Seattle, WA	1.81	−0.42	30
Oklahoma City, OK	1.64	−0.09	15
Houston, TX	1.63	−0.31	26
Dallas, TX	1.60	−1.34	34
Kansas City, MO	1.41	0.02	12
Cleveland, OH	1.22	−0.32	27
Philadelphia, PA	1.21	0.22	6
St. Louis, MO	1.18	0.28	4
Minneapolis, MN	1.15	−0.12	17
Phoenix, AZ	1.13	−0.73	33
Sacramento, CA	1.12	−0.28	25
Cincinnati, OH	1.08	−0.03	14
Baltimore, MD	1.01	0.66	1
Tulsa, OK	0.99	−0.20	19
San Antonio, TX	0.94	0.03	11
Milwaukee, WI	0.86	−0.19	18
Birmingham, AL	0.83	−0.12	16
Pittsburgh, PA	0.80	0.23	5
Nashville, TN	0.72	−0.21	20
Denver, CO	0.70	−0.37	29
Washington, DC	0.69	0.32	3
Charlotte, NC	0.67	−0.23	21
Columbus, OH	0.64	−0.28	23
New Orleans, LA	0.62	0.04	9
Atlanta, GA	0.58	−0.53	32
Salt Lake, UT	0.55	−0.42	31
Richmond, VA	0.50	0.00	13

Note: An SMI value < 1 indicates a supply imbalance and rent growth will be less than inflation.

proportion of their output is often consumed outside of the local area. Non-base sectors, on the other hand, are dependent on local consumption and government spending activity. The demand for personal services and retail trade are dependent on such local trends, and are often classified as non-base.

McNulty (1995) evaluates overbuilding in the context of economic base theory. Economic base activity can be highly cyclical and, with significant lags, cause expansion in non-base economic sectors to continue well after base sectors have begun to slow. Since the decision to build often depends on the strength of local economic activity, overbuilding may often be the result of overly positive signals that lenders and developers perceive at the time a project is first conceived.

The linkages between base and non-base economic sectors determine the overall level of economic activity in a local area economy. Treyz (1993) derives in detail an economic base model and converts income and spending accounts for a local economy into an employment representation. Total employment (E) in a local economy is determined as a function of employment dependent on local consumer and government spending (ECG); employment dependent on exports, including the federal government ($EXFG$); and employment dependent on planned investment (EIL_p):

$$E = ECG + EXFG + EIL_p, \qquad E = ECG + EBN,$$

where

$$EBN = EIL_p + EXFG, \qquad K = E/EBN. \tag{2}$$

Economic base employment (EBN) is therefore dependent on employment related to planned investment and exports. The economic base multiplier (K) may be interpreted as the long-run effect of changes in base employment on total employment. There are several methods for estimating base employment. The planned investment component is often estimated by new construction employment. Export-related employment may be estimated by one of three methods: (1)a judgmental, or ad hoc approach, where the analyst makes a subjective assessment of industries that directly or indirectly export outside of the local area; (2) the location quotient approach, which determines base employment from industry concentration ratios; and (3) the minimum requirements approach, in which base employment is the amount of employment in each industry above the minimum amount necessary to support local consumer and government spending.

Although there are limitations to each approach, the location quotient method offers an objective standard for classifying base employment. This approach assumes that when a local industry has a share of employment greater than the national average, the industry exports all of the output associated with employment that is in excess of the national average share. Mathematically, the location quotient (LQ_i) for a particular industry (i) in a local economy is determined as:

$$LQ_i = (E_i/E)/(E_{i,us}/E_{us}), \tag{3}$$

where E and E_{us}, are total employment at the local and national levels. Industry export-oriented base employment ($EXFG_i$) is determined by:

$$\begin{aligned} EXFG_i &= 0 && \text{if } LQ_i <= 1, \\ EXFG_i &= ((LQ_i - 1)/LQ_i) * E_i && \text{if } LQ_i > 1. \end{aligned} \tag{4}$$

In order to identify the relationship between base employment and office construction activity, base employment was generated by MSA using the location quotient approach. The employment data source is 1980 to 1997 annual observations from the Standard & Poor's/DRI Business Demographics Database. The database is a collection of employment for 243 industries at approximately the three-digit Standard Industrial Classification (SIC) level. Since one of our research goals is a comparison of the three different indexes in terms of their abilities in predicting the risk of overbuilding, the limitations of the employment data, both in terms of its frequency and its start date, places limits on the construction of the two other indexes.

Office Stock and Economic Base Volatility

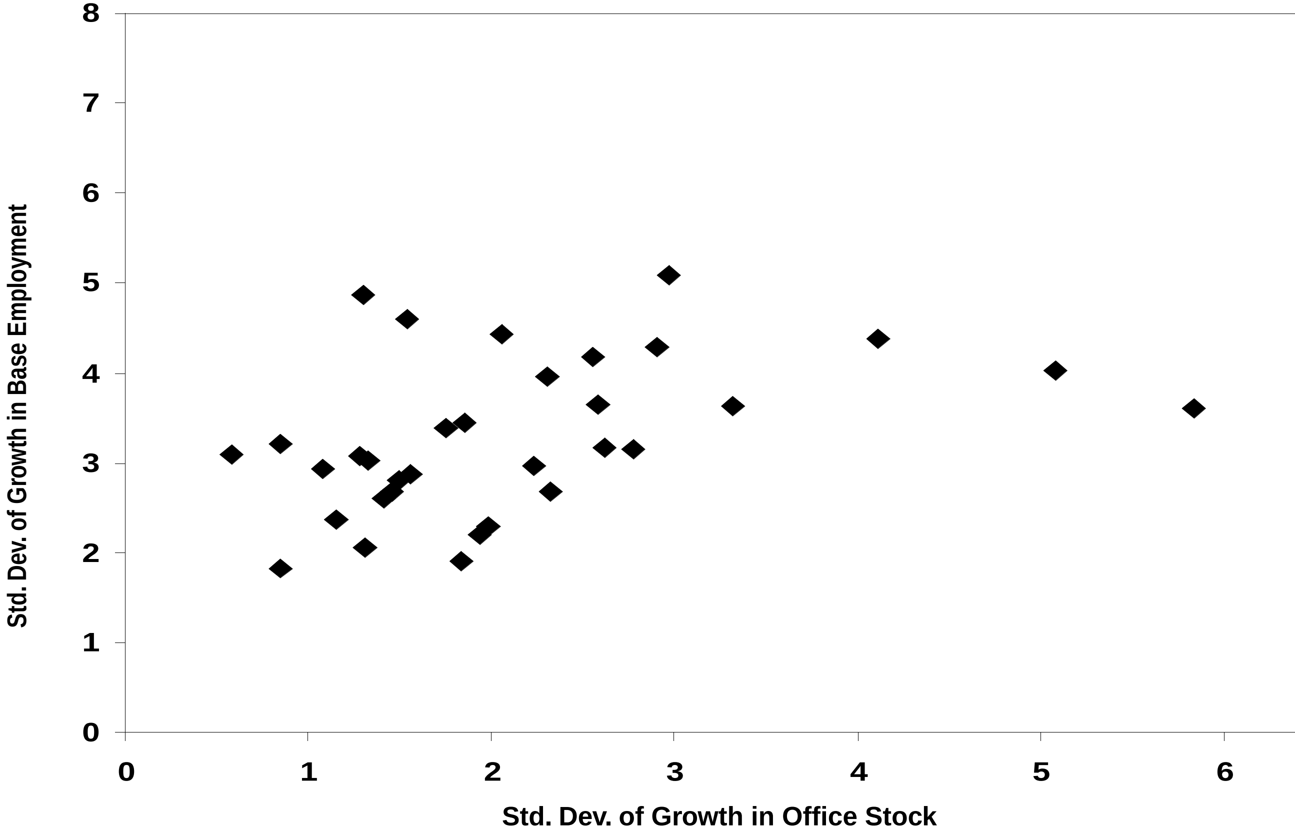
A cursory examination of the economic base measure provides insight into its usefulness as a leading indicator for characterizing office building activity across markets. At the metropolitan area level, movements in the economic base are linked to the performance of office markets over the past decade. Anecdotally, Houston's rising concentration in the oil industry, and Los Angeles' reliance on defense and aerospace activities during the 1980s are often cited as factors in driving these cities' boom and bust office market cycles.

Statistically, evidence of the linkage between economic base volatility as a factor in determining office stock volatility may be identified through a simple linear model. Volatility may be represented as the standard deviation of annual changes in the office stock and employment variables. In Exhibit 5, office stock volatility (σ_{stock}) is represented as a function of average growth in total nonfarm employment (EEA), economic base employment (EBN), and the volatility of each of these measures (σ_{eea} and σ_{ebn}):

$$\begin{array}{llllll} \sigma_{stock} = & -0.681 & -\ 0.039\ \sigma_{eea} & +\ 0.249\ EEA & +\ 0.754\ \sigma_{ebn} & -\ 0.128\ EBN. \\ & (-0.9) & (-0.3) & (0.8) & (4.2^{*}) & (-0.4) \end{array} \tag{5}$$

In Equation (5), the t-Statistics are in parentheses, the $R^2 = .321$, $N = 34$ and 4.2 is significant at 1% level. The model in Equation 5 was estimated using cross-sectional observations for the thirty-four MSAs. The volatility and average growth measures were estimated from annual 1980–1997 observations. As Equation (5) shows, volatility in economic base employment is a highly significant factor in explaining the volatility in office stock on a cross-sectional basis. In contrast, measures of average growth in total employment and base employment, as well as the volatility in total

Exhibit 5
Volatility in Office Stock Growth vs. Volatility in Economic Base Growth



employment growth are statistically insignificant. This relationship between the volatility in office stock growth and the volatility in economic base employment can be seen in Exhibit 5.

Estimation and Results

The indexes described above were incorporated into three separate logit regression models. In this framework, we wish to analyze the probability of overbuilding at a certain time period given the index values. The logit model is based on the logistic cumulative density function given by:

$$P_i = F(X_i'B) = 1/(1 + e^{-X_i'B}), \tag{6}$$

where X_i' is a vector of explanatory variables, B is the vector of parameters and P_i is the probability of overbuilding, which is constrained to the value of the logistic cumulative density function. Estimation of the parameters in Equation (6) involves maximizing the likelihood function of a vector of overbuilding observations (denoted by the value 1 for a period of overbuilding, 0 otherwise) with the index values. While the logit framework may have the perceived disadvantage of discretely classifying markets as overbuilt or not, this structure may be used to assign unique probabilities to underlying index values. This allows analysts the ability to compare probabilities of overbuilding across time and markets, and to assess the impact of changes in the index values on the probability of overbuilding.

Logit models for the thirty-four MSAs were estimated in panel form using maximum likelihood techniques. Observations were pooled across markets in an attempt to gain more efficient parameter estimates. Each model's intercept term was allowed to vary across MSAs in order to capture the cross-sectional, or market-specific effects. The leading index, SMI, and base employment models were estimated using annual observations from 1981 through 1997. As a result, the leading indicator and SMI indexes were converted to average annual rates from a quarterly frequency, to ensure consistency with the base employment frequency. Office overbuilding was also defined at an annual frequency as periods in which MSA growth in office stock was at least one standard deviation above its long-term average for at least two quarters, not necessarily consecutive, in that year. In addition, since much of the overbuilding that occurred in the 1980s may have been exacerbated by tax policy, we included a dummy variable for the Tax Reform Act of 1986 in the models.

Exhibits 6–8 show the functional form of the specifications and statistical results for each of the three indexes. The appropriate lag length for each specification was determined by maximizing the log of the likelihood function over a fixed set of sample observations. As the exhibits show, the estimated coefficients for each of the three indexes and the Tax Reform Act dummy are significant at the 1% level. The optimum lag structure for both the leading economic indicator index and the base employment index was a two year lag, whereas a one year lag for the first difference of the SMI maximized the log of the likelihood function.

Exhibit 6
Leading Index Model—Two Period Lag

Variable	Coefficient	Std. Error	*t*-Statistic
Intercept			
Atlanta	−25.05	3.25	−7.7
Baltimore	−22.84	2.97	−7.7
Birmingham	−23.69	2.99	−7.9
Boston	−23.12	3.07	−7.5
Charlotte	−23.84	3.02	−7.9
Chicago	−22.44	2.86	−7.8
Cincinnati	−21.74	2.76	−7.9
Cleveland	−22.87	2.89	−7.9
Columbus	−23.80	2.97	−8.0
Dallas	−22.60	2.90	−7.8
Denver	−28.46	3.75	−7.6
Houston	−23.69	3.04	−7.8
Kansas City	−22.29	2.86	−7.8
Los Angeles	−23.23	2.95	−7.9
Milwaukee	−23.59	2.95	−8.0
Minneapolis	−22.60	2.83	−8.0
Nashville	−23.98	3.06	−7.8
New Orleans	−24.99	3.22	−7.8
New York	−24.61	3.13	−7.9
Oklahoma City	−26.40	3.41	−7.7
Philadelphia	−23.02	2.98	−7.7
Phoenix	−23.02	2.93	−7.9
Pittsburgh	−23.64	2.94	−8.0
Richmond	−24.84	3.17	−7.8
Riverside	−21.08	2.74	−7.7
Sacramento	−22.20	2.75	−8.1
Salt Lake City	−23.59	2.96	−8.0
San Antonio	−23.05	2.98	−7.7
San Diego	−22.31	2.81	−8.0
San Francisco	−23.11	2.88	−8.0
Seattle	−23.88	2.97	−8.0
St. Louis	−24.04	3.03	−7.9
Tulsa	−24.47	3.11	−7.9
Washington, D.C.	−23.63	3.13	−7.6
$JLEAD_{t-2}$	20.99	2.63	8.0
$DTAX86_t$	−1.86	0.34	−5.5

Note: Log likelihood = −158.76. Nos. of overbuilding observations (*OVER* = 1) = 90. Nos. of non-overbuilding observation (*OVER* = 0) = 420. All *t*-Statistics significant at 1% level. *OVER* = Overbuilding variable, 1 if present, 0 otherwise. *JLEAD* = Leading Indicator Index, lagged 2 periods. *DTAX86* = Dummy variable for Tax Reform Act of 1986.

$$OVER_{i,t} = b_{0,i} + b_1\ JLEAD_{i,t-2} + b_2\ DTAX86_t + e_{i,t}$$

Exhibit 7
Space Market Index Model—One Period Lag

Variable	Coefficient	Std. Error	*t*-Statistic
Intercept			
Atlanta	0.13	0.65	0.2
Baltimore	0.48	0.61	0.8
Birmingham	−1.41	1.06	−1.3
Boston	0.78	0.61	1.3
Charlotte	−0.78	0.80	−1.0
Chicago	0.27	0.65	0.4
Cincinnati	0.21	0.64	0.3
Cleveland	−0.11	0.72	−0.2
Columbus	−1.55	1.07	−1.5
Dallas	−0.19	0.72	−0.3
Denver	−1.72	1.07	−1.6
Houston	−1.00	0.82	−1.2
Kansas City	0.26	0.64	0.4
Los Angeles	−0.31	0.70	−0.4
Milwaukee	−1.60	1.07	−1.5
Minneapolis	−0.71	0.80	−0.9
Nashville	−0.75	0.80	−0.9
New Orleans	−1.14	0.84	−1.4
New York	−1.81	0.91	−2.0*
Oklahoma City	−1.12	0.86	−1.3
Philadelphia	0.14	0.64	0.2
Phoenix	−0.23	0.70	−0.3
Pittsburgh	−1.59	1.08	−1.5
Richmond	−0.81	0.80	−1.0
Riverside	0.86	0.59	1.5
Sacramento	−0.76	0.80	−1.0
Salt Lake City	−1.63	1.07	−1.5
San Antonio	−0.36	0.71	−0.5
San Diego	−0.26	0.70	−0.4
San Francisco	−1.22	0.87	−1.4
Seattle	−1.54	1.07	−1.4
St. Louis	−1.48	1.06	−1.4
Tulsa	−2.05	1.14	−1.8*
Washington, D.C.	0.75	0.59	1.3
$DSMI_{t-1}$	−1.11	0.27	−4.1**
$DTAX86_t$	−1.47	0.29	−5.0**

Note: Log likelihood = −201.55. Nos. of overbuilding observations (*OVER* = 1) = 90. Nos. of non-overbuilding observation (*OVER* = 0) = 420. *OVER* = Overbuilding variable, 1 if present, 0 otherwise. *DSMI* = Space Market Index, first difference, lagged 1 period. *DTAX86* = Dummy variable for Tax Reform Act of 1986.

$$OVER_{i,t} = b_{0,i} + b_1 DSMI_{i,t-1} + b_2 DTAX86_t + e_{i,t}$$

*Significant at the 10% level.
**Significant at the 1% level.

Exhibit 8
Economic Base Employment Model—Two Period Lag

Variable	Coefficient	Std. Error	*t*-Statistic
Intercept			
Atlanta	−0.55	0.70	−0.8
Baltimore	0.94	0.63	1.5
Birmingham	−1.45	1.07	−1.4
Boston	0.92	0.63	1.5
Charlotte	−0.88	0.81	−1.1
Chicago	0.28	0.65	0.4
Cincinnati	0.25	0.64	0.4
Cleveland	−0.02	0.71	<-0.1
Columbus	−1.83	1.07	−1.7*
Dallas	−0.82	0.74	−1.1
Denver	−2.40	1.14	−2.1*
Houston	−1.52	0.97	−1.6
Kansas City	0.27	0.66	0.4
Los Angeles	−0.35	0.73	−0.5
Milwaukee	−1.46	1.07	−1.4
Minneapolis	−0.96	0.81	−1.2
Nashville	−1.70	0.88	−1.9*
New Orleans	−0.40	0.83	−0.5
New York	−0.61	0.82	−0.8
Oklahoma City	−1.04	0.94	−1.1
Philadelphia	0.05	0.64	0.1
Phoenix	−1.18	0.77	−1.5
Pittsburgh	−1.60	1.17	−1.4
Richmond	−1.09	0.89	−1.2
Riverside	0.35	0.61	0.6
Sacramento	−0.96	0.81	−1.2
Salt Lake City	−2.03	1.10	−1.9*
San Antonio	−0.77	0.75	−1.0
San Diego	−0.33	0.71	−0.5
San Francisco	−0.49	0.81	−0.6
Seattle	−1.83	1.08	−1.7*
St. Louis	−1.56	1.07	−1.5
Tulsa	−1.60	1.20	−1.3
Washington, D.C.	0.16	0.63	0.3
$EBNCH_{t-2}$	0.23	0.04	5.5**
$DTAX86_t$	−1.66	0.31	−5.4**

Note: Log likelihood = −192.30. Nos. of overbuilding observations (*OVER* = 1) = 90. Nos. of non-overbuilding observation (*OVER* = 0) = 420. *OVER* = Overbuilding variable, 1 if present, 0 otherwise. *EBNCH* = Base Employment % Change, lagged 2 periods. *DTAX86* = Dummy variable for Tax Reform Act of 1986.

$$OVER_{i,t} = b_{0,i} + b_1 EBNCHI_{i,t-1} + b_2 DTAX86_t + e_{i,t}$$

*Significant at the 10% level.
**Significant at the 1% level.

As in linear models, summary goodness-of-fit measures are useful in assessing the logit model's explanatory power. Amemiya (1981) offers several measures that can be used, including a chi-square test statistic and a "pseudo" R^2 statistic. Under the null hypothesis that the index coefficient value is zero ($H_0 : B_2 = 0$), Judge, Griffiths, Hill, Lutkepohl and Lee (1985) note that:

$$\ln L(w) = n \ln (n/t) + (t - n) \ln ((t - n)/t), \tag{7}$$

where n is the number of observed successes (periods of overbuilding) and t is the total number of observations, $L(w)$ is the maximum value the log-likelihood function can take when $B_2 = 0$. It then may be derived asymptotically that:

$$-2[\ln L(w) - \ln L(\mathrm{O})], \tag{8}$$

follows a chi-square distribution, where $L(\mathrm{O})$ is the maximized value of the likelihood function with the estimated parameters. The pseudo R^2 statistic is then given by:

$$\rho^2 = 1 - \ln L(O)/ \ln L(w). \tag{9}$$

Exhibit 9 details the results of the chi-square test and pseudo R^2 calculations for each of the models. All models have a significant explanatory power, with pseudo R^2 statistics ranging from 65% on the SMI model to 72% on the leading index model. All chi-square test statistics reject the null hypothesis that the estimated parameters are equal to zero at the 1% level of significance, indicating that all three indexes are significant predictors of overbuilding.

Despite the fairly close range in the goodness-of-fit statistics, each of the indexes provides a different assessment of the current risk of overbuilding in the office sector. The fitted probabilities were calculated for each model over the historical time period, 1983–1997, and forecasted for 1998. Exhibits 10–12 detail the results. The mean probability of overbuilding in 1998 across all MSAs ranges from 4% for the leading index model to 15% for the SMI and base employment models. Under the SMI model, Dallas, Atlanta, Phoenix and Riverside rank highest in the probability of overbuilding in 1998. Boston, Riverside, Baltimore and Atlanta rank highest in terms of the risk

Exhibit 9
Summary Goodness of Fit Measures

	Log-Likelihood	Chi-square	Pseudo R^2
SMI_{t-1}	−201.55	750.98	0.65
Leading Index$_{t-2}$	−158.76	836.56	0.72
Base Emp. Change$_{t-2}$	−192.00	770.08	0.67

Note: All Chi-square test statistics significant at the 1% level.

Exhibit 10
Estimated Overbuilding Risk Based on Leading Index

	Estimated Probability of Overbuilding			Year-Over-Year Change in Estimated Probability		Starts Existin
Metropolitan Area	1998	1997	1996	1998/1997	1997/1996	1997
Cincinnati, OH	0.12	0.13	0.25	−0.01	−0.12	1.4
Riverside, CA	0.11	0.10	0.18	0.01	−0.08	0.8
Phoenix, AZ	0.10	0.08	0.13	0.02	−0.05	2.8
Kansas City, MO	0.10	0.07	0.16	0.03	−0.09	3.0
Chicago, IL	0.08	0.08	0.13	0.00	−0.06	0.9
Birmingham, AL	0.08	0.07	0.10	0.01	−0.03	1.6
Sacramento, CA	0.07	0.06	0.10	0.01	−0.04	3.2
Dallas, TX	0.07	0.06	0.12	0.01	−0.06	4.3
Cleveland, OH	0.06	0.06	0.12	0.00	−0.06	1.1
San Diego, CA	0.06	0.05	0.08	0.01	−0.03	2.6
Salt Lake, UT	0.06	0.05	0.09	0.00	−0.04	0.9
Boston, MA	0.06	0.04	0.09	0.02	−0.05	1.6
Minneapolis, MN	0.05	0.04	0.09	0.00	−0.05	2.6
Charlotte, NC	0.04	0.03	0.06	0.01	−0.03	3.8
San Francisco, CA	0.04	0.03	0.04	0.01	−0.01	2.2
San Antonio, TX	0.04	0.04	0.11	0.00	−0.07	4.4
Seattle, WA	0.04	0.02	0.02	0.02	0.00	2.1
Nashville, TN	0.03	0.02	0.06	0.00	−0.03	3.8
Pittsburgh, PA	0.03	0.02	0.04	0.01	−0.01	0.8
Baltimore, MD	0.03	0.03	0.07	0.00	−0.04	1.4
Columbus, OH	0.02	0.02	0.04	0.00	−0.02	4.3
Philadelphia, PA	0.02	0.02	0.05	0.00	−0.03	0.9

Exhibit 10 (continued)
Estimated Overbuilding Risk Based on Leading Index

Metropolitan Area	Estimated Probability of Overbuilding			Year-Over-Year Change in Estimated Probability		Starts Existi
	1998	1997	1996	1998/1997	1997/1996	1997
New Orleans, LA	0.02	0.02	0.03	0.00	−0.01	0.8
St. Louis, MO	0.02	0.02	0.04	0.00	−0.02	2.2
Los Angeles, CA	0.02	0.01	0.03	0.00	−0.01	0.6
Washington, DC	0.02	0.01	0.05	0.00	−0.03	2.0
Tulsa, OK	0.01	0.01	0.02	0.00	−0.01	0.7
Richmond, VA	0.01	0.01	0.02	0.01	−0.02	1.8
Milwaukee, WI	0.01	0.01	0.04	0.00	−0.02	1.0
Atlanta, GA	0.01	0.01	0.02	0.00	−0.01	5.4
New York, NY	0.01	0.01	0.01	0.00	−0.01	0.6
Houston, TX	0.01	0.01	0.02	0.00	−0.01	0.9
Oklahoma City, OK	0.00	0.00	0.01	0.00	0.00	1.6
Denver, CO	0.00	0.00	0.00	0.00	0.00	3.0
Mean	0.04	0.04	0.07	0.01	−0.03	2.1
Max.	0.12	0.13	0.25	0.03	0.00	5.4
Min.	0.00	0.00	0.00	−0.01	−0.12	0.6
Std. Dev.	0.03	0.03	0.06	0.01	0.03	1.3

Note: Sorted by probability of overbuilding.

Exhibit 11
Estimated Overbuilding Risk Based on Space Market Index

	Estimated Probability of Overbuilding			Year-Over-Year Change in Estimated Probability		Starts Existi
Metropolitan Area	1998	1997	1996	1998/1997	1997/1996	1997
Dallas, TX	0.44	0.07	0.07	0.38	0.00	4.3
Atlanta, GA	0.43	0.50	0.13	−0.06	0.37	5.4
Phoenix, AZ	0.33	0.27	0.14	0.06	0.13	2.8
Riverside, CA	0.33	0.20	0.24	0.13	−0.04	0.8
Chicago, IL	0.32	0.23	0.09	0.09	0.15	0.9
Boston, MA	0.32	0.29	0.30	0.03	−0.01	1.6
Kansas City, MO	0.24	0.31	0.19	−0.07	0.12	3.0
Cincinnati, OH	0.24	0.24	0.15	−0.01	0.10	1.4
Washington, DC	0.23	0.34	0.48	−0.11	−0.13	2.0
Cleveland, OH	0.21	0.28	0.12	−0.08	0.16	1.1
Baltimore, MD	0.21	0.28	0.26	−0.07	0.02	1.4
Philadelphia, PA	0.17	0.23	0.17	−0.06	0.06	0.9
Charlotte, NC	0.16	0.15	0.16	0.01	−0.01	3.8
Nashville, TN	0.15	0.14	0.09	0.02	0.04	3.8
San Antonio, TX	0.12	0.14	0.15	−0.02	−0.01	2.6
San Diego, CA	0.12	0.07	0.09	0.05	−0.02	2.2
Richmond, VA	0.12	0.16	0.14	−0.04	0.03	1.8
Sacramento, CA	0.11	0.08	0.06	0.04	0.02	3.2
Minneapolis, MN	0.11	0.15	0.08	−0.05	0.07	2.6
New Orleans, LA	0.09	0.09	0.08	0.00	0.01	0.8
Salt Lake, UT	0.08	0.10	0.08	−0.02	0.02	4.4
Houston, TX	0.08	0.07	0.06	0.01	0.01	0.9

Exhibit 11 (continued)

Estimated Overbuilding Risk Based on Space Market Index

	Estimated Probability of Overbuilding			Year-Over-Year Change in Estimated Probability		Starts Existi
Metropolitan Area	1998	1997	1996	1998/1997	1997/1996	1997
Los Angeles, CA	0.08	0.02	0.02	0.05	0.00	0.6
Denver, CO	0.07	0.12	0.08	−0.05	0.04	3.0
Columbus, OH	0.07	0.08	0.05	−0.01	0.03	4.3
Birmingham, AL	0.07	0.07	0.07	0.00	0.00	1.6
Oklahoma City, OK	0.06	0.05	0.06	0.02	−0.01	1.6
Milwaukee, WI	0.06	0.04	0.04	0.02	0.00	1.0
St. Louis, MO	0.05	0.06	0.04	0.00	0.02	0.9
Seattle, WA	0.04	0.02	0.03	0.02	−0.01	2.2
Pittsburgh, PA	0.04	0.05	0.05	−0.01	0.00	0.8
San Francisco, CA	0.04	0.01	0.01	0.02	0.00	2.1
Tulsa, OK	0.03	0.03	0.02	0.00	0.01	0.7
New York, NY	0.02	0.03	0.02	−0.01	0.00	0.6
Mean	0.15	0.15	0.11	0.01	0.03	2.1
Max.	0.44	0.50	0.48	0.38	0.37	5.4
Min.	0.02	0.01	0.01	−0.11	−0.13	0.6
Std. Dev.	0.12	0.12	0.10	0.08	0.08	1.3

Note: Sorted by probability of overbuilding.

Exhibit 12
Estimated Overbuilding Risk Based on Base Employment

	Estimated Probability of Overbuilding			Year-Over-Year Change in Estimated Probability		Starts Existin
Metropolitan Area	1998	1997	1996	1998/1997	1997/1996	1997
Boston, MA	0.39	0.44	0.39	−0.05	0.05	1.6
Riverside, CA	0.36	0.43	0.20	−0.07	0.22	0.8
Baltimore, MD	0.36	0.34	0.33	0.01	0.01	1.4
Atlanta, GA	0.31	0.24	0.31	0.07	−0.07	5.4
Chicago, IL	0.27	0.24	0.33	0.04	−0.09	0.9
Philadelphia, PA	0.25	0.24	0.39	0.01	−0.15	0.9
Cincinnati, OH	0.23	0.22	0.19	0.01	0.03	1.4
Seattle, WA	0.23	0.12	0.11	0.11	0.01	2.1
Washington, DC	0.22	0.30	0.29	−0.08	0.01	2.0
Kansas City, MO	0.21	0.20	0.28	0.01	−0.08	3.0
Phoenix, AZ	0.20	0.31	0.28	−0.10	0.03	2.8
Los Angeles, CA	0.20	0.19	0.08	0.01	0.10	0.6
Dallas, TX	0.17	0.13	0.07	0.04	0.06	4.3
Cleveland, OH	0.15	0.22	0.28	−0.06	−0.06	1.1
San Francisco, CA	0.15	0.20	0.13	−0.06	0.07	2.2
New Orleans, LA	0.11	0.13	0.10	−0.02	0.03	0.8
New York, NY	0.11	0.09	0.13	0.02	−0.04	0.6
Sacramento, CA	0.10	0.11	0.09	−0.01	0.03	3.2
Oklahoma City, OK	0.09	0.10	0.12	−0.01	−0.02	1.6
San Diego, CA	0.09	0.17	0.10	−0.08	0.07	2.6
San Antonio, TX	0.09	0.14	0.18	−0.06	−0.03	4.4
Tulsa, OK	0.07	0.04	0.04	0.03	0.00	0.7

Exhibit 12 (continued)

Estimated Overbuilding Risk Based on Base Employment

	Estimated Probability of Overbuilding			Year-Over-Year Change in Estimated Probability		Starts Existin
Metropolitan Area	1998	1997	1996	1998/1997	1997/1996	1997
Houston, TX	0.07	0.06	0.05	0.00	0.01	0.9
Minneapolis, MN	0.06	0.07	0.12	−0.01	−0.06	2.6
Columbus, OH	0.06	0.05	0.10	0.01	−0.04	4.3
Birmingham, AL	0.06	0.09	0.04	−0.03	0.05	1.6
Richmond, VA	0.06	0.06	0.11	0.00	−0.06	1.8
Milwaukee, WI	0.06	0.06	0.08	−0.01	−0.01	1.0
St. Louis, MO	0.05	0.02	0.02	0.04	0.00	2.2
Charlotte, NC	0.05	0.13	0.09	−0.07	0.03	3.8
Salt Lake, UT	0.03	0.04	0.07	−0.01	−0.03	0.9
Pittsburgh, PA	0.03	0.03	0.03	0.00	0.00	0.8
Nashville, TN	0.03	0.07	0.06	−0.05	0.01	3.8
Denver, CO	0.02	0.03	0.03	−0.01	0.00	3.0
Mean	0.15	0.16	0.15	−0.01	0.00	2.1
Max.	0.39	0.44	0.39	0.11	0.22	5.4
Min.	0.02	0.02	0.02	−0.10	−0.15	0.6
Std. Dev.	0.11	0.11	0.11	0.05	0.07	1.3

Note: Sorted by probability of overbuilding.

of overbuilding under the base employment model. In contrast, Cincinnati, Riverside, Phoenix and Kansas City rank highest under the leading index model.

The leading index model generally shows an overall lower risk of overbuilding compared with the base employment and SMI models. To some degree, this may reflect the inclusion of two national index components, which contributed to a steep drop in leading index values for nearly all MSAs in 1995. Yet, there is clear evidence that office construction activity has begun to gain pace nationally as well as in most of the MSAs included in this study. This situation highlights the potential difficulty of using non-local leading indicators to determine the probability of overbuilding. At any given point in time, certain components within the leading index may or may not be the most appropriate for gauging overbuilding. Unlike the leading index model, the SMI and economic base employment models offer objective criteria for assessing the probability of overbuilding. Furthermore, as Exhibits 11 and 12 illustrate, the SMI and base employment models show more consistency in the forecast probability rankings.

In sum, the three indexes provide a useful assessment of the risk of overbuilding across the thirty-four office markets. Atlanta, Boston, Riverside, Phoenix and Kansas City score higher in terms of their current risk of overbuilding than most other markets. Although none of the indexes currently generate a probability of overbuilding in excess of 50%, several markets are at risk of overbuilding, with probabilities in excess of 30% under the SMI and base employment specifications. Four MSAs, Atlanta, Boston, Dallas and Riverside, consistently show up on the SMI model and the economic base model as having high probabilities of overbuilding.

Conclusion

This article examined three different indicators of economic and office market activity and their utility in determining the risk of overbuilding in the office sector. Using a logit model framework, all three of these indexes were statistically significant in explaining periods of overbuilding. While the leading index model provides the highest goodness-of-fit measure, the model's potential utility in predicting overbuilding may be questionable since the choice, appropriateness and determination of leading indicators for identifying periods of strong construction activity entail a high degree of subjectivity. In contrast, both the SMI and base employment indexes offer more objective assessments of changes in the local real estate markets. The SMI provides a clear picture of the demand/supply balance in metropolitan area real estate markets, making it a useful analytical tool. In addition, the variation in economic base activity was significant in explaining the variation in office stock growth across markets. Within the logit framework, strong positive changes in base employment were associated with subsequent periods of overbuilding.

Although the models provide a high degree of explanatory power, there are a number of caveats. The panel model specification ignores local market effects, which may give rise to incorrect probabilities of overbuilding. In addition, other factors that may be important in determining overbuilding such as rent growth, land availability and zoning, were not directly accounted for in the specifications. More elaborate models of the probability of overbuilding could incorporate MSA specific building lags, and utilize additional factors that may influence the development process, such as information on capital market flows and projects in the planning pipeline. However, our intent was not to replace such econometrically driven models. Rather, the goal of this research was to identify indexes that could be readily calculated, which could aid the analyst in determining the risk of overbuilding across all MSAs.

The integration of real estate into the public capital markets will impose a level of discipline on the development process that heretofore has not previously existed. As a result, the increasing securitization of real estate through REITs and CMBS may reduce the volatility of future real estate cycles. However, given the inherent lags in construction, we believe that commercial real estate will continue to be plagued by overbuilding, albeit at more subdued levels. Our research results can be used to identify those markets that are at most risk of overbuilding. While the three indexes examined in our research are not replacements for monitoring individual projects in the planning pipeline, they do provide a useful function in signaling which markets are at most risk from overbuilding. Since real estate returns are directly related to the demand-supply balance, these measures of overbuilding risk in particular markets can be used by portfolio managers as inputs into a tactical real estate allocation process to enhance their returns.

Notes

[1] Office stock, employment, and vacancy rate data used in this analysis is from the F.W. Dodge/McGraw-Hill Companies' database. F.W. Dodge uses the Bureau of Labor Statistics' national industry-occupational matrix to determine office employment at the metropolitan area level. Employment in a set of ''office-intensive'' occupations are summed for each one-digit SIC, plus durable and nondurable manufacturing. This time series is then interpolated and divided by total employment in each one-digit SIC, forming a set of office employment weights by industry. The weights are then applied to one-digit SIC data from the Standard & Poor's/DRI metropolitan area employment database to form an estimate of metropolitan area office employment.

[2] The columns show the value of the skewness coefficient, defined as $a_3 = m_3/s^3$, where s^3 is the sample standard deviation cubed and m_3 is the third moment of the distribution,

$$m_3 = \sum (x_i - \bar{x})^3/n.$$

[3] The number of overbuilding periods and rank order of markets will, of course, change if the definition of overbuilding changes from one to more than one standard deviation above the long-term average growth in stock. Increasing the criteria for overbuilding to two standard deviations lowers the mean quarterly number of overbuilding periods from twelve to four across all thirty-four MSAs for the 1977 to 1997 sample period. However, the market rankings in terms of the number of periods of overbuilding appear to be robust with changes in the standard deviation criteria. The correlation coefficient of overbuilding periods by market under the one and two standard deviation criteria is 0.65.

[4] Lesarge and Magura (1987) detail this process in constructing a leading indicator for metropolitan area employment in Ohio.

[5] For a detailed discussion of variance-weighting methodology as it applies to the national Index of Leading Economic Indicators, see BEA (1996). In summary, the current methodology for calculating the Index involves four basic steps. First, month-to-month changes are calculated for each component. If the component is in a percent change or rate form, simple differences are calculated; otherwise symmetric percent changes are calculated. Second, the standard deviation of each component is calculated and then ‘‘standardized’’ to sum to one. The component changes are then multiplied by the ‘‘standardized’’ factors to create adjusted index components. Third, the composite leading index level is calculated by summing the components and then recursively solving a symmetric percent change formula. Finally, the component index base is set at 1992 = 100.

[6] The sources for the leading index components are: residential housing starts, F.W. Dodge/McGraw-Hill; average weekly hours worked in manufacturing—Bureau of Labor Statistics; help wanted advertising index—Conference Board; yield curve—Standard & Poor’s/DRI; exchange rate—Federal Reserve Board. These components, as well as others, are used in the leading indexes constructed by RFA (1997) and DRI (1985).

[7] In this formulation, F.W. Dodge’s historical and forecast building stock database and office employment data are used.

References

Amemiya, T., Qualitative Response Models: A Survey, *Journal of Economic Literature*, 1981, 19:19, 1483–536.

Benjamin, J. D., G. D. Jud and D. T. Winkler, The Supply Adjustment Process in Retail Space Markets, *Journal of Real Estate Research*, 1998, 15:3, 297–307.

Bureau of Economic Analysis, U.S. Department of Commerce, Business Cycle Indicators, December 1996.

Eppli, M. J. and J. D. Shilling, Speed of Adjustment in Commercial Real Estate Markets, *Southern Economic Journal*, 1995, 61:4, 1127–45.

Gardner, R. J., The Causes and Consequences of Real Estate Investment Cycles, *Real Estate Finance*, 1993, 10:2, 43–6.

Gentile, R., The Geographic Variation in ‘Normal’ Vacancies, Special Study in *F.W. Dodge Real Estate Analysis and Planning Service*, 1992(2).

Gordon, J. N., P. Mosbaugh and T. A. Canter, Integrating Regional Economic Indicators with the Real Estate Cycle, *Journal of Real Estate Research*, 1996, 12:3, 469–99.

Grebler, L. and L. S. Burns, Construction Cycles in the United States since World War II, *Journal of the American Real Estate and Urban Economics Association*, 1982, 10:2, 201–22.

Grenadier, S. R., The Persistence of Real Estate Cycles, *Journal of Real Estate Finance and Economics*, 1995, 10:2, 95–121.

Han, J., The Next Millennium Will Be Different, *Mortgage Banking*, 1999, 59:5, 20–26.

Horst, T., Regional Leading Economic Indicators, *Regional Financial Review*, Regional Financial Associates, 1997, 8:7, 8–14.

Judge, G. G., W. E. Griffiths, R. Carter Hill, H. Lutkepohl and T. -C. Lee, *The Theory and Practice of Econometrics*, Second edition, New York: John Wiley, 1985.

Kling, J. L., and T. E. McCue, Office Building Investment and the Macroeconomy: Empirical Evidence, 1973–1985, *Journal of the American Real Estate and Urban Economics Association*, 1987, 15:3, 234–55.

——., Stylized Facts about Industrial Property Construction, *Journal of Real Estate Research*, 1991, 6:3, 293–304.

Kozlowski, P. J., Regional Indexes of Leading Indicators: An Evaluation of Forecasting Performance, *Growth and Change*, 1987, 18, 62–74.

Lesarge, J. P. and M. Magura, A Leading Indicator for Ohio SMSA Employment, *Growth and Change*, 1987, 18, 36–49.

McNulty, J. E., Overbuilding, Real Estate Lending Decisions, and the Regional Economic Base, *Journal of Real Estate Finance and Economics*, 1995, 11:1, 37–53.

Miles, M., A Foundation for the Strategic Real Estate Allocation: The Space Market Index, *Real Estate Finance*, 1997, 14:3, 23–30.

Miles, M. and D. Guilkey, A Tactical Look at the Space Market Index, *Real Estate Finance*, 1998, 15:4, 39–45.

Mueller, G. R., Understanding Real Estate's Physical and Financial Market Cycles, *Real Estate Finance*, 1995, 12:1, 47–52.

Riddiough, T., The Evolving Linkages Between Public Markets and Real Estate, Paper presented at the MIT Center For Real Estate Members' Meeting, December 1998.

Shilton, L., Patterns of Office Employment Cycles, *Journal of Real Estate Research*, 1998, 15: 3, 339–54.

Sivitanides, P. S., and R. C. Sivitanidou, Construction Movements in Office-Commercial Real Estate Markets, *Real Estate Finance*, 1999, 16:4, 51–59.

Standard & Poor's/DRI, Overview of Metropolitan Area Indexes, Unpublished manuscript, 1985.

Torto, R. G. and W. C. Wheaton, Commercial Real Estate Outlook 1999, *Mortgage Banking*, 1999, 59:4, 42–9.

Treyz, G. I., *Regional Economic Modeling: A Systematic Approach to Economic Forecasting and Policy Analysis*, Boston: Kluwer Academic Publishers, 1993.

Wheaton, W. C., The Cyclic Behavior of the National Office Market, *Journal of the American Real Estate and Urban Economics Association*, 1988, 15:4, 281–99.

Wheaton, W. C. and R. G. Torto, An Investment Model of the Demand and Supply for Industrial Real Estate, *Journal of the American Real Estate and Urban Economics Association*, 1990, 18: 4, 530–47.

Wheaton, W. C. and L. Rossoff, The Cyclic Behavior of the U.S. Lodging Industry, *Real Estate Economics*, 1998, 26:1, 67–82.

Wood, A. P. and M. Gallagher, New Construction and the Role of REITs: Will They Bring the Much Anticipated Discipline to the Space Market?, Paper presented at the American Real Estate Society Meeting, April 1998.

Voith, R. and T. Crone, National Vacancy Rates and the Persistence of Shocks in U.S. Office Markets, *Journal of the American Real Estate and Urban Economics Association*, 1988, 16:4, 437–58.

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