

Office Market Demand Analysis and Estimation Techniques: A Literature Review, Synthesis and Commentary

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Abstract

Judgmental or applied office demand analyses have appeared in the literature for the past forty years. First, using office demand to population ratios, researchers moved to more comprehensive forecasting models that estimate segmented office demand from a growing set of variables. Although estimating equations now better reflect the underlying factors that create demand, improvements are needed in estimating office demand using employment; vacancy rates; demand for specialized office space; submarket overlap and competition; changes in supply resulting from obsolescence, conversion, and demolition; and improvement in primary data collection. Additional empirical work is also needed to verify which refinements to the model significantly improve the accuracy of the estimating equations.

Office market literature can be divided between two related but separate foci. The first focus is the body of office market literature reviewed by McDonald (2002). This body of work can be best described as the literature that determines the factors that affect the office market using econometric techniques. As a conclusion to this component of office market literature, the studies generally reveal that the demand for office space is a function of rent and employment. Thus, the McDonald article provides a valuable review of this segment of the office market literature.

Pittman and Thrall (1992) classify empirical models of real estate markets into two basic types: econometric and judgmental. Guy and Harris (1997) assert that emphasis on econometric techniques has led to more sophisticated modeling techniques without leading to a better understanding of market dynamics. They suggest that marketing research can help explain the causes of change and the profile of demand in order to match demand with supply. This is needed as occupier demand undergoes significant changes in terms of technology, work practices, corporate management, environmental pressures, and social influences. "Office occupiers are not homogeneous; different business sectors are undergoing distinctive processes of change, which have spatial as well as temporal variation. Demand does not advance and recede *en masse*; it is a continuous process of adjustment and realignment in which numerous activities are subject to numerous pressures for change," (Guy and Harris, 1997, p. 134) Organic, structural, and technological changes are acting upon businesses and the market to change occupiers' demand and the space they are provided. They call for more research to identify the changing structure of property market demand.

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The second body of office market literature that was not included in the McDonald article assists with understanding the dynamics of the office market and warrants its own literature review. This article offers a review of that literature to identify the conceptual process underlying the historical development of an office demand estimating equation, and to set the stage for incorporation of changes in the structure of office market demand. This body of literature focuses on the techniques and tools to perform an office market demand analysis. These works develop the models, formulas, and relationships needed to quantify estimates of demand and explore the issues and problems that arise for the market analysts. Rather than looking at national movements in supply and demand, these studies are based on understanding demand and supply factors, the relationship between demand and supply, as well as environmental conditions that affect their relationship in the market. They focus on the types of analysis that market decision makers use to determine whether to buy, build, or sell, as well as to position office buildings in the local marketplace and anticipate upcoming changes in that market. The authors and their work discussed in this literature review have established the foundation upon which office market demand analysis and estimation currently rests.

Literature Review

A chronological array of office market studies appears in Exhibit 1. For the last forty years, researchers have been adapting and expanding judgmental office demand forecasting models. Some authors have focused on identifying problems and shortcomings in the techniques. Others have reiterated models developed earlier and applied them to new situations. A few have contributed substantially to the development of a complex and more complete model of the office market. This literature review selects the most influential articles from Exhibit 1 and reviews them in depth in relation to the introduction of new concepts and techniques. Other articles that have contributed less significantly are included in relation to the principal articles.

The articles by Jennings (1965) and Detoy and Rabin (1972) were the start of two related conceptual threads in office space demand forecasting. Jennings and his successors use a ratio of some type to relate population or employment to office space demand. Detoy and Rabin and their successors use an estimating equation that includes a series of variables that create demand for office space. As time progressed other authors added to the basic models by refining the initial concepts and/or including other variables. This literature review will trace the evolution of the two general approaches and the development of the office demand forecasting techniques.

Ratio Method

Office market demand analysis and forecasting techniques have developed in less than a straight line process. Simple ratios were reasonable attempts to use limited data to estimate demand in a relatively homogeneous market. If the labor participation rate, unemployment rate, industrial and occupational composition of the economy, and office space used per employee remain constant, analysts could use simple ratios based on available population and employment data to estimate gross demand for office

Exhibit 1
Chronological Array of Office Market Demand Analytical Techniques Publications

Year	Authors	Title	Summary of Major Points
1965	Jennings	Predicting Demand for Office Space	Uses a historic office stock to population ratio and a population forecast to forecast office space demand.
1972	Detoy and Rabin	Office Space: Calculating the Demand	Use the change in total employment, the office employment to total employment ratio, and average square feet of office space per employee to forecast office space demand.
1975	Lex	Marketing Studies for Office Buildings	Introduces the relationship between office space and total employment to ratio method.
1977	Messner, Boyce, Trimble, and Ward	Analyzing Real Estate Opportunities	Point out that both size and growth of population of area will influence number and types of businesses and jobs requiring office space. Provide simple case study estimating office space demand from estimated employment growth in office jobs and a space usage per employee ratio focusing on capture rate of submarkets and a specific building.
1983	Bible and Whaley	Projecting an Urban Office Market	Refine forecasting model with detached space ratio, leased space ratio, and net square footage to gross square footage ratio.
	Grissom and Kuhle	The Space Time Segmentation Technique (ST3): A New Approach to Market Analysis	Focus on movement of existing tenants within the local market, introducing the time element in estimating demand from these tenants depending on the remaining term of leases.
	Kelly	Forecasting Office Space Demand in Urban Areas	Incorporates the variability of number of office jobs among economies comprised of different industries into the ratio method.
1984	Schloss	Technical Note: Use of Employment Data to Estimate Office Demand	Refines use of occupational categories to estimate office workers by examining BLS national data on occupational categories for the FIRE and Service industry divisions. Calculates an annual office prone multiple for employment; however empirical example uses total employment data from a household survey.
1985	Del Casino	A Risk Simulation Approach to Long-Range Office Demand Forecasting	Introduces Monte Carlo simulation to produce a probability distribution of office demand forecasts based on ratios of population, labor force participation, white collar workers in speculative buildings, and space per worker.
	Martin and English	Forecasting Demand for Multi-tenant Office Space	Uses a ratio of service sector employment to population to estimate demand due to growth in employment.

Exhibit 1 (continued)
Chronological Array of Office Market Demand Analytical Techniques Publications

Year	Authors	Title	Summary of Major Points
1987	Clapp	Handbook for Real Estate Market Analysis	Discusses how the proportion of office workers in each industry varies among geographic areas and changes over time and why space per worker varies with occupations, rent, and available space. Demonstrates use of employment forecast by industry and proportion of office workers to estimate growth in office employment. Incorporate disaggregation into office nodes into forecasting model.
1988	Kimball and Bloomberg Birch Carn, Rabianski, Racster, and Selden	Office Space Demand Analysis Forecasting Overbuilt Office Markets Applied Real Estate Market Analysis	Quantifies office space per worker by occupation, illustrating the fallacy of using a standard area per worker in forecasting equations. Restate Deto and Rabin (1972) forecasting equation while discussing the complications of headquarters offices. Explain methods to check employment estimates by calculating historic ratios of local employment to that of a larger area for which a forecast is available, then applying the ratio to that forecast. Show how to allocate an aggregate employment forecast among local industries using historic local proportions along with changes taking place in the structure of local employment by industry. Show how to use a multiplier to increase employment forecasts that exclude government workers, self-employed persons, farm workers, domestic service workers, and railroad employees to include all private sector employees, as well as government workers. Illustrate how to use cross-classification of state industrial employment by occupation from the U.S. Census Bureau to estimate office-using employment by industry, and then reduce the ratios to exclude workers not located in speculative space. Introduces consideration of size of firm. as well as mergers and acquisitions to estimating office workers and space demand. Restates issues surrounding estimating office employment: space per employee, existing supply, and future construction. Estimates absorption rate for a specific building incorporating elements of segmented forecasting model.
	Dowall	Office Market Research: The Case for Segmentation	
	Hysom	Office Market Analysis: A Solution to Overbuilding?	
	Whaley	Scanning Office Markets to Find the Best Sites	

Exhibit 1 (continued)
Chronological Array of Office Market Demand Analytical Techniques Publications

Year	Authors	Title	Summary of Major Points
1989	Clapp	Absorption Forecasts Using Employment and Population Growth	Uses FIRE employment index as proxy for total office employment in estimating demand and absorption. Discusses how space usage per employee may vary over time with rents.
	Crone	Office Vacancy Rates: How Should We Interpret Them?	Explains how suppliers' planned vacancy rate that should be factored into forecasting equation will vary over time and among markets.
	Powers and Hunter	Anticipating Office and Industrial Space Demand: How to Effectively Anticipate a Market Area's Turning Point	Empirical estimate of Florida office demand based on office workers by industry and a space per worker parameter, emphasizing the need for primary data collection in the local market. Suggest demand is related to cost of capital that lowers construction costs and reduces rents.
1989	Rogers	A Model for Forecasting Office Space Demand	Illustrates a simplified model for estimating speculative space. Mentions, but does not empirically account for issues raised in earlier works (government workers, headquarters space, upgrading, office workers not located in freestanding space, the uneven usage of office space among service industries, a natural vacancy rate, building efficiency, and variation in office space per worker by industry, occupation, and location).
1992	Ragas, Ryan and Grissom	Forecasting Office Space Demand and Office Space per Worker Estimates	Empirical test of Kimball and Bloomberg's model in Texas and Louisiana, finding a wide range of space per worker between cities, submarkets, and headquarters buildings.
1993	Clapp	Dynamics of Office Markets	Restates the Clapp (1989) proxy office employment and office employment index forecasting method, comparing it with an approach Birch (1986) used in an Arthur Anderson report that estimates employment by industry and occupation with corresponding space per worker parameters. Concludes that the more complex and costly Birch approach probably produces more accurate results.
	Corcoran	Searching for the Bottom of the Office Market	Reiterates how changing local industrial composition or lower rents can increase demand without increasing employment.
	Kately	Office Marketability Studies	Recommends net absorption approach to estimating demand over employment growth for analysis for a specific building.

Exhibit 1 (continued)
Chronological Array of Office Market Demand Analytical Techniques Publications

Year	Authors	Title	Summary of Major Points
	Myers and Mitchell Powers	Identifying a Well-Founded Market Analysis Office Submarket Delineation in Tenant Locational Behavior	Focus on estimating the demand for a specific building as part of an appraisal. Explains how submarkets evolve and how to evaluate their competitiveness, assisting with the allocation of demand. Describes how a gravity model can be applied to develop a spatial index that the analyst can use to rank submarkets; however, most of the components of the model are aggregates that ignore segmentation and disaggregation of employment demand and office space supply.
1994	Fanning, Grissom, and Pearson	Market Analysis for Valuation Appraisals	Provide background on how office space demand is a derived demand from the services provided in the offices, stating that in the short run, the ratio between population and office employment and, therefore, office space remains relatively constant. Discusses variations in office space per worker among markets and over time. Case study estimates demand for Class A freestanding office space from an employment forecast segmented by industry and occupation with the percentage of those workers who are employed in freestanding office buildings based on the analyst's judgment. The space per office employee is based on BOMA surveys or local historical data. They then adjust for a "normal" vacancy rate and consider existing vacant space and forecasted construction to establish net demand for new Class A office space in the market area. Uses the ratio of occupied office space to total employment applied to an employment forecast as a check on the estimating equation.
	Rabianski	Linking Particular Office Marketability to the Market	Develops an equation linking the stock of office space in a market area to new construction, demolitions, conversions, and vacant space. Relates historic absorption to the equation for the market area. Links the office market equation and the amount of rentable space that a subject property brings to the market. The analysis creates a relationship between the subject property and the market and then shows the occupancy level of the subject property will change as office space is absorbed and constructed.

Exhibit 1 (continued)
Chronological Array of Office Market Demand Analytical Techniques Publications

Year	Authors	Title	Summary of Major Points
	Shilton	The Eight Myths of Office Demand Forecasting	Criticizes some common procedures in demand analysis, including using employment in FIRE industries as a proxy for office employment, estimating office employment as a steady percentage of total employment in different geographic areas and over time, ignoring how large firms and corporate headquarters create demand for their own space, as well as for ancillary services, and using an aggregate vacancy rate. Suggests a disaggregated or bottom-up approach to the analysis of local office markets illustrated with a case study of the Paisley market. Suggests forecasts consider trends in space needs of different types of employees and filtering.
1995	Jones	An Economic Basis for the Analysis and Prediction of Local Office Property Markets	
	Malizia and Howarth	Clarifying the Structure and Advancing the Practice of Real Estate Market Analysis	
	Wincott and Mueller	Market Analysis in the Appraisal Process	
1996	Hakfoort and Lie	Office Space per Worker: Evidence from Four European Markets	Provides suggested outline for an office market analysis as part of an appraisal. Empirical study of office space demand per worker. Finds differences among cities, industry sectors, and different size buildings with a negative relationship between rent and space per worker.
1997	Howland and Lindsay	Where Do Tenants Come From?	Traces demand for space in Prince George County, Maryland to start-ups and firms moving from outside the metropolitan area, just two of the possible generators of demand.
1998	Howarth and Malizia	Office Market Analysis: Improving Best-Practice Techniques	Restates and expands upon suggestions of Malizia and Howarth (1995) to use exogenous information to improve forecasts used in market analysis, incorporating the influence of megatrends that are affecting user preferences and product design and factoring in trends in occupational and industry employment, changing space needs of different occupations, and trends in tenure choice.

Exhibit 1 (continued)
Chronological Array of Office Market Demand Analytical Techniques Publications

Year	Authors	Title	Summary of Major Points
	Liang and Kim	Demand for Office Space: Neither Feast Nor Famine	Identifies changes in labor force participation. Asserts almost all office-occupying jobs are in "managerial and professional specialty" and the "technical, sales, and administrative support" categories based on BLS data and the authors' assumptions about office employment ratios by occupational category. Empirical analysis demonstrates U.S. office employment growth exceeding growth in total employment. Forecasts change in space per worker.
2001	Schmitz and Brett	Real Estate Market Analysis	Suggests using a combination of the office employment and net absorption methods to estimate trends in office space demand. Warns against using straight line forecasts, stressing the importance of incorporating knowledge about changing space per worker and local conditions.
2004	Rabianski	Office Market Demand Analysis	Incorporates government/private employment, specialty office employment, and owner-occupant segmentation into the forecasting model.
2005	Fanning	Market Analysis for Real Estate	Reiterates the same process provided in Fanning, Grissom, and Pearson (1994), however, uses percentage of office employment in three NAICS supersectors as a proxy for total employment in multi-tenant office space because of the difficulty of estimating freestanding office inhabitants within each sector. A comparable ratio method is also presented where the ratio of office space to population or employment is determined for a similar but slightly larger city, then that ratio is applied to the forecasted future population or employment in the city under study to estimate future office space demand.

space. The most influential works dealing with the ratio approach include the initial work by Jennings (1965) followed by Kelly (1983) and Clapp (1989).

Jennings

The first publication on the topic of office space demand analysis is a work by Christopher R. Jennings that appeared in the *Appraisal Journal* in 1965. This article revealed that office demand analysis as an organized body of knowledge did not exist prior to World War II. In the post World War II period, practitioners developed a "handicraft method" referred to as the "ratio method." Ratio methods relate quantity of office space demanded to some available measure of population or employment. Once calculated for a single city over time, a larger geographic area or a comparison area, the ratio is applied to the subject area's population or employment to estimate current and future demand for office space.

Jennings (1965) used a population ratio, explaining that the ratio should be based on the metropolitan population and averaged over time. Although Jennings did not provide a formula in his article, his office space estimating equation can be stated in the following manner:

$$D_{t+1} = \left(\frac{S}{P}\right)P_{t+1}. \quad (1)$$

Where:

- D_{t+1} = Demand for total office space in a future time period;
- S = Stock of office space in a given period;
- P = Population in a given period;
- S/P = Average of the ratio for several recent years; and
- P_{t+1} = Forecasted population in time period $t + 1$.

In this postwar era, two simplifying assumptions were made to make the estimation of total office floor space easier. First, only the office space in the CBD was estimated because in most cases this was the only major site of office space. Second, only the space used by major offices, large space users typically occupying 50,000 square feet or more, was estimated. These assumptions would be inappropriate in today's office market. Even at that time Jennings (1965) recognized weaknesses in this model arising from both national and local factors. First, the immediate past may not be relevant as a predictor of the immediate future. This was true of the postwar era when employment was growing at an increasing rate. This is also a problem when the industrial composition of the national and the local economy is shifting from manufacturing activity to more office space intense non-manufacturing activity. Jennings also pointed out that the ratio is not spatially consistent. The ratio among metropolitan areas can differ based on their industrial structure, their function as a headquarters location, and the size of the functional geographic region served. These shortcomings provided direction for future researchers to refine the ratio approach.

Jennings was the first author to report on the office market filtering effect that is similar to filtering in the housing market. "As the more ebullient and dynamic concerns move into new offices, others come to fill the premises which they have vacated. Hence, a 'hierarchy' of offices exists in most cities. ..." (Jennings, 1965, p. 380). Such filtering will influence relative demand for different classes of office space. He also asserted that firms that upgrade their space also generally increase the amount of space they require by 20% because most long-established offices are overcrowded and moving into a new office allows the firm to reorganize the layout of equipment, files, personnel, etc.

It follows that Jennings (1965) states that the process of estimating future office space demand requires that the analyst inventory existing space, classified by age and condition, with two condition groupings: first- and second-class. He defines these classes consistently with current discussions of Class A versus Class B office space.

Jennings (1965) suggested the use of regression analysis and determining an ordinary least squares trend line based on historic construction and expected changes in the local economy. However, he resorted to crude ratios himself in providing a target Class A to B/C ratio to estimate replacement demand and "reasonable" CBD office space per metropolitan resident ratios.

Kelly

Kelly (1983) improved ratio analysis by raising the sophistication of the approach, rejecting the assumption of homogeneous demand, criticizing the unrealistic estimates of average or normal annual new space demand based on historical construction, as well as simply calculating a demand index of net new absorption relative to total inventory. He suggested analysts must evaluate market area boundaries, consider conversions and relocations, as well as changing concentrations and dispersions of employers within the area, and forecast office demand based not on population, but on fundamental analysis of employment data by job and industry. Kelly provided evidence of the variance in white-collar employment ratios among industries in New York City in 1980 as well as over time, thus pointing out the need to consider the differences in the office employment ratio in more than just a one-digit SIC format. However, Kelly does not take the final step to convert office jobs into quantity of space demanded.

Clapp

Clapp (1989) created an "occupied square footage/employment index" to estimate absorption (new space demand). He started with total available office space and the vacancy rate to generate occupied square footage on an annual basis, ignoring the classifications or hierarchy of offices. Then he used FIRE industry employment as a proxy for office employment, the "employment index," and divided it into occupied square footage to obtain an "occupied square footage/employment index," becoming the first to incorporate the occupied space per employee demand parameter in a ratio

approach. However, use of FIRE employment as a proxy for office employment has its drawbacks. Most but not all workers in FIRE are located in offices. The FIRE industry has a wide variation in office space usage with executives at the high end and back office employees at the low end. Moreover, these two different classes of office workers can be located in different office markets and in different office space types (i.e., Class A versus Class B space). Also, not all office employees are in the FIRE category. Each SIC code and now NAICS sector contains office employment to a different extent. So, in two local economies with the same FIRE employment, a given level of growth in service sector employment may create different levels of office demand depending on what types of service jobs they are. The third step was to estimate changes in the demand parameter (occupied space per employee) based on historical trends and the researchers' understanding of forces influencing these trends. Clapp then forecasted the "occupied square footage/employment index" and applied it to a forecast for FIRE employment growth to obtain a forecast of total occupied office space. From this he estimated annual absorption by subtracting current occupied space from future estimated occupied space.

From the start, researchers such as Jennings (1965), Lex (1975), and Del Casino (1985), while explaining how to use ratio methods, also discussed the unrealistic assumptions of applying such ratios in different local economies and at different times as the composition of the economy varies and is shifting. They recognized that the demand for space is not homogeneous across spatial and Class submarkets. They also recognized the impact that modifications in work practices could have over time. Clapp (1993) notes the trade off between accuracy and cost, concluding that a forecasting model will likely produce more accurate results. The attraction of the ratio approach is its simplicity and the limited data needed to perform the calculations. Thus, the approach still has its appeal, as evidenced by Fanning's (2005) suggestion of using the ratio of office space to population or employment in a similar but slightly larger city as a check on the estimate of office space demand derived from a forecasting equation. As another compromise, some researchers, such as Martin and English (1985), have used office space ratios as a base for estimating demand, but expanded the approach to incorporate factors from the forecasting equation models.

Forecasting Equation Method

The most substantive forecasting equation work progressed from Detoy and Rabin (1972) through works by Bible and Whaley (1983) and Kimball and Bloomberg (1987), to Rabianski (2004).

Detoy and Rabin

A major step forward to address the heterogeneity and dynamic nature of the modern office market was the Detoy and Rabin (1972) model in *Urban Land* that mapped the derivation of office space demand as a process based not only on numbers of residents, employees or jobs, but also on changing space needs and movement within the market. They were the first to recognize the need to stratify employment by industry to allow

for the variance in occupations and office demand. They also considered the reality of the market in that any estimate of net demand should consider a normal vacancy rate. In their model, demand for additional office space is a function of five factors:

- Existing tenants expanding their space requirements (d_1);
- New tenants moving into the community, relocating firms (d_2);
- New tenants emerging from start-up business venture in the area (d_3);
- Existing tenants upgrading their space requirements (d_4); and
- Existing tenants in buildings forced to relocate because their present office space is being removed from the inventory (d_5).

Supply of available space in the office market (which could also be termed change in supply or annual marginal supply or space placed on the market) is also a function of five corollary factors:

- Existing tenants going out of business reducing their space requirements (s_1);
- Existing tenants reducing space requirements (s_2);
- Existing tenants moving out of the community, relocating firms (s_3);
- New office space being added (including conversion from one class to another as well as conversion to/from non-office space from/to office space) (s_4); and
- Vacant space from the previous period (office overhang) (s_5).

The first task in the estimating equation is to identify the net additional office space demand from employment, which Deto and Rabin (1972) symbolize by G . They set out the following equation:

$$G = \alpha[(d_1 + d_2 + d_3) - (s_1 + s_2 + s_3)]. \quad (2)$$

The significance of this equation is that the change in employment is a "net" figure and that it is a proxy for the real world changes in the local economy represented by $(d_1 + d_2 + d_3)$ and $(s_1 + s_2 + s_3)$. The symbol " α " represents average space used by an office employee.

The estimating equation for net office space demand is then written in the following format:

$$D - S = G + U + O_r - O_a - O_v. \quad (3)$$

Where:

D = Demand for office space;

S = Supply of office space;

$G = \alpha[(d_1 + d_2 + d_3) - (s_1 + s_2 + s_3)];$

$U = d_4$, demand from upgrading;
 $O_r = d_5$, demand from relocation;
 $O_a = s_4$, new supply; and
 $O_v = s_5$, existing vacant space.

The estimating equation is further refined by admitting the need for a "normal, desirable" vacancy level that will allow tenants and owners to schedule moves; this is symbolized as V_n . Realization of V_n brings about a differentiation between D and D^* , which represents total demand, including normal vacant space. The mathematical relationship between D and D^* is given by the following equation:

$$D^* = \frac{D}{1 - V_n} \quad (4)$$

When this V_n relationship is inserted into the previous estimating equation, the following estimating equation arises:

$$D^* - S = \frac{(G + U + O_r)}{(1 - V_n)} - (O_a + O_v), \quad (5)$$

where D is given by $(G + U + O_r)$.

The final modification to the estimating equation is the specification of a relationship between upgrading or filtering (U) and demand ($G + U + O_r$). The authors state that "historic data or informed judgment" can relate U as a percentage (β) of G .

The estimating equation is then written in the final format:

$$D^* - S = \left(\frac{1}{1 - V_n} \right) (\beta G + G + O_r) - (O_a + O_v). \quad (6)$$

Detoy and Rabin (1972) suggested estimating G from employment estimates by SIC codes and office employment coefficients (φ), which the authors provided from previous research. They proposed using field surveys to estimate normal vacancy rates, office space removed from inventory, and space overhang as inputs to the model. They illustrated the model with cases, but did not test it empirically.

In addition to developing the estimating equation, Detoy and Rabin (1972) presented several ideas for refinement that later researchers incorporated: submarkets based on class of space and location, and segmented demand based on type of office tenant. They specifically stated that office demand is not a direct function of population, making ratios such as the one provided by Jennings (1965) inappropriate. They also cautioned that growth in service industries would not create a proportional growth in office space demand as many service workers are not office occupiers, a fallacy of using FIRE employment as a proxy for office employment.

Bible and Whaley

Bible and Whaley (1983) introduced a new variable to account for the demand for additional space for existing employees as the average space per employee changes over time. Thus, total demand for office space is a function of existing employees expanding into larger spaces and new employees moving into similar sized office areas. They also introduced three new ratios into the forecasting equation that further refine gross office demand:

- Detached space ratio;
- Leased space ratio; and
- Net square footage to gross square footage ratio.

These variables were applied in an empirical example from Southeastern Virginia that uses national employment projections combined with BLS data on employment by sector and occupation, as well as space per new employee derived from BOMA surveys and a change in square footage for existing employees based on historical trends. They do not provide a rationale for how they set the percentage of detached space. They suggest examining national and local office rents and vacancy rates to establish the vacancy allowance for the equation. A historical average of net-to-gross space ratios is then used.

Kimball and Bloomberg

Kimball and Bloomberg (1987) presented an estimating equation, discussing it in a series of steps. While their equation was not very innovative, they discussed specific data sources and the assumptions made in the forecasting process. They used total employment forecasted by one-digit SIC categories (despite the earlier criticism of this generalization by Kelly), extracted the office space occupants using BLS data on occupational categories by SIC, then allocated a percentage to freestanding offices. To convert employees to space demand, they recommended using space per employee obtained from BOMA, a local survey, or an estimation obtained by dividing current total occupied space in the market by the number of office employees. They compared gross demand to existing and estimated future space to derive net unsatisfied demand. The gross estimate of office demand should be allocated to submarkets based on office node shares. As the unsatisfied demand estimates are based on occupied space, the authors pointed out the need to gross up the estimates to account for vacancy in determining the total space that should be built. The process is illustrated with a fictional case study. This outline did not address some of the issues raised by earlier works, such as increases/decreases in space demand for existing employees as average space per worker changes.

Rabianski

In a recent office market analysis publication, Rabianski (2004) discussed the problems of disaggregation, segmentation, target marketing, market demand variables,

and market demand modeling. He clarified that market analysis can be conducted either on a gross or net space demand basis. His equations incorporate many of the refinements and criticisms of earlier researchers.

Rabianski (2004) discussed two methods for estimating the proportion of employees in each industry who occupy office space. In addition to Kimball and Bloomberg's (1987) approach of national BLS data on occupations by industry, he suggested using primary occupational categories and the researcher estimate of the proportion of local workers in each industry who are in office occupying jobs. The author provided such estimates for the Atlanta MSA.

Expanding earlier discussions of segmentation, Rabianski (2004) cited the need to identify government employees, special space demanding occupations such as medical workers, and owner-occupants. He also reiterated the need to allocate employment and demand to geographic submarkets and the Class of space demanded.

Rabianski (2004) discussed how sources such as BOMA and private real estate firms can provide widely varying space per employee estimates, calling upon the analyst to exercise judgment using recent absorption experience from primary data collection on new occupants. He mentioned including changes in space per employee in different areas and over time and how a term can be incorporated to adjust for additional or less space per existing worker.

Based on this, Rabianski (2004) provides both a stock and a flow disaggregated demand model:

$$D = \alpha\beta\Phi\theta\pi\tau\gamma E_T \quad (7)$$

$$\Delta D = \alpha\beta\Phi\theta\pi\tau\gamma(\Delta E_T) \quad (8)$$

Where:

- D = Demand for disaggregated and segmented existing office space;
- ΔD = Demand for additional disaggregated and segmented office space;
- α = Percentage of private sector employment by SIC code allocated to the office node;
- β = Percentage of private sector employees allocated to the Class space;
- Φ = Office space per private sector employee;
- θ = Percentage of private sector employees who occupy office space;
- π = Percentage of total employment in the private sector;
- τ = Percentage of private sector employment in tenant-occupied space;
- γ = Percentage of private sector employment in general office space; and
- E_T = Total employment.

For net demand, Rabianski (2004) adds current supply, change over time, and an acceptable vacancy rate to reach:

$$\Delta D = \alpha\beta\Phi\theta\pi\tau\gamma(\Delta E_T) + (\Delta\Phi)E^* - V - (NC + R + C) - d. \quad (9)$$

Where:

- E^* = Private sector employment;
- V = Vacancy for the disaggregated office type;
- NC = New construction of disaggregated office type;
- R = Rehabilitated office space to change class;
- C = Conversions; and
- d = Demolitions.

Rabianski (2004) showed a numerical example, listing some general data sources, but identified the need for field research to determine the tenure of existing buildings and the amount of general versus specialized office space. He said one can use recent absorption to allocate new demand among the geographic submarkets or use analyst's judgment.

Other works have contributed to the comprehensive forecasting model. Some refined the use of occupational categories to estimate office workers (starting with Schloss, 1984). Others identified other factors that affect the range of space demand per office worker among firms, between submarkets, and over time (Grissom and Kuhle, 1983; Clapp, 1987; Birch, 1988; Dowall, 1988; Crone, 1989; Powers and Hunter, 1989; Shilton, 1994; Hakfoort and Lie, 1996; and Liang and Kim, 1998).

Conclusion

This literature review traced the conceptual process underlying the historical development of an office demand estimating equation. The major works that developed the models, formulas, and relationships needed to quantify estimates of demand have been summarized and placed in context. The authors and their work discussed in this literature review established the foundation upon which office market demand analysis, estimation, and forecasting currently rests.

The field of applied office market analysis has grown and matured since initial reliance on crude ratios in the years following World War II reported on by Jennings (1965). Researchers continue to refine and expand models introduced first by Detoy and Rabin (1972) and then others in the 1970s to explain the dynamic relationship between supply and demand in this sector of the real estate market. The goal of these researchers is to attain greater understanding of the behavior of the office market and its participants in order to design more accurate demand estimating equations.

Demand segmentation and property disaggregation have become standard procedures in the office market estimation and forecasting process, acknowledging the heterogeneous nature of the market. The need to apply these procedures will be even more significant in the future as businesses change and workspaces are modified to accommodate varying needs.

An accurate office employment forecast is the basis for estimating additional office space demand. Most researchers rely on government sources for estimates of current employment and expected growth. This data may be incomplete or unreliable. In the United States, for example, some federal data are gathered on participants in the labor market and thus are reported based on the location of their residence, not their place of work. Some agencies only gather data on employers with a minimum number of employees, missing small businesses and self-employed service workers. Employment by industry is preferred as researchers have demonstrated that the proportion of office workers varies by industry. More refined industrial categories allow the researcher to more precisely estimate the number of office workers.

However, the identification of office workers within industrial categories remains a problem. Reliance on FIRE and Services industrial categories as a proxy for office employment is fraught with problems. With technological changes, outsourcing, and other changes in work practices, the occupational composition of some industries is shifting, changing the proportion of workers requiring office space and altering the proportional relationship between FIRE and services employment and total office employment. No single method of estimating the proportion of office workers has been empirically proven to be superior.

The naivety of estimating average space per office worker is now well recognized because empirical work has illustrated the need to adjust estimates for differences among industries, individual firms within an industry, occupations, location, and market conditions (Birch, 1988; Powers and Hunter, 1989; Ragas, Ryan, and Grissom, 1992; Hakfoort and Lie, 1996; and Liang and Kim, 1998). As the distribution of occupations changes in the economy, so does the average space per worker. As the industrial composition of the local economy changes, so will the relative demand for office space. Rising or falling rents will also influence space allocation. As employers search for flexibility and implement such space reduction methods as shared workspaces, hoteling, and hotdesking, average space per worker in these environments may decline (Gibson, 2003). The impact of these changing work practices on office use is being felt unevenly across industrial categories.

Office demand forecasting continues to focus on speculative general office space, with little attention paid to the other segments of the office market. If more accurate segment demand estimates are required, better specifications are needed for specialized workers and their space requirements to estimate demand for specialized offices, especially with the growing medical services industry. "Smart" and "green" buildings have been discussed for years and the demand for them may be increasing (Rudin and Gilbert, 1998). However, the models do not delineate them as separate segments. Also, the small free-standing office market is almost totally ignored, yet it is in competition and impacts demand for large, multi-tenant office buildings. The same can be said for the owner-occupant market.

Little has been published regarding the delineation of market and submarket areas on which data is collected for estimation with these models. When working with a single

area, researchers must quantify the spillover effects and the importance of competitive advantage in allocating demand across geographic areas. Use of GIS analysis could enhance the models presented herein.

Multiple definitions and measures of vacancy and availability rates have been identified, allowing the analyst to more accurately assess the net demand for space. Filtering, intra-market relocation, and changes in tenure preferences have been recognized as relevant factors that affect submarket absorption. All these improvements are reflected in the complex forecasting equation model best exemplified by Rabianski (2004). Disaggregated rates by submarket and class reflect the true balance of supply and demand amongst competitors. The composition of the inventory of vacant space must be examined in terms of obsolescence, contiguous location, and other factors that affect its suitability for tenants. Furthermore, vacant space has been classified as frictional, as cyclical, and as structural, which represents high levels of physical deterioration, functional obsolescence, and external obsolescence (Rabianski, 2002).

As researchers continue to refine these models and improve specifications of the variables, office market analysis will continue to benefit with more accurate and reliable analysis and forecasting. Empirical tests are needed along the way to ensure that new specifications improve the results. Practical considerations of the relative cost of additional data gathering versus improvement in estimation must also be considered.

References

- Bible, D.S. and J.W. Whaley. Projecting an Urban Office Market: A Source of Information for Appraisers. *Appraisal Journal*, 1983, 51:4, 515-23.
- Birch, D.L. *America's Office Needs: 1985-1995*. Chicago, IL: Arthur Anderson & Co., 1986.
- . Forecasting Overbuilt Office Markets. *SIOR/Perspective*. 1988, January/February, 2-7.
- Carn, N., J. Rabianski, R. Racster, and M. Selden. *Real Estate Market Analysis*. Englewood Cliffs, NJ: Prentice-Hall, 1988.
- Clapp, J.M. *Handbook for Real Estate Market Analysis*. Englewood Cliffs, NJ: Prentice Hall, 1987.
- . Absorption Forecasts Using Employment and Population Growth. In J.M. White (ed.). *Forecasting: Market Determinants Affecting Cash Flows and Reversions*. AIREA Research Series Research Report 4. Chicago, IL: American Institute of Real Estate Appraisers, 1989, 14-28.
- . *Dynamics of Office Markets*. AREUEA Monograph Series No. 1. Washington, DC: Urban Institute Press, 1993.
- Corcoran, P.J. Searching for the Bottom of the Office Market. *Real Estate Review*, 1993, 23:1, 15-21.
- Crone, T.M. Office Vacancy Rates: How should We Interpret Them?, Federal Reserve Bank of Philadelphia, *Business Review*, 1989, May-June, 3-12.
- Del Casino, J.J. A Risk Simulation Approach to Long-Range Office Demand Forecasting. *Real Estate Review*, 1985, 15:2, 82-87.

- Detoy, C.J. and S.J. Rabin. Office Space: Calculating the Demand. *Urban Land*, 1972, June, 4-13.
- Dowall, D.E. Office Market Research: The Case for Segmentation. *Journal of Real Estate Development*, 1988, 4:1, 34-43.
- Fanning, S.F., T.V. Grissom, and T.D. Pearson. *Market Analysis for Valuation Appraisals*. Chicago, IL: Appraisal Institute, 1994.
- Gibson, V. Flexible Working Needs Flexible Space? *Journal of Property Investment & Finance*, 2003, 21:1, 12-22.
- Grissom, T.V. and J.L. Kuhle. The Space Time Segmentation Technique (ST3): A New Approach to Market Analysis. *Real Estate Issues*, 1983, 8:2, 21-29.
- Guy, S. and R. Harris. Property in a Global Risk Society: Towards Marketing Research in the Office Sector. *Urban Studies*, 1997, 34:1, 125-40.
- Hakfoort, J. and R. Lie. Office Space per Worker: Evidence from Four European Markets. *Journal of Real Estate Research*, 1996, 11:2, 183-96.
- Howarth, R.A. and E.E. Malizia. Office Market Analysis: Improving Best-Practice Techniques. *Journal of Real Estate Research*, 1998, 16:1, 15-34.
- Howland, M. and F.E. Lindsay. Where Do Tenants Come From? *APA Journal*, 1997, 63:3, 356-64.
- Hysom, J. Office Market Analysis: A Solution to Overbuilding? *Commercial Investment Real Estate Journal*, 1988, 7:3, 9-13.
- Jennings, C. Predicting Demand for Office Space. *Appraisal Journal*, 1965, July, 377-82.
- Jones, C. An Economic Basis for the Analysis and Prediction of Local Office Property Markets. *Journal of Property Valuation & Investment*, 1995, 13:2, 16-30.
- Kately, R. Office Marketability Studies. In J.R. White (ed.). *The Office Building*. Chicago, IL: CRE and Appraisal Institute, Washington, DC: SIOR Educational Fund, 1993, 184-202.
- Kelly, H. Forecasting Office Space Demand in Urban Areas. *Real Estate Review*, 1983, 13:3, 83-95.
- Kimball, J.R. and B.S. Bloomberg. Office Space Demand Analysis. *Appraisal Journal*, 1987, 55:4, 567-77.
- Lex, R.A. Marketing Studies for Office Buildings. *Real Estate Review*, 1975, 5:2, 101-03.
- Liang, Y. and J.H. Kim. Demand for Office Space. *Real Estate Finance*, 1998, 15:2, 37-44.
- Malizia, E.E. and R.A. Howarth. Clarifying the Structure and Advancing the Practice of Real Estate Market Analysis. *Appraisal Journal*, 1995, January, 60-8.
- Martin, W.B. and W.D. English. Forecasting Demand for Multitenant Office Space. *Commercial Investment Journal*, 1985, 4:1, 7-9.
- McDonald, J.F. A Survey of Econometric Models of Office Markets. *Journal of Real Estate Literature*, 2002, 10:2, 223-42.
- Messner, S.D., B.N. Boyce, H.G. Trimble, and R.L. Ward, *Analyzing Real Estate Opportunities: Market and Feasibility Studies*. Chicago, IL: National Association of Realtors, 1977.
- Myers, D. and P.S. Mitchell. Identifying a Well-Founded Market Analysis. *Appraisal Journal*, 1993, 61:4, 500-08.
- Pittman, R.H. and G.I. Thrall. Improving Real Estate Market Research. *Real Estate Issues*, 1992, 17:1, 1-7.
- Powers, R.T. Office Submarket Delineation in Tenant Locational Behavior, In J.R. White (ed.). *The Office Building*. Chicago, IL: CRE and Appraisal Institute, Washington, DC: SIOR Educational Fund, 1993, 170-83.
- Powers, R.T. and B.F. Hunter. Anticipating Office and Industrial Space Demand: How to Effectively Anticipate a Market Area's Turning Point. *SIOR/Perspective*. 1989, November/December, 2-7.

- Rabianski, J. Linking Particular Office Marketability to the Market. *Real Estate Review*, 1994, 24:3, 83–6.
- . Vacancy in Market Analysis and Valuation. *Appraisal Journal*, 2002, 70:2, 191–99.
- . Office Market Demand Analysis. *Real Estate Review*, 2004, 33:2, 16–33.
- Ragas, W.R., R.L. Ryan, and T.V. Grissom. Forecasting Office Space Demand and Office Space per Worker Estimates. *SIORF Perspective*, 1992, March/April, 2–8.
- Rogers, R.C. A Model for Forecasting Office Space Demand. In J.M. White (ed.). *Forecasting: Market Determinants Affecting Cash Flows and Reversions*. AIREA Research Series Research Report 4. Chicago, IL: American Institute of Real Estate Appraisers, 1989, 29–42.
- Rudin, W.C. and J.J. Gilbert. Smart and Ready: Wired Buildings Create New Demand. *Commercial Investment Real Estate*, 1998, 17:1, 10S–12S.
- Schloss, N. Technical Note: Use of Employment Data to Estimate Office Demand. *Monthly Labor Review*, 1984, 107:12, 40–44.
- Schmitz, A. and D.L. Brett. *Real Estate Market Analysis*. Washington, DC: Urban Land Institute, 2001.
- Shilton, L. The Eight Myths of Office Demand Forecasting. *Real Estate Finance Journal*, 1994, Winter, 67–72.
- Whaley, J. Scanning Office Markets to Find the Best Sites. *Commercial Investment Real Estate Journal*, 1988, 7:5, 50–54.
- Wincott, D.R. and G.R. Mueller. Market Analysis in the Appraisal Process. *Appraisal Journal*, 1995, 63:1, 27–32.

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