A Dynamic Analysis of the U. S. Office Market
and Lease-versus-Buy Decisions
from 1951 to 1990

by

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Abstract

This thesis analyzes the determinants of office absorption, investment, rental adjustment, and lease-versus-buy (LVB) decisions. The office model presented in this thesis differs from past studies in that it recognizes explicitly: 1) the interactions between the capital and property markets; 2) that owner-occupants, renters, and lessors make up the office market participants; 3) the existence of incentives to leverage and to trade in office investments; 4) the mid- to long-term nature of typical office lease agreements; and 4) non-financial incentives in the office LVB decisions.

Theoretically, from an owner-occupant firms' point of view, both the demand for and supply of office space are assumed to be a function of the level of and growth in office employment so that supply adjustments occur appropriately to demand shocks. In contrast, the demand for rental office space is believed to be a function of growth in office employment and expected rental costs. The investment in rental office space is a function of a lagged price, which is further assumed to be a function of absorption and vacancy rates, equilibrium capitalization rate, and net operating income. The change in rental rate is assumed to be determined by the difference between actual and optimal vacancy rates. The optimal vacancy rate is assumed to be a function of lagged absorption to stock ratio, investment rate, and linearly rising structural vacancy rate. Finally, the LVB decisions are assumed to be affected by local market conditions, national market conditions over time, and user firms' characteristics.

Empirically, when the sample period, from 1951 to 1990, is split into two subperiods (1951 to 1970 and 1971 to 1990), the office market behavior is found to be inconsistent between the two subperiod, which reflects the emergence of the active rental office market in the second subperiod. Specifically, the first (second) subperiod is better estimated by the owner-occupant (rental) office market equations. Especially for office investment in the second subperiod, the equilibrium capitalization rate, which is determined by the capital market, is found to be a critical determinant. Using a logit model on 2,137 observations of LVB decision, the non-financial determinants are able to correctly predict 76 percent of the overall observations.

The persistence of booms and busts in the rental office market appears to be a result of long lags (three years) in and slow rate (about 38 percent per year) of supply adjustments coupled with frequent changes in fiscal and monetary policy. Contrary to the traditional belief, simulation results show that high inflation and ordinary tax rates actually reduce the capitalization rate thereby boosting the level of office investments.

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Chapter 1

Introduction and Thesis Outline

1.1   Introduction

Real estate is one of the most valuable assets owned or leased by American

businesses. Results of several surveys demonstrate the magnitude of corporate real

estate holdings. Zeckhauser and Silverman [1981] surveyed corporate real estate

holdings in the United States in 1981 and estimated that corporations owned four-

to-seven billion square feet of building space, leased two-to-seven billion square

feet, and controlled an additional 70-to-140 million acres of raw land. They also

estimated that the total worth of corporate real estate assets in 1981 was

somewhere between $700 billion and $1.4 trillion. More recently, Roulac [1989]

estimated that, in 1988, corporations were the most important players in the non-

residential real estate market with a nearly 75 percent market share or nearly

$2.6 trillion out of $3.5 trillion of total non-residential real estate capital (both debt

and equity). The Bureau of Economic Analysis' (BEA) Industry Wealth and

Investment data confirm the significance of corporate real estate holdings. For

example, in terms of 1982 dollars, the gross stock of industrial and commercial

properties increased from $349 billion in 1947 to $1.4 trillion in 1990. Looking at

only the office properties, the gross stock quadrupled from $110 billion in 1947 to

$440 billion in 1990.

Surveys that analyze corporate space usage cast doubt on the conventional belief that corporations lease office facilities with greater frequency than industrial/warehouse facilities (see, for example, Smith and Wakeman [1985]). Wheaton and Torto [1990] show that 45 percent of the gross stock of industrial and commercial warehouse properties is occupied by owners. Recent data, supplied by CB Commercial, regarding office properties in 53 major U.S. metropolitan areas, reveal that approximately 15 percent of all office space is occupied solely by owners, and an additional 20 percent is occupied by owners who also lease out a part of their owned space to other firms. Similarly, a survey of large firms conducted by The International Facilities Management Association in 1987 [1987] indicated that 54 percent of all office space is owner-occupied. Another extensive survey by The Energy Information Administration (EIA) in 1989 [1991] estimated an even higher percentage of office ownership. It estimated that approximately 32 percent of all surveyed office space is owned by sole owner-occupants, and 38 percent is owned by owner-occupants who also rent to other tenants.

These figures indicate that the corporate real estate market, and the office market in particular, is composed of two types of firms. The more traditional type is the owner-occupant firms that invest in the market primarily for their own uses. The other type consists of "rental" firms that rent properties to the corporate users. While real estate firms are the largest providers of rental office space, firms in other industries, specifically the insurance industry, also provide a non-trivial amount of rental office space.

Accordingly, the overall office investment and absorption behavior and rent-adjustment must exhibit and be determined by combined actions of both types of firms. Presumably the owner-occupant firms' investment behavior is a direct response to their own needs for office space and is less sensitive to the office market cycles or volatility than that of the "rental" firms. In fact, the "rental" firms may be the primary generators of office market volatility. Similarly, the demand function for office space with an active rental market must be different from that without an active rental market. One of three objectives of this thesis is to identify the determinants of the demand for and supply of office space with an explicit recognition of the owner-occupant and "rental" firms that make up the overall office market.

Another objective of this thesis is to model the office market by allowing the capital market and the property market to interact to determine the demand for and supply of office space. While the relationship between these two markets seems intuitively obvious, many studies have failed to consider them simultaneously by assuming that they act autonomously. Only recently, DiPasquale and Wheaton [1992A] have provided a theoretical basis to understand the interaction of the capital and property markets and Fisher [1992] suggests the need for integrating the two markets.

Finally, the third objective of this thesis is to understand driving force behind the growing dominance of the rental office space by identifying and testing possible non-financial determinants of lease-versus-buy (LVB) decisions. The traditional

approaches in analyzing the LVB decision focus on financial factors and assume that non-financial factors do not pose asymmetries between a lessor and a lessee. However, a unique set of characteristics of the office market (e.g., indivisibility, heterogeneity, durability, and persistence of market disequilibrium) suggests that market conditions and user characteristics should be important in the LVB decisions.

Three pragmatic reasons exist for limiting the scope of the study to office properties. First and foremost, the office market has received much attention recently due to its explosive growth in supply. Not surprisingly, the recession of 1991 and the period leading to it evidenced the fragility of the market and the severity of the over-investment. This type of phenomenon suggests the importance of proper capital investment policies and market awareness in fueling economic activities. Second, firms perceive office properties as "generic" in nature; and therefore are not seriously constrained in making the tenure choice. Unless the type of real estate assets is readily available in both rental and sales markets, firms may not have a realistic tenure choice. Third, there exists a severe lack of consistent and historic data on other non-residential real estate markets. Of all the data reviewed, the office market seems to provide the most complete data necessary for testing theoretical models.

1.2   Thesis Outline

The thesis is organized in the following manner. In Chapter 2, the historical

trends of the office investment, accumulated stock, and vacancy rates over the last 40 years are presented. Both the investment and stock data are reviewed based on gross and net values in order to identify the amount of replacement versus new investment (the replacement investment accounts for the difference between gross and net investment). The gross stock data confirm the well-known observation that over one-half of the existing stock was built over the last twenty years. In addition to the analysis of the level of investment, various investment ratios are presented. The two most relevant ratios are investment to previous year's stock and investment to GNP ratios. Surprisingly, these two ratios appear to behave quite similarly -- the correlation coefficient of these two ratios is 0.975. Even these ratios confirm that the level of office investment in the 1980s is simply unparalleled. The vacancy rate over the last 40 years is presented to show that it increased gradually until the mid-1960s and, since then, it has exhibited the well-known cyclical nature of the rental market.

Two major sets of previous investigations into office market investment behavior are presented in Chapter 3. Currently, there is a lack of a coherent office market investment model with a substantive theoretical basis which reconciles the capital and property markets that determine the behavior of the office market. Macroeconomists have developed capital investment models which aggregate all fixed assets and treat them homogeneously, with little regard to peculiarities of the commercial properties, such as high-leverage mortgages, the incentive to trade, and the significance of the rental investments. These models focus primarily on the dynamics of interest, inflation, and tax rates, which are important; however, they

cannot tell the complete story. In particular, if one ignores the rental investments, one cannot explain the vacancy cycles which have occurred over the last 30 years.

On the other hand, real estate economists have developed and empirically tested office models that lack a sound theoretical basis because they focus on the rental market as if owner-occupant firms do not exist. Moreover, these models do not incorporate the dynamics of the capital market that influence office investment behavior. For example, the dynamic issues of interest rates, inflation rates, and tax policies that the macroeconomists find so important should be -- but are not -- incorporated explicitly in these models. Rather, the models treat these factors as constant in an attempt to analyze the property market equilibrium. Empirically they tend to rely on relatively short time-series data, which cannot portray the full impact of changes in the capital and property markets.

In Chapters 4 and 5, equations that determine the demand for and the investment in office space are developed and tested empirically. The office market model presented in this thesis recognizes both the consumption and investment nature of the office investment behavior by treating office space as containing both property and capital values. The property value is determined by the unique characteristics of the office market such as vacancy rates, rental rates, and office employment growth, whereas the capital value reflects those characteristics such as interest rates, inflation rates, and tax rates that affect the decision to invest in any assets. Since the office market is composed of owner-occupant and rental spaces, this office market model explicitly considers a different set of incentives for their investment

behavior. From the owner-occupant firms' point of view, the office investment is a direct response to a rising office employment, and a higher (lower) cost-of-capital is believed to discourage (encourage) investment assuming that the supply cost remains relatively stable. On the other hand, the rental office space demand is assumed to be determined by office employment as well as market rent rates. Rental office investment is based primarily on the expected price; hence, substantial speculative behavior (i.e., sporadic over- and under-investment) is expected to occur. In other words, the amount of spread between the expected market price and the supply cost is believed to determine the level of rental office investment. For example, an increase in the net operating income and/or a decrease in the capitalization rate can raise the expected market price, which leads to a higher investment rate.

The empirical content of this thesis differs from the past researches on the office market (which have relied on a spatial unit (i.e., square feet) for their empirical analysis) in that a constant dollar value of investment and stock series are used. Serious problems arising from using the spatial unit for analysis are: 1) depending upon geographical regions, same-sized office buildings may have substantially different values; 2) within a given city, a building's value varies according to its level of quality and specific location; 3) over time, the value of office stock can change even though the size of the stock remains the same depending upon the average age of the stock; and 4) in the capital market, office buildings are analyzed, like any other assets, based on the rate of return, which is difficult to translate into the spatial unit, given the heterogeneous nature of office buildings.

In addition, the time span of the data used in this thesis is far more extensive than that commonly used in previous studies. While most of the office models have been empirically tested for a period of less than 20 years, the data employed in this thesis go back to 1947. By testing 40 years of data, the model can be tested to determine the degree of stability of the estimated coefficients, which could not have been possible with the previous studies by the real estate economists using only 10 to 20 years of data.

The empirical tests following the theoretical development of the demand and investment models validate the hypothesis generated by the models. One of the salient characteristics of the office market is that when the 40-year period examined is split into two 20-year subperiods, one finds that the rental market has emerged as a significant component of the overall office market only within the last 20 years. Additionally, the rental market, without the ability to adjust supply accurately and quickly, has contributed to the increased volatility in the office market during the last 20 years as the user firms attempt to deal with the greater fluctuations in the cost of capital or the rental rate. The rental market's inherent problem, which leads to the proverbial office cycles, is that the investment occurs with very long lags and very low adjustment rates.

In Chapter 6, a rental adjustment model is developed and tested empirically. In developing this equation, the traditional notion that the rental rate adjusts in response to the difference between the actual and optimal vacancy rates is maintained; however, the optimal vacancy rate is assumed to be a function of a

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linearly rising long-term structural vacancy rate, and past absorption and investment rates. The basis for assuming a linearly rising long-term structural vacancy rate is that office user firms have been increasingly reliant on the rental office space. In other words, as the demand for rental office space, as oppose to owner-occupant office space, has increased, the structural vacancy rate should also increase. Unfortunately, without access to a marginal rental rate time-series, the empirical testing relies on average rental rates between 1971 and 1990. Even with the average rental rate series, the empirical findings suggest that change in rent is affected positively by past absorption rate and the time variable and negatively by past investment and vacancy rates.

Chapter 7 presents the relationship among interest rate, inflation, tax policy, and office investment behavior. The ability to induce changes in the interest rates and taxes is the basic power behind monetary and fiscal policies exercised by a government. All economists agree that lowering the effective tax rates acts as a stimulus for the economy to grow faster. Accordingly, U.S. tax rules and monetary policy have been based on a notion that accelerating the depreciation deductions, lowering statutory tax rates, and lowering the inflation rate interact to encourage investment. However, the nature of office investment with high leverage ratio and trading characteristics completely contradict this widely accepted conclusion. Chapter 7 shows that from both theoretical and empirical perspectives, high inflation and tax rates, when coupled with accelerated depreciation deductions, encourage office investment. The anti-inflationary policy and frequent tax rule changes that have occurred in the 1980s, along with the long lags characterizing

rental investment behavior, have had quite the opposite of the desired stabilizing effect. Simulation results show that they have actually amplified the cycles in the office market and have prolonged its state of disequilibrium.

Chapter 8 presents various theories on determinants of the office tenure choice and these determinants are tested empirically. The traditional approach to lease-versus-buy (LVB) analysis sets non-financial factors equal and focuses on the effective marginal tax rates as the main source of asymmetries between a lessee and a lessor. However, empirical evidences show that a majority of firms both lease and buy office properties. In other words, the effective marginal tax rates cannot be the key determinant of LVB decisions. Initially, following the equilibrium capitalization rate calculations in Chapter 5, an equilibrium office rental rate equation, which reflects the high-leverage mortgages and the incentive to trade, is developed. The equilibrium office rental rate equation indicates that the most critical and yet most uncertain variable in the equation is an estimation of the present value of residual claim. This suggests that a firm's level of risk aversion with respect to the future value of office buildings may be far more critical in determining the tenure choice.

More importantly, eight sets of non-financial sources of asymmetries between leasing and buying are theorized and tested empirically. They can be classified under three categories: 1) local market conditions, 2) national market conditions over time, and 3) user characteristics. Using a logit model and 2,137 observations provided by CB Commercial, the model correctly predicted about 76 percent of

overall observations.

Finally, in Chapter 9, a summary of the model and empirical findings, limitations of the model, areas of further study, and policy implications are provided.

1.3   Summary of Empirical Findings

The empirical results validate the key hypotheses proposed in the thesis. They are:

1) The office market has experienced a structural change between 1951 and 1990 as a result of presence of the active rental office market over the last two decades. When the sample period is split into two subperiods (i.e., 1951-1970 and 1971-1990), the estimated coefficients are strikingly unstable. Specifically, in estimating the level of office absorption, the first subperiod, which is dominated by owner-occupants, is better explained by a stock-flow model, whereas the second subperiod, which is dominated by lessees, is better explained by a flow model. Also, the investment equation is consistent with the absorption equation for the first subperiod as one would expect (i.e., the supply responses appropriately to the changes in the demand functions). However, for the second period, the level of office investment is substantially determined by the level of price (i.e., the underlying theory of Tobin's q model) rather than the level of or growth in office employment.

2) The interactions between property and capital markets are absolutely important in understanding the ways in which the rental office market behaves. Considering the second subperiod only, statistical fit of the investment equation improves significantly by specifying variations in the equilibrium capitalization rate over time. The main difference between the equilibrium capitalization rate and the market capitalization rate is the rate at which the net operating income is expected to change in the future. This difference appears to be proxied reasonably well by lagged vacancy and absorption rates.

3) Contrary to the general belief by macroeconomists, higher inflation and ordinary tax rates actually help lower the office user-cost-of-capital. Simulation results show that the poor timing of the tax policy changes in the 1980s contributed to the unprecedented level of investments in the mid-1980s. Without a doubt, this led to the much discussed problem of over-supply of office space in the late-1980s and early-1990s. Without a significant surge in office employment in the 1990s, the excess supply of office space is not expected to erode soon.

4) A set of non-financial determinants is able to correctly predict office tenure choices at a rate of 76 percent. The determinants can be classified into local market conditions, national market conditions, and user characteristics. Because of the size factor (i.e., a ratio of square feet occupied to building size), in the absence of an active office condominium market, many office users appear to be simply forced out of the ownership alternative.

Chapter 2

Historical Trends in Supply of and Vacancy Rates in Office Property

2.1 Introduction

The purpose of this chapter is to review the movement of the office investment, stock, and vacancy rates between 1947 and 1990. While many macroeconomists have investigated the determinants of the aggregate value of non-residential fixed investment, the ways in which firms invest in a single asset category have been poorly-understood. Office property, in particular, has been a growing component of the commercial properties, structures, and GNP over the last 40 years. Still, high variability of the office investment series suggests that its underlying determinants need to be identified and understood.

Traditionally, macroeconomists have examined investments in terms of the demand for capital, which implies that the supply responds appropriately to the changes in the demand function. However, the rental market's vacancies distort the presumed relationship between supply of and demand for office space. With some assumptions, the proportional share of rental investment and stock are estimated, and the market disequilibrium (measured by the vacancy rates) are presented. Over the last 40 years, vacancy rates, while exhibiting cyclical behavior, have increased dramatically as the rental portion of the office market has

increased.

2.2   Office Investment and Stock

To measure historical investment patterns in office property, this thesis relies on

data provided by the BEA on Fixed Business Wealth and Investment. The BEA

compiles annual data on 72 types of capital (i.e., nonresidential structures and

producers' durable equipment) by 62 types of industries. The Wealth data begin in

1947 and include gross stock, capital input, net stock, depreciation, and discards.

To arrive at constant-cost valuation, the implicit GDP price-deflators are used.

The GDP price deflator series differs slightly from the Nonresidential Structures

price deflator series (most notably in years 1981 and 1982); however, they appear

to be reasonably close to one another as shown in Figure 1.

The difference between the gross and net stock values is that the former employs

the one-hoss shay decay assumption and the latter assumes a constant exponential

deterioration rate. While there is a consensus in employing the exponential decay

assumption due to its computational simplicity, the gross stock value measures

most closely the stock of office buildings in terms of the level of service delivered.

A rationale for using the gross stock is that once a building is completed, it

provides the same or similar amount of services during its lifetime. Since gross

investment accounts for the value of new properties and replacement of the

existing properties, net investment, which is defined as the gross investment less

discards, determines the true changes in the historical investment patterns.

IMPLICIT PRICE DEFLATORS
GDP vs. Nonresidential Structures
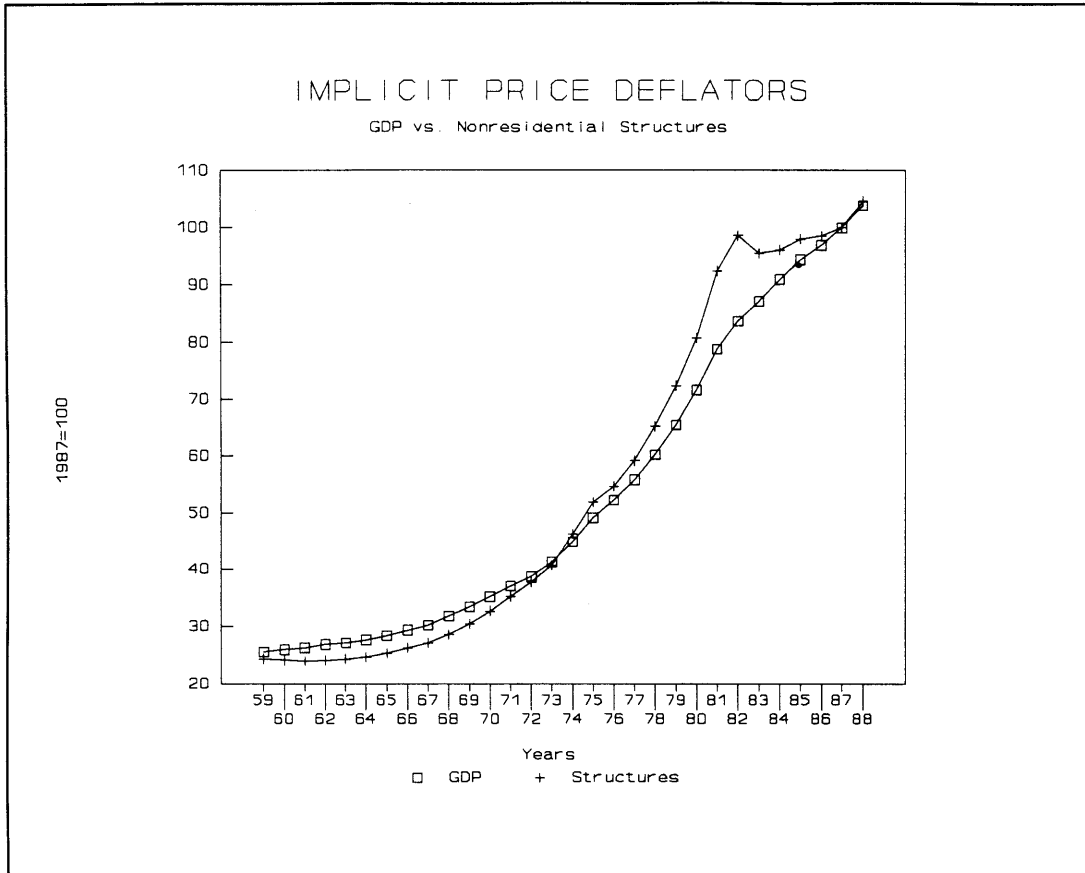
Figure 1

Figure 2 shows the gross and net investment in office properties between 1948 and 1990 in 1982 dollars. Prior to the mid-1950s, gross investment was relatively stable at around $3 billion. Between the mid-1950s and 1973, it increased gradually to about $13 billion and then dropped to $8 billion in 1976. The most striking observation of the trend is the astonishing growth rate of investment between the late-1970s and the mid-1980s. In 1985, the investment peaked at $28 billion, which is double the amount in 1973 when the previous peak occurred.

INVESTMENT IN OFFICE PROPERTIES
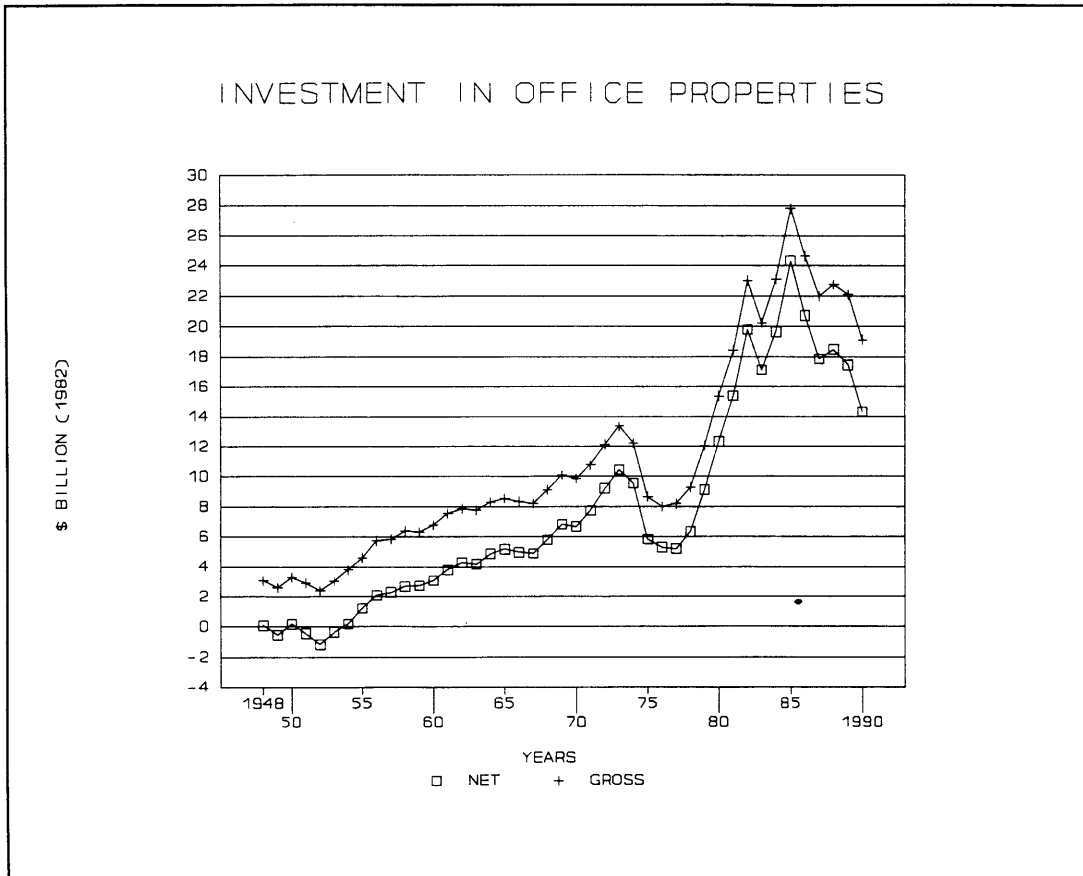
Figure 2

The net investment pattern closely follows the gross investment pattern. The replacement investment accounts for, quite consistently, $3 billion over the last 40 years. Over time, the proportion of replacement to gross investment declined -- prior to the mid-1950s, virtually all of the gross investment represented replacement and, in 1985, the replacement consisted of only about 11 percent of the gross investment. A declining rate of replacement investment, as opposed to the traditional theory of a constant replacement investment rate, is explained by a consistent decline in the average age of office buildings over the 40-year period. Specifically, the average age of office stock declined from over 20 years to under 10 years between 1947 and 1990.

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GROSS STOCK OF OFFICE
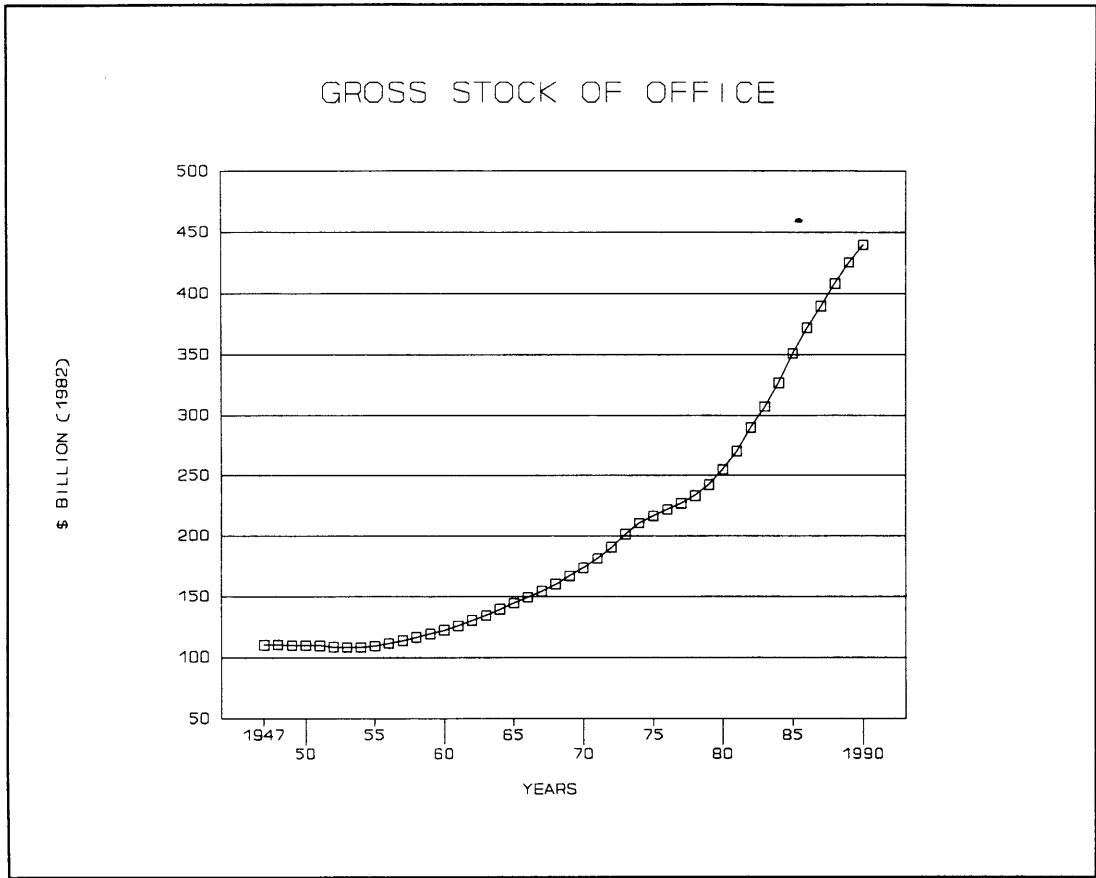
Figure 3

Figure 3 shows the gross stock of office properties between 1947 and 1990 in 1982 dollars. In the absence of a true market value time-series on the office stock which would provide annual change in the market value relative to the general price deflator, the gross stock time-series is used as the closest proxy. The reasonableness of the gross stock figure is confirmed by they Society of Industrial and Office REALTORS' (SIOR) 1990 survey [1991], which estimated the office stock at $400 billion (approximately $278 billion in 1982 dollars) and Institute of Real Estate Management (IREM) and Arthur Andersen's 1991 survey [1991], which estimated the office stock at $1 trillion (approximately $695 billion in 1982 dollars).

During this period, the gross stock quadrupled from approximately $110 billion in 1947 to $440 billion in 1990. And much of the growth occurred in the 1980s. This pattern coincides with Birch's [1990] statement:

> We tend to forget that as recently as 1960, we had relatively little office space. We were an agricultural and then an industrial economy, and few people worked in office buildings. By 1960 we had still built only about 27% of the office space existing today. Said another way, 43% of all office space ever built in the U.S. was built in the past 10 years and about 60% has been built in the past 20 years.

The Energy Information Administration's survey [1991] also estimated that about 52 percent of office stock in 1989 was built during the past 20 years. In fact, in 1947, the gross stock of office buildings was only two-thirds of the industrial buildings stock, whereas, by 1990, they were virtually identical.

Rather than looking at the absolute values of investment in and stock of office properties, investigating relative values is more insightful since the economy, in general, has been growing over time and over the last 40 years, the GNP has also quadrupled. One must also be cognizant of the fact that the level of office investment in the 1980s is not only high in terms of its absolute value but also disproportionally high in relative terms. Several ratios presented below provide those relative values.

First, the ratio of net office investment to the gross stock shows the growth rate of the office supply. Figure 4 illustrates that in the mid-1950s, the growth rate increased from negative one percent to positive two percent, and until the early

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1970s, the rate increased fairly steadily to about five percent. Between 1973 and 1977, the rate dropped back to two percent only to rebound to a historic peak at around seven percent in 1982 and again in 1985. By 1990, it dramatically decreased to about three percent. During the same period, the growth rate of net investment in all non-residential structures ranged from a low of one percent in 1948 and 1990 to a high of 3.5 percent in 1965 and 1981. Indeed, the growth rate of office supply is significantly more volatile (in term of both magnitude and frequency) than the growth rate of all nonresidential structures.
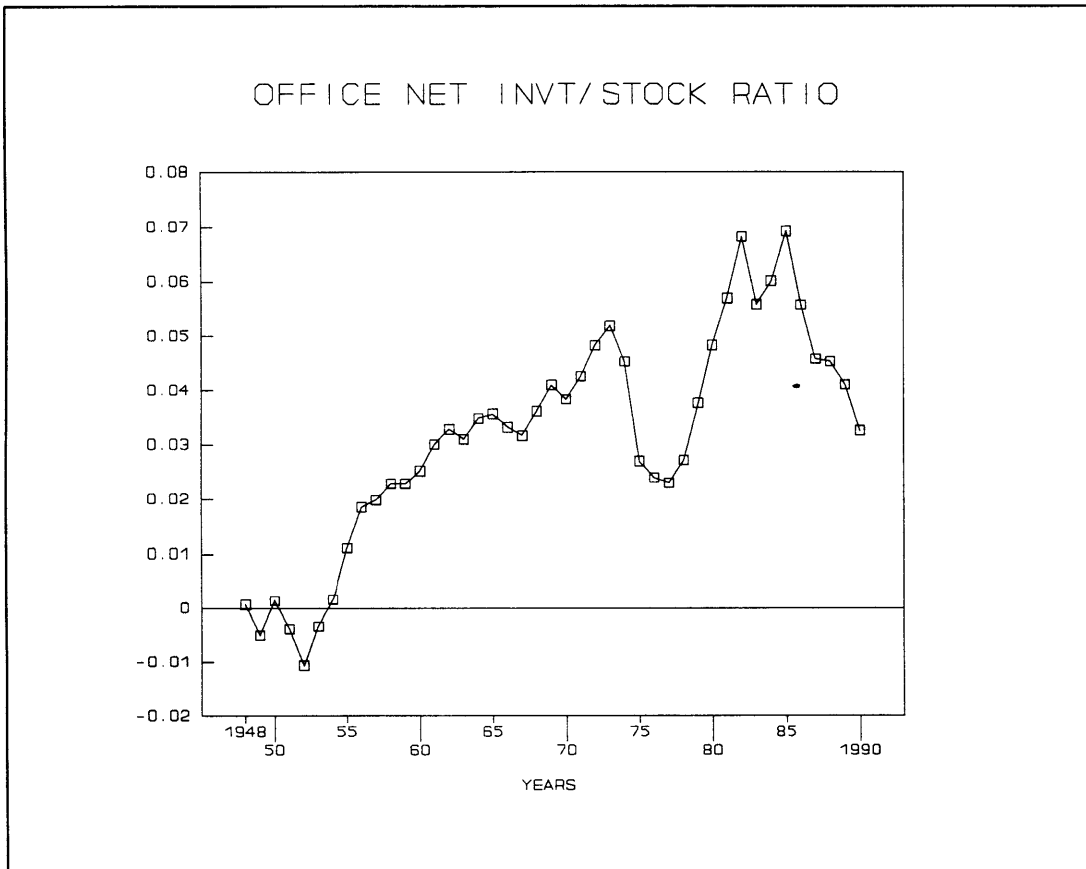
Figure 4

Second, ratios of the net office investment to the net investment in the total

structures as well as the total capital (i.e., structures and equipment) can show

whether the office investment expenditures pattern is significantly different from

that of the aggregate plant (structures) and equipment expenditures. Figures 5

and 6 represent the proportional share of the office net investment.
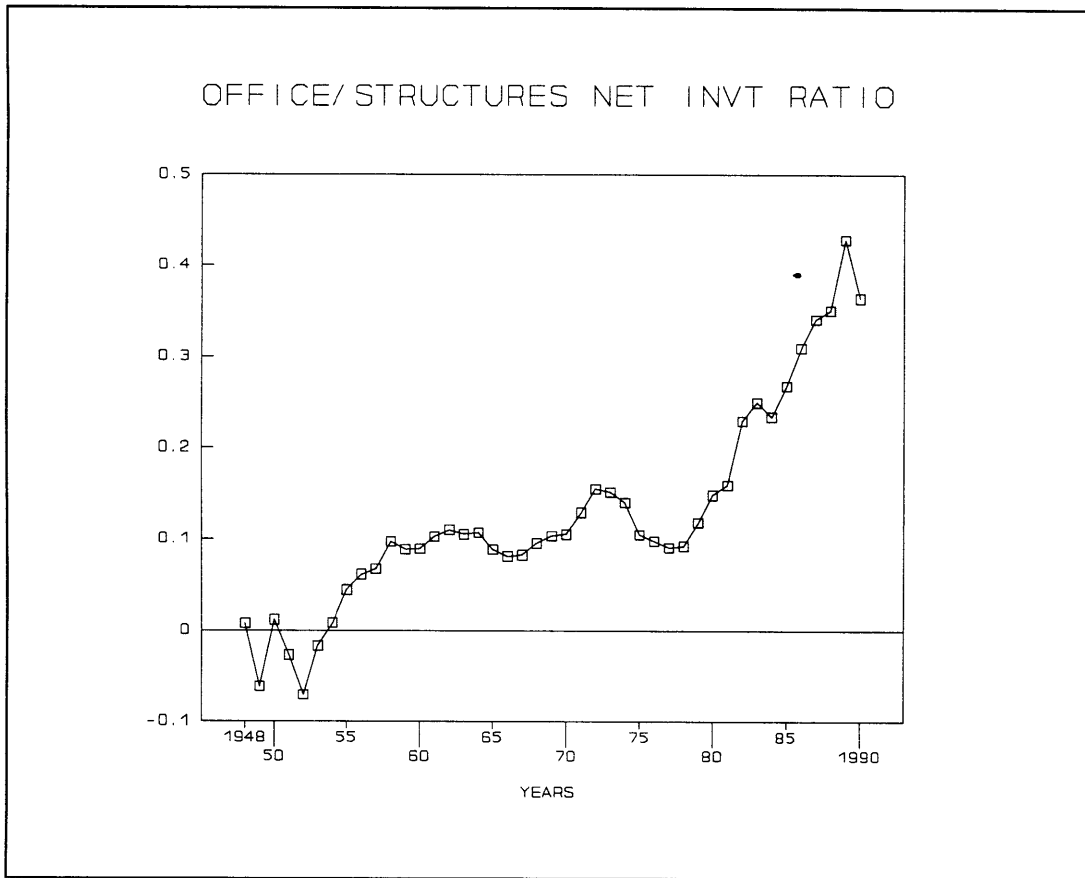
Figure 5

Figure 5 shows that between the late 1950s and the early 1980s, the net

investment in office space made up approximately 10 percent of that in all

structures. However, in the 1980s, the proportional share of net investment in

office buildings relative to all the structures increased and peaked at around 40

percent in 1989.

OFFICE/CAPITAL NET INVT RATIO

YEARS
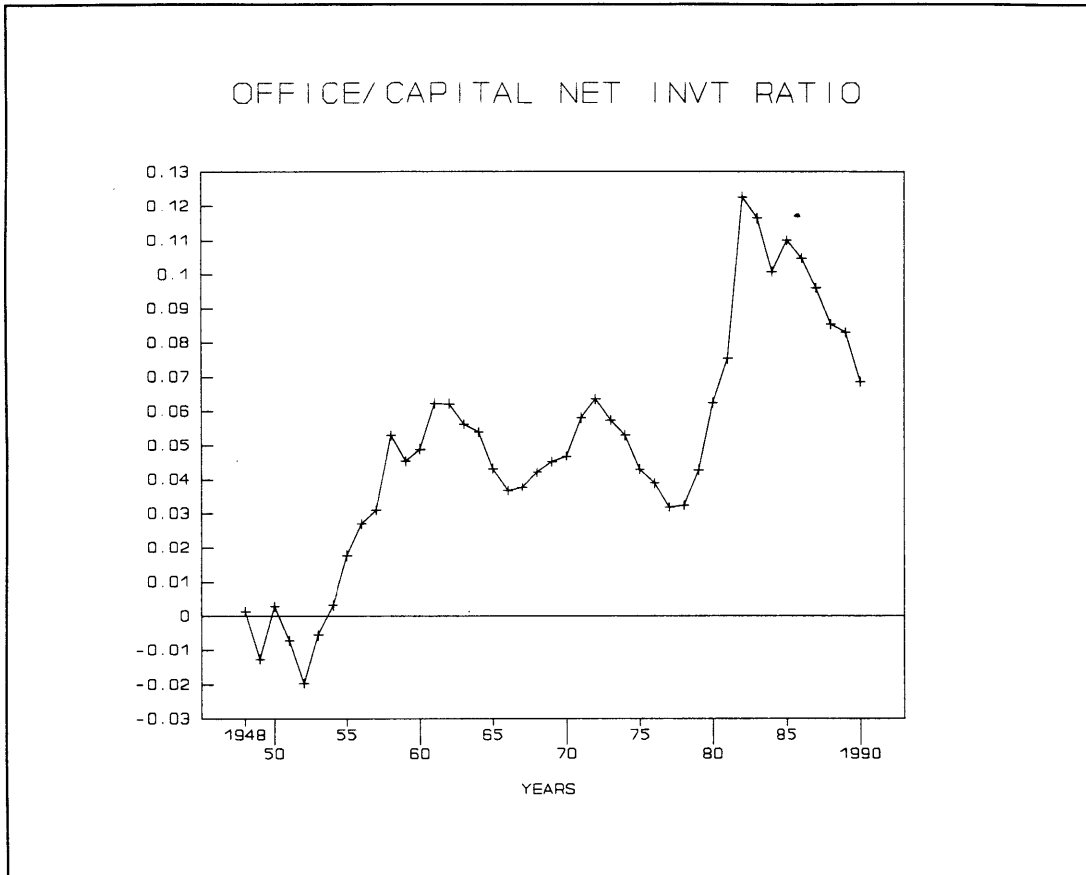
Figure 6

Figure 6 shows that, consistent with the previous two ratios, the period between

the late-1940s and mid-1950s experienced negative or very low office investment

rates. Between the late-1950s and the early-1980s, the proportional share of office

to total capital net investment was cyclical but, nevertheless, it averaged around

five percent. By 1982, the ratio peaked at 12 percent, and since then, it has

dropped back to about seven percent. The reason that the office/capital ratio has

declined since 1982, rather than remaining high near the 1982 level or continuing

to increase as the office/structures ratio did, is due to an even more rapidly

increasing level of investment in office, computing, and accounting machinery in

the 1980s. Clearly, these two ratios suggest that the early-1950s, with negative investment rates, and the 1980s, with exceptionally high investment rates, cannot be considered as "normal" periods in terms of office investment expenditures.

Third, the negative office net investment level during the late-1940s to the early-1950s as well as the increasing level in the 1980s had a significant impact on the proportional share of the gross stock of office space to both total structures and capital. Figures 7 and 8 depict these ratios.
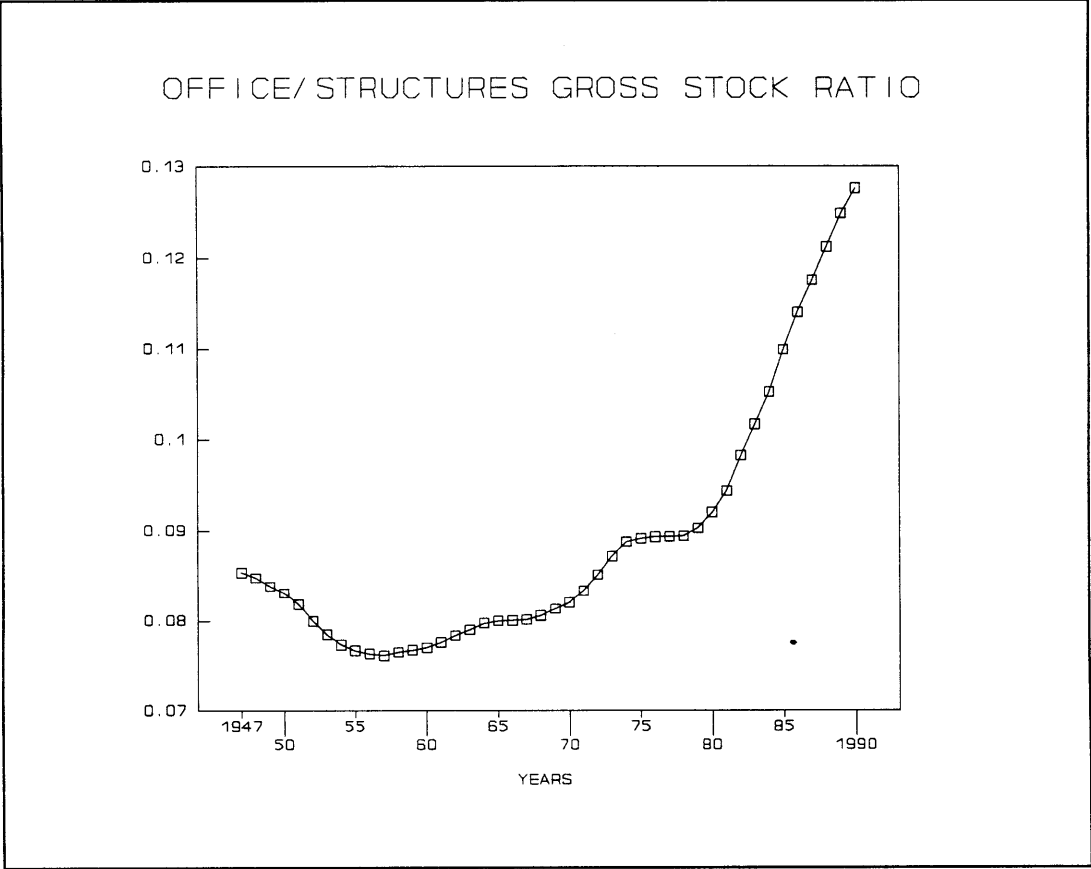
Figure 7

Figure 7 shows that office buildings accounted for approximately 8.5 percent of the

total stock of structures in 1947. The ratio dropped to about 7.5 percent in the

mid-1950s, and increased thereafter to about 9 percent by 1980. Since 1980, the

office share has been increasing steadily, reaching almost 13 percent in 1990.

Figure 8 shows that the office to capital gross stock ratio between 1947 and 1990

resembles a U-shaped curve. In both 1947 and 1990, the ratio was nearly six

percent. Between the mid 1950s and the early-1980s, the ratio fluctuated between

4.6 percent an 4.8 percent.

OFFICE/CAPITAL GROSS STOCK RATIO
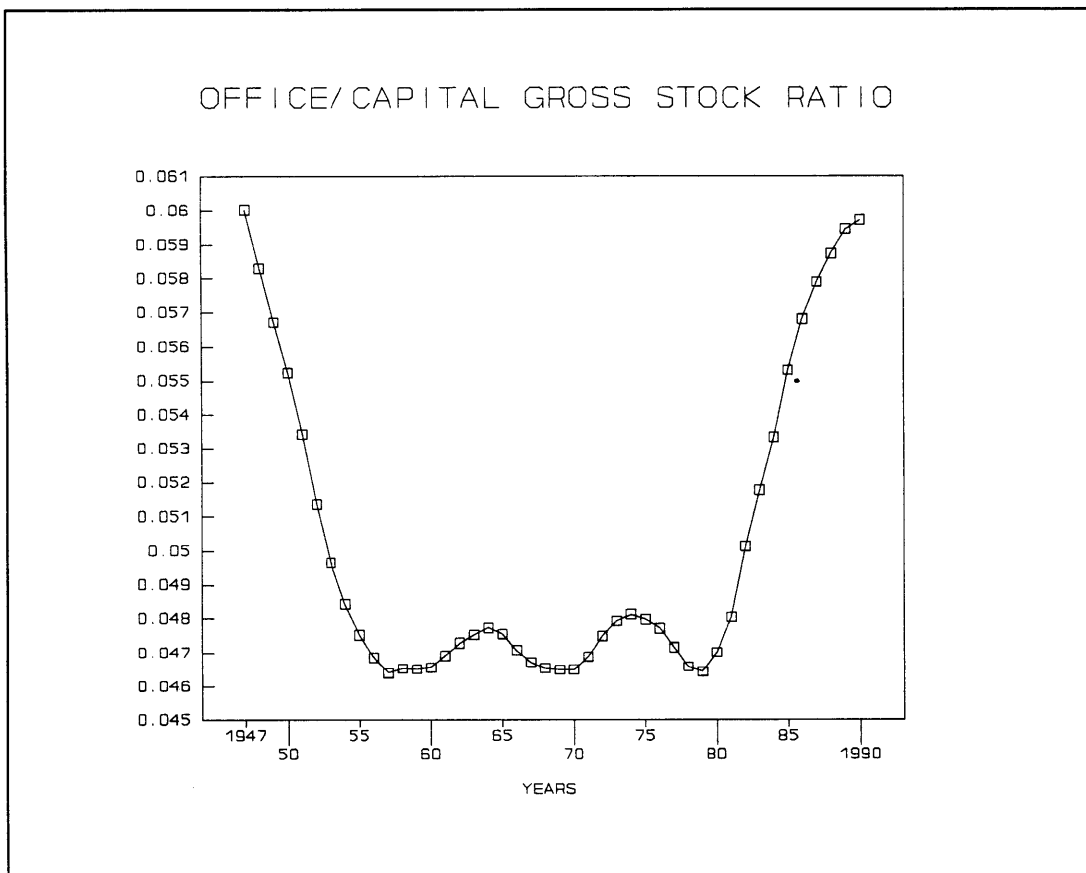
Figure 8

Based on these figures, one can postulate that the 1980s represented a period of

unusually high office stock, which is confirmed by unusually high vacancy rates in the 1980s. Also Figure 8 suggests that the late-1940s and the early-1950s may have been a period of excess supply. The excess supply in the 1940s and 1950s is not reflected in the vacancy rates, which suggests that the excess may have come from owner-occupant firms. If in fact the excess supply did exist in the late-1940s, the negative or very low investment rates (Figures 4, 5, and 6) observed in the late-1940s and early-1950s appear to be a reasonable and appropriate response.

Fourth, another indicator of the office investment level is the office net investment to GNP ratio, which is shown in Figure 9. This ratio indicates the relative amount of GNP that is accounted for by the net investment in office buildings. The pattern of this ratio is quite close to that of the office net investment to gross stock ratio shown in Figure 4 -- the correlation coefficient is remarkably high at 97.5 percent. The office net investment to GNP ratio increased between the mid-1950s to the early-1970s from negative 0.1 percent to about 0.4 percent. It dropped in the mid-1970s to about 0.2 percent and peaked close to 0.7 percent in 1982 and again in 1985. Thereafter, the ratio dropped to approximately 0.35 percent in 1990.

The above illustrations reveal the high variability of investment in office buildings relative to overall structures, capital, and GNP. The two most striking and consistent observations are: 1) very low investment rates prior to 1960, and 2) unprecedentedly high investment rates in the 1980s. Also, the investment rates in the 1960s and the 1970s appear to exhibit modest cyclical behavior. The high variability of the investment rates points out the importance of identifying and

OFFICE NET INVT/GNP RATIO
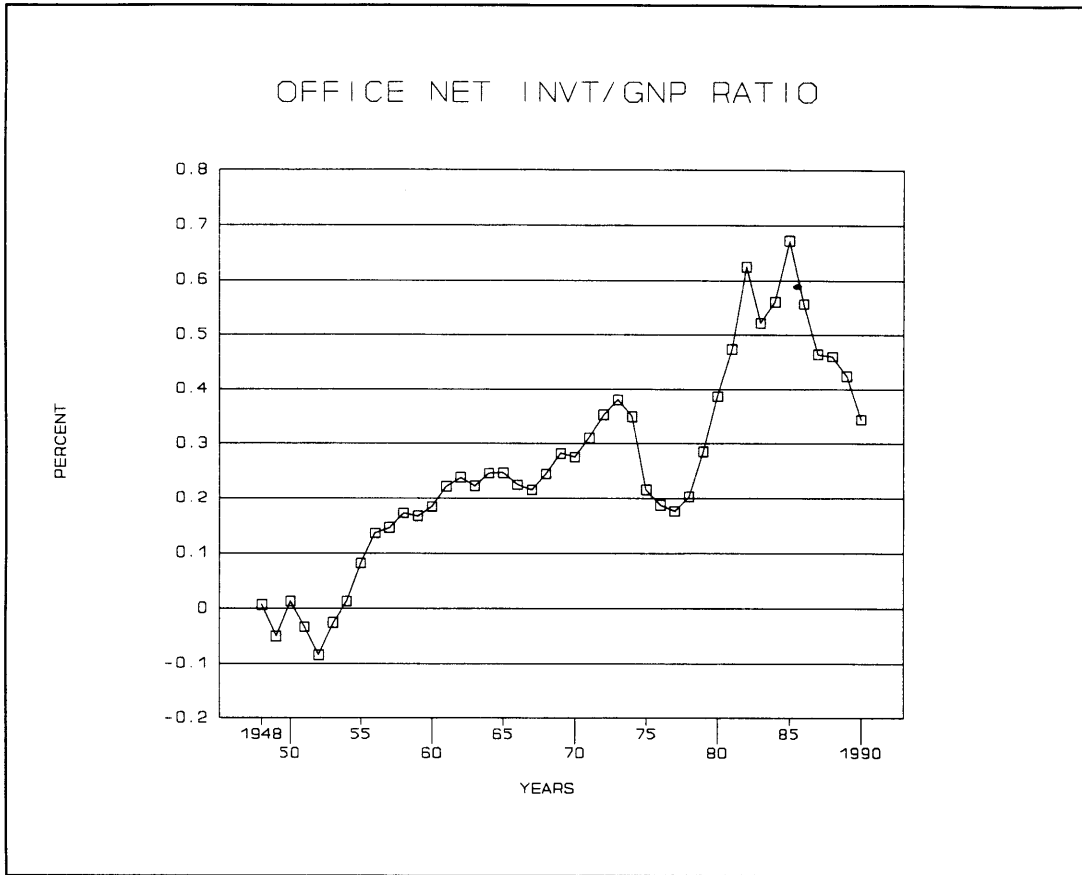
Figure 9

measuring the impact of fundamental demand and supply factors.

2.3 Office Vacancy Rates

As long as vacant rental office space exists, the amount of office space actually

occupied does not equal the amount of stock available in the market; thus

disequilibrium exists in the office market. As a result, the investment and stock

values discussed in the previous section do not necessarily equal the amount

absorbed and demanded since vacancy rates fluctuate.

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The most relevant indicator of the degree of disequilibrium in the rental market is the vacancy rate. It measures the stock (i.e., the supply) in relation to the actual occupancy (i.e., the demand) for office space. Following Wheaton [1987], the national vacancy data were compiled from two sources: CB Commercial, a national commercial brokerage company, and the Building Owners and Managers Association's (BOMA) "Experience Exchange Report." Figure 10 illustrates the vacancy rates between 1947 and 1991. There appear to have been three distinct office vacancy cycles over the last 30 years and the average rate seems to have been increasing over time. Causes of the growing average vacancy rates and persistence of the cycles are postulated below.

First, the fundamental cause of the growing imbalance appears to be the increasing role of the speculative rental market. Developers and investors in the rental market cannot forecast and respond properly to the constantly fluctuating demand and yet they have become the most significant providers of office space over the last 20 years.

Assuming that investment, which includes both new constructions and acquisitions of existing office buildings, made by firms in the real estate and insurance carrier (REIC) industries is directed predominantly to the rental market, whereas firms in the other (Other) industries invest primarily for their own uses, the office market has evolved dramatically over the last 40 years as the REIC's share of the office stock has become significantly large in the 1980s. Figure 11 illustrates the percentage share of the REIC's portion of the gross office stock.

NATIONAL OFFICE VACANCY RATES
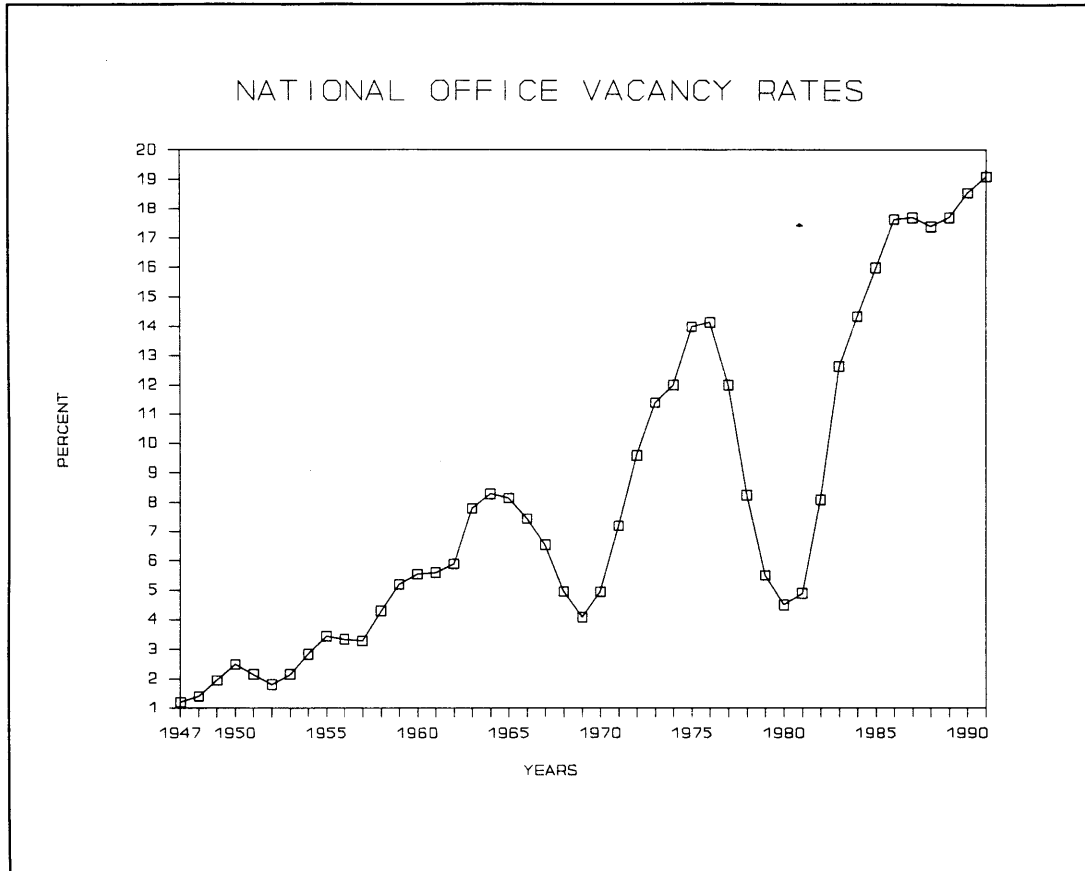
Figure 10

Between 1947 and 1964, the REIC's stock declined from approximately 26 percent

to 23 percent. Parenthetically, this declining trend started in the early-1930s,

shortly after a decade of accumulating office space in the 1920s. Between the mid-

1960s and the mid-1970s, the REIC's share increased briefly reaching a peak at

around 25 percent and dropped back to about 23.5 percent. Since then, the REIC's

share continued to increase as its stock reached nearly 40 percent in 1990.

Interestingly, much of the growth occurred in the 1980s when the REIC's market

share of the office stock increased by about 54 percent.

In comparing the REIC's portion of the office employment and the REIC's stock of

% of Gross Stock of Office Buildings
by RE & Insurance Industries
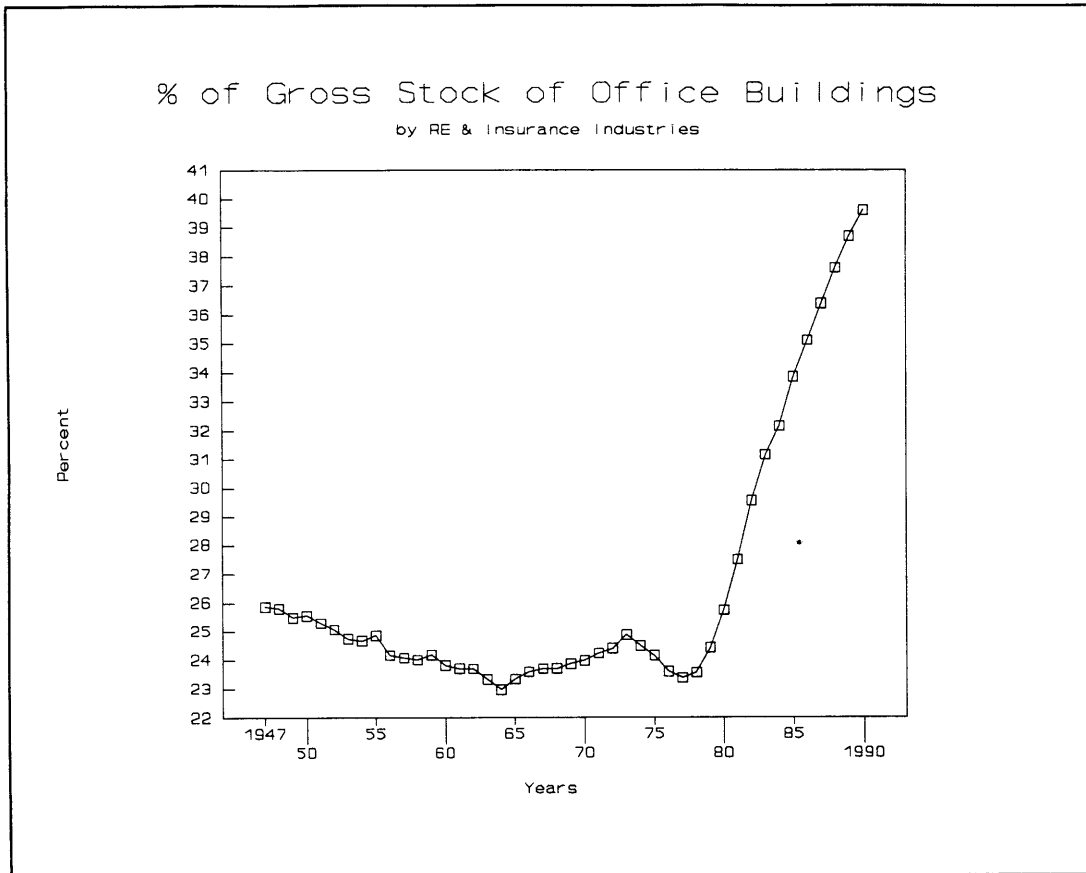
Figure 11

office buildings, one can postulate that much of the REIC's stock prior to the 1970s

must have been invested for their own uses rather than for the rental market.

Specifically, the ratio of REIC's employment to the total office employment declined

consistently from about 30 percent in the late-1940s to about 18 percent in 1990.

The trend in this ratio and the REIC's stock ratio remained parallel until the mid-

1960s, which suggests that only a minor portion of the REIC's stock could have

been actually available for the rental market. Since the mid-1960s, the growing

proportion of the REIC's stock in contrast to the continually declining portion of

the REIC's employment can only imply that much of their investments in office

buildings must have been for the rental market.

Net Inv't in Office Buildings
between REIC and Other

$ Billion (1982)

□ REIC + Other
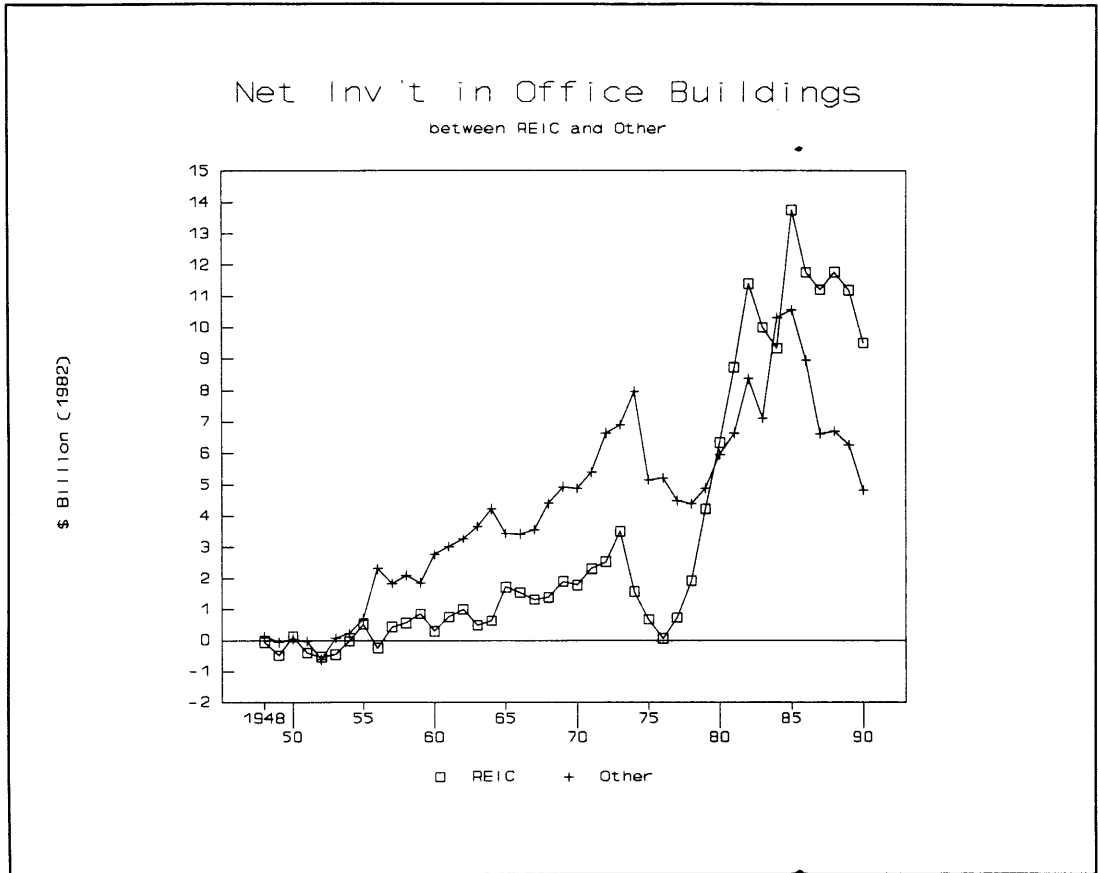
Figure 12

Figure 12 shows the constant dollar value of the net investment series between the

REIC and Other (non-REIC) industries. Clearly, the REIC's investment was only a

minor portion of the total investment prior to the 1970s. Between the late 1940s

and the late 1960s, the REIC's net investment grew from a negative amount to

about $2 billion whereas the Other's net investment increased from a negative

investment to about $5 billion. The mid-1970s' recession had a drastic impact on

the REIC's investment in comparison to that of the Other. For example, in 1976,

the REIC's investment dropped to $62 million from $3.5 billion in 1973. In

contrast, the Other's investment dropped from $8 billion in 1974 to $4.4 billion in

1978. The most prominent market change occurred in the 1980s when the amount

of the REIC's investment surpassed that of the Other.

Figure 13 shows the proportional share of the total gross investment made by the REIC. The REIC's portion of the gross investment series, which has never been higher than 30 percent prior to the 1980s, hovered consistently around 50 percent in the 1980s.
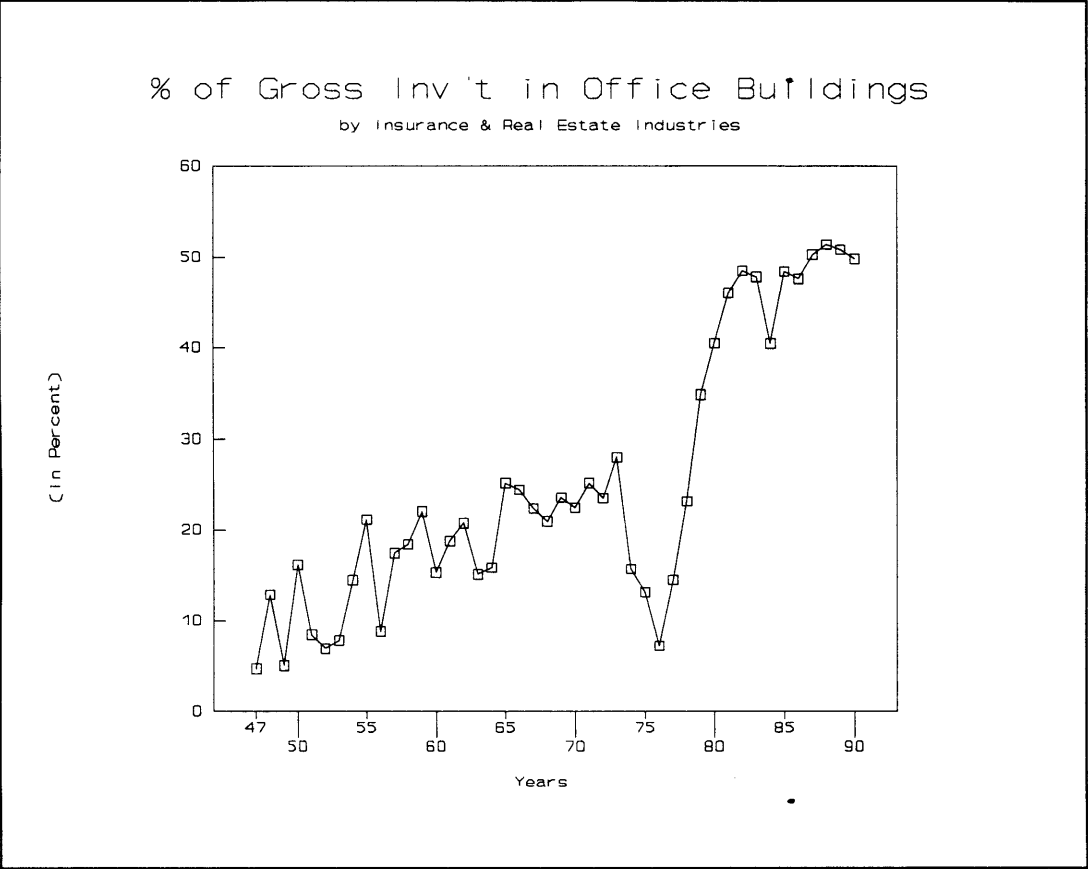
Figure 13

Second, the causes of this cyclical imbalance between demand and supply which result in persistent booms and busts can be attributed to three fundamental characteristics of the rental market. The first factor is the contrast in the timing

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between the building construction and building servicing periods; office buildings are constructed in one period, while the service they bring to the market extends over several decades. Hence a typical building will experience a series of demand fluctuations during its life. As long as these fluctuations exist, vacancy cycles appear to be inevitable. Secondly, the rental office investment process involves a very long gestation period to formulate expectations, to make decisions, and to physically develop buildings. Within the stage of developing the building, the task of assembling land, financing, and construction entails time-consuming processes, which appear to be getting only longer. Thus the delay in the timing between the shortage of office supply and the delivery of additional office space can be as long as several years. Thirdly, related to the second factor, the decision to invest this year is predetermined by the expectations formulated several years ago about the economic and market conditions of the current year. Without a reliable forecast of anticipated demand and supply responses, firms resort to extrapolating previous economic and market conditions to formulate their expectations. The method of extrapolation tends to exacerbate the cyclical behavior of the rental market.

The peculiarities of the office market make the cycles more severe than those observed with other fixed capitals. Specifically, office buildings are characterized by high transactions costs, indivisibility, and heterogeneity that an actual supply adjustment to demand and market changes involves long time lags and is hampered by inaccurate information. In most cases, the continually fluctuating nature of the demand for office space is never sufficiently adjusted by supply. These incomplete adjustments persist, and therefore, disequilibrium in the market

is pervasive and significant.

2.4   Concluding Remarks

The office investment and stock data over the last 40 years reveal that office buildings have become an increasingly important component of GNP as well as national private wealth. In terms of 1982 dollars, average annual office net investments in the last four decades (i.e., 1950s to 1980s) were $935 million, $4,372 million, $7,310 million, and $16,263 million. Between 1947 and 1990, the gross office stock quadrupled from approximately $110 billion to $440 billion. Particularly, the high office investment levels in the 1970s and 1980s propelled the office stock to more than double between 1970 and 1990.

The low investment levels in the 1950s and unusually high investment levels in the 1980s are investigated in relation to office stock, other non-residential structures, capital, and GNP. Instead of finding a relatively constant share of office investment, one finds that the early-1950s was a period of unusually low (in fact negative) investment rates and that the 1980s was a period of unusually high investment rates.

The office vacancy rates between 1947 and 1991 indicate that: 1) the average vacancy rates have been rising; and 2) the cycles appear to be persistent.   The rising average vacancy rates seems to be caused by the increasing role of the rental market. Assuming that the firms in real estate and insurance carriers make up a

majority of the rental office investors, their proportional shares of total office investment and stock have also increased dramatically in the 1980s. This appears to coincide with such high vacancy rates observed in the 1980s. The persistence of vacancy cycles appears to be caused by: 1) the contrast in the timing between the building construction and building servicing periods; 2) the investment process involves a very long gestation period; and 3) the lack of reliable forecast of anticipated demand and supply responses.

Given the magnitude of volatility in the office market, there is a need to understand its causes, and its implications by exploring the ways in which firms invest in and utilize office buildings. In doing so, it might be possible to forecast such expected variations and, ultimately, expected excessive or shortage of investment may be managed to bring more stability in the market by the government's fiscal or monetary policy. In the following chapter, past studies on capital and office investment are presented along with some of problems associated with the models.

Chapter 3

A Review of Previous Studies

3.1 Introduction

This chapter is not intended to review all the studies that have explored the various incentives for complex capital investment decisions. Rather, it is meant to discuss briefly two distinct categories of theoretical models that attempt to explain the determinants of capital investment and problems associated with the models. The first category consists of aggregate investment expenditure models developed by macroeconomists. Due to the aggregation of various assets without respect to their unique characteristics, empirical results of these models have not been very successful in their predicting performance. A greater problem in directly applying these models to the office market is that they do not explicitly recognize the rental component of the office market. For example, in studying the impact of the TRA of 1986 on equipment and structures investments, Auerbach and Hassett [1991] were able to explain much of variations in the equipment investments. However, in estimating the level of investment in structures, they could not even get a positive adjusted R^2. The second category of models is developed by real estate economists, who have focused on the rental office market and ignored the owner-occupant firms. Moreover, these models focus on variations in the property market and fail to consider the dynamic issues influenced by the capital market.

3.2   Past Models of Aggregate Investment Expenditures

Most of the existing investment models define the demand for investment as the difference between the desired and actual amount of stock, denoted K_t^* and K_{t-1}, respectively. The speed of adjustment, denoted α, determines the rate at which the gap between K_t^* and K_{t-1} is closed. If α were 0, then the gap does not change, whereas, if α were 1, then the gap is closed within one time period. The net investment, denoted I, is:

$$I_t = \alpha(K_t^* - K_{t-1}) + \mu_t \qquad (1)$$

where $\mu_t = \rho\mu_{t-1} + \varepsilon_t$ to represent a stochastic disturbance.

To add flexibility to the equation, various forms of distributed lags have been incorporated. Three notable models, which differ in determining the desired stock, are presented below.

One of the earliest investment models is the accelerator model developed by Clark [1917], which assumes that a firm's desired stock is a constant function of its output. Therefore, the investment level is a linear function of changes in the output. This model has been criticized for its simplistic approach of measuring the expected future conditions by the past level of output as a surrogate. Depending on the surrounding circumstances, such as business cycles, firms are expected to

behave differently toward the investment level. Specifically, some of the problems of the model are: 1) a firm may increase its investment level for the purpose of improving its efficiency and future profitability without the past or current output increasing; 2) if the level of output is falling rapidly, a firm may not be able to disinvest at the same rate; and 3) a firm exhibiting increasing return to scale experiences a decreasing level of investment rather than the constant level assumed in the model.

The neo-classical model developed by Hall and Jorgenson [1967] has been advanced to explicitly optimize the desired stock to interest rates, prices, tax policies, and output. The attractive feature of this model is that it allows substitution among capital, labor, and other inputs that the accelerator model does not. The crux of the model is the estimation of the user-cost-of-capital that firms implicitly charge themselves, which equals the "market" rental rate in theory. The model specifies the user-cost-of-capital as a function of the opportunity cost of funds, depreciation rate of the capital, capital gains or losses, and effects of various taxes. While the model, being theoretically sound, specifies clearly the factors that determine the demand for capital investment, empirical implementation of it has been hampered by the difficulties in estimating the user-cost-of-capital. Specifically, they are: 1) calculating marginal effective tax rates is inexact due to the complexity of tax laws; 2) measuring the discount rate is complicated by various sources (i.e., debt, internal cash flows, and new equity) of funds and their respective costs; and 3) a certain level of expected price appreciation or loss must be assumed when it is unobservable. Additionally, in using a simple Cobb-Douglas production function,

some controversies arose as to whether the assumption that the elasticity of substitution between capital and labor equals unity or zero. If it were zero and the elasticity of optimal capital stock with respect to output equals unity, then the model reduces to the accelerator model.

Tobin's q model [1969] postulates that the level of investment depends on the ratio, known as q, of the market value to replacement value of the firm. This model suggests that a firm would invest if its marginal q is greater than unity since the model assumes that the future profitability is completely summarized by the market value. Tobin's q model can be related to the neoclassical model by transforming the q ratio, which is in terms of asset prices, to a revised ratio in terms of flow prices. This is easily done by replacing the numerator with the market rental rate and the denominator with the user-cost-of-capital. Problems encountered in the empirical implementation of this model are: 1) difficulties in calculating marginal q versus average q; 2) omission of intangible assets in calculating q; and 3) inability to value untraded debt obligations.

The prevalent and most serious problem of all these models is that all capital resources are treated homogeneously as if investment in equipment and structures can all be aggregated based on the monetary value. The process of this aggregation ignores the complementarity characteristics of capital goods, which suggests that there exists an optimal combination of the capital goods that maximizes a firm's value. The economic implication of recognizing the complementarity is that the level of utilization of existing stock of individual

capital goods must be accounted for in order to understand the investment behavior.

3.3 Past Models of the Rental Office Market

Standard neo-classical office market models attempt to explain office investment, absorption, and rental rate adjustments -- three equations are typically developed and tested empirically. Most of the studies are extensions of Rosen [1984] and Wheaton [1987], who originally developed office market models. Rosen theorizes that: 1) investment is a function of expected rental rate, vacancy rate, construction costs, interest rates, and tax laws; 2) absorption is a function of office employment, and rental rate; and 3) change in rental rate is a function of actual and optimal vacancy rates, where the optimal vacancy rate is further assumed to be the sample average. Unexpectedly, Rosen's empirical results reveal that only the lagged vacancy rates is significant in determining the investment level.

Wheaton postulates that: 1) investment level is a function of real rental rate, vacancy rate, office employment growth rate, amount of stock, construction costs, and short-term interest rates; 2) absorption is a function of real rental rate, the level of office employment, and office employment growth rate; and 3) change in real rental rate is a function of actual and a constant structural vacancy rates. In the absence of a reasonably reliable real rental rate series, he assumed that the difference between actual and structural vacancy rates with appropriate lag determines the movement of real rental rates. For example, a relatively high (low) vacancy rate is expected to reduce (raise) the future rental rate and

correspondingly the asset price, which reduces (raises) the current investment level. Results using the model showed that in determining the investment level, the vacancy rates, the amount of stock, and the office employment growth rates were statistically significant, while the construction costs and the short-term interest rates were not. Later, Wheaton and Torto [1988] provide some empirical evidences that, indeed as Wheaton has assumed, the change in office rental rate is determined by the level of excess vacancy rate. While the past studies assume a constant structural vacancy rate, they allow the structural vacancy rates to rise linearly over time. Based on their data, they conclude that "real office rents drop approximately two percent annually, for every percentage point of 'excess vacancy' in the market."

Hekman [1985] uses a two-stage least squares method to model the office markets at the metropolitan level. Specifically, he assumes that: 1) the level of rent is a function of vacancy rate, gross national product, total employment, and unemployment rate of local SMSA; and 2) the level of investment is a function of predicted equilibrium rent, office employment growth rate, construction costs, and interest rates. The empirical results of this study show that construction costs and interest rates are not statistically significant in determining the level of investment. However, because Hekman estimates the level of rent rather than change in rent, his rent equation does not explain the rental adjustment.

Shilling, Sirmans, and Corgel [1987] model the change in rental rate as a function of actual and a constant structural vacancy rate, and operating expenses at the

metropolitan level. As expected, the level of excess vacancy rate affects the rental

rate negatively; however, the operating expenses variable is found to be

statistically insignificant. Also, they find that the structural vacancy rates vary

greatly among metropolitan areas.

Voith and Crone [1988] develop and estimate a model that decomposes the

variance in office vacancy rates into market-specific, time-specific, and random

components based on a model developed to analyze natural rates of unemployment.

Using vacancy data between 1980 and 1987, they find that the national average

vacancy rate increased significantly in late 1982 and they speculate reasonably

that the liberalized Economic Recovery Tax Act of 1981 may have lowered the cost

of holding vacant space. Also their empirical results reveal that high-growth cities

have higher natural vacancy rates in response to their higher expected absorption

rates.

Clapp, Pollakowski, and Lynford [1992] focus on the intrametropolitan differences

in the office markets based on the models developed by Rosen and Wheaton. In

addition to the standard neo-classical model, they include cross-sectional locational

variables which reflect agglomeration of office firms by industry. They assume

that: 1) the level of investment is a function of expected rent, average and actual

vacancy rates, operating costs, construction costs, interest rates, and property

taxes; 2) the level of absorption is a function of change in employment, rental rates

in the observed zone and competing zones, and zone-specific variables; and 3) the

change in rent is a function of interest rate, actual and average vacancy rates, and

expected change in employment. Like Wheaton, they substitute vacancy rates for rent in the absence of rental information. In using Boston area data, they conclude that spatial agglomerations are important determinants of office absorption.

Pollakowski, Wachter, and Lynford [1992] analyze the office markets at the metropolitan level to determine whether the size of the local market affects the ways the local markets behave. They postulate that competitive factors operate more strongly in markets with larger numbers of participants. They model that: 1) the level of absorption is a function of office employment, real rental rate, employment growth rate, and a lagged occupied stock of metropolitan areas, as well as a set of metropolitan interactive variables; 2) the investment level is a function of rent, employment growth rate, construction costs, and operating costs of metropolitan areas, and interest rate, along with the metropolitan dummy variables; and 3) change in rental rate is a function of actual and the optimal (assumed to be the sample average) vacancy rates, and the metropolitan dummy variables. Based on data from 21 metropolitan areas between 1981 and 1990, they find the metropolitan size does affect the empirical results. Counter-intuitively, the level of absorption is insensitive to the rental rate and the interest rate variable is statistically insignificant in determining the level of investment.

Wheaton and Torto [1993] theorize that rent-adjustment at the metropolitan level is a constant proportion of the gap between the optimal rental rate and a lagged actual rental rate, in which the optimal rental rate is a linear function of lagged absorption and vacancy rates. Using their hedonic office rent indices between 1979

and 1991, they find that the lagged absorption and rental rates are statistically significant and improve the statistical fit of the estimation. Their model and empirical results suggest that rents should stabilize both on the low and high side, even as vacancy remains high (or low).

All the above models assume that variations in vacancy, rental rates, and thus investment level respond to the changing level of demand for office space and further assume that the capitalization rate remains constant. According to these models, a shock in the demand for space can be traced as follows: as the demand drops, vacancies (or excess vacancies) rise causing the market rent to drop sufficiently to stabilize the vacancies. The lower rental rate combined with an assumed constant capitalization rate lowers the price, which in turn reduces the level of new construction. As the supply of new office buildings declines for an extended amount of time, coupled with the lower rental rate raising the level of demand for office space marginally, the vacancies drop until the market rent, and, implicitly, price return to the previous level. If, however, the supply continues to dwindle or if there is an unexpected surge in demand for space, then the market rent, and, accordingly, price, increase due to an even lower vacancy rate.

The main problem of these models is that they assume that as rental rates rise, the asset prices rise, which in turn increase the level of new construction. Presumptions made in the models are that the capitalization rate and the ratio of rental revenues to operating expenses are constant. However, there exist no theoretical nor empirical evidence supporting the presumptions. The capitalization

rate is defined as the net operating income divided by asset value. In theory, changes in the tax laws, depreciation rates, inflation rates, and interest rates affect the capitalization rates significantly. Empirical evidence supporting the notion of a variation of the capitalization rates is provided by a survey from the American Council of Life Insurance (ACLI). According to ACLI, the national average capitalization rate (based on the stabilized occupancy) of office buildings ranged between 8.2 and 13.3 percent over the last 25 years. The ratio of rental revenues to net operating income also varies considerably due to the variations in vacancy rates, rental rates, and inflation rates. During a period of high (low) vacancy rates, the ratio is expected to be low (high) since a substantial portion of the operating expenses consists of fixed expenditures such as real estate taxes and administrative costs. Similarly, the rising rental rate raises this ratio. Also, since most of the lease terms are not adjusted annually, during the period of accelerating (decelerating) inflation rates, the ratio is likely to be low (high). BOMA reports that the ratio ranged between 1.94 and 3.51 over the last 45 years.

The impact of tax law, inflation, and interest rates changes on the value of office properties has been studied by Hendershott and Ling [1984] and DiPasquale and Wheaton [1992A]. Recognizing this important linkage between property and capital markets, they theorize that the level of investment is a function of price relative to the cost of replacement, which is exactly the underlying theory of Tobin's q model. DiPasquale and Wheaton theorize that price is a function of rent and capitalization rate. They assume further that the capitalization rate is a function of long-term interest rate, expected growth in rents, the risks associated

with that rental income stream, and the treatment of real estate in the U.S.

federal tax code. The level of absorption is a function of rent and general economic

conditions. Because they model long-run equilibrium conditions, DiPasquale and

Wheaton assume that the rent adjusts so that the supply equals demand.

3.4   Concluding Remarks

In this chapter a group of previous studies on aggregate capital investment and

office investment models have been discussed. These studies explored different

aspects of office investment behavior as they ignore variations in either the

property market or capital market. In general, the aggregate models consider the

owner-occupant firms without explicit recognition of the rental market. Also, these

models focus only on the dynamic impact of the capital market. The traditional

office models, on the other hand, assume that the rental market makes up the

entire office market; thus they assume that variations in vacancy rates and/or

rental rates can determine the investment rates. Clearly, they neglect the

variability of the cost of capital that is espoused by the macroeconomists.

The particular problems associated with the above models imply that by merging

the motives of these models, that is, by considering the property and capital values

as well as explicitly recognizing the rental and owner-occupant firms' investment

behavior, one can begin to develop a more coherent model that truly reflects the

complex set of incentives that determine the demand for and supply of office space.

As DiPasquale and Wheaton [1992A] point out: "developing an intuitive framework

similar to the one in this paper that traces the intermediate-term dynamic path to a new equilibrium remains a formidable challenge." In the next three chapters, three sets of equations modelling the demand for and supply of office properties, and the rental adjustment, are developed and tested with an explicit recognition of the interactions between capital and property markets.

Chapter 4

The Demand for Office Space

4.1   Introduction

One of the main hypotheses in this thesis is that the office market is composed of rental and owner-occupied space, and, accordingly, a model must reflect explicitly the different demand behavior between the firms that seek to lease and to own office space. Since office investment patterns discussed in Chapter 2 suggest that the office market has changed from a market that was dominated by the owner-occupied space prior to the 1970s to one that is shared by both the owner-occupied and rental space, the hypothesis can be tested. In this chapter, two sets of equations are developed and tested empirically. The first set of equations focuses on the demand behavior of firms that seek owner-occupied space and the second set combines firms that seek both owner-occupied and rental space. The main difference between these two sets of equations is that the former is determined by office employment level and growth, whereas the latter is determined jointly by office employment growth and expected rental costs. Of course, given the high transactions costs and time involved in adjusting holdings of either owner-occupied (e.g., new constructions and purchase-and-sale agreements) or rental (e.g., rental agreements) space, the speed of adjustment is critical in modelling the demand equations.

4.2   The Theory

4.2.1   The Demand for Owner-Occupied Space

The model of the demand for new owner-occupied office buildings (i.e., absorption) employed in this thesis is a variation of the accelerator model. Instead of assuming that the investment is a constant function of the growth of output (i.e., sales, GNP), the level of and the growth of office employment are assumed to determine the demand for office investment. In other words, the number of office employees is considered as the fundamental force that determines the demand for office space. Since the main purpose of owning or leasing office space is to house workers and their equipment, the office workers and the office space are assumed to maintain very high complementarity. Unlike investment in certain equipment (e.g., assembly machinery), office buildings simply do not provide substantial substitutability to the investment in labor. It is difficult to imagine situations in which a firm invests heavily in office workers without the concomitant investment in office space to house them. A lack of adequate office space for the workers is likely to diminish their productivity. Conversely, providing a profuse amount of office space for the workers probably will not increase their productivity significantly. Thus one can assume that there exists a desired or optimal amount of office space (i.e., occupied stock) in relation to the number of office workers. Specifically, an optimal combination of capital (both structures and equipment) and labor that maximizes a firm's profitability is assumed to exist.

This model makes an implicit assumption that wages, taxes, interest rates, and prices impact indirectly on the demand for owner-occupied office buildings. In other words, these factors directly affect the level and growth rate of office employment. Firms are assumed to consider a host of associated costs, including the cost of office space, before deciding to hire additional employees.

Assuming that vacancy rates are constant for all qualities and ages of office buildings, the amount of occupied space (in constant dollars), denoted OS_t, is defined as:

$$OS_t \equiv S_t(1-v_t) \tag{2}$$

where S_t = gross stock of office space in period t, and

v_t = vacancy rate in period t.

Assuming that OS_t bears a constant proportionality, a ratio that equals w, to the number of office employees, denoted EMP_t, the accelerator model implies that the optimal amount of occupied space, denoted OS_t^*, is:

$$OS_t^* = wEMP_t \tag{3}$$

Due to the adjustment costs and time involved, OS_t^* is unlikely to be equal to OS_t. The traditional flexible accelerator model specifies a constant partial adjustment

coefficient as α (Equation (1) in Chapter 3) to relax the instantaneous adjustment assumption. Hence, the amount of absorption or the change in the amount of occupied space is specified as:

$$\Delta OS_t = \alpha(OS_t^* - OS_{t-1}) = \alpha wEMP_t - \alpha OS_{t-1} + u_t \tag{4}$$

where $u_t = \rho u_{t-1} + \varepsilon_t$.

Given the high costs of adjustment inherent in the owner-occupied office market due to long durability of buildings, fixity of location, and indivisibility characteristics, the framework of this homogeneous capital model, in which all investment can be modified and reconfigured, cannot work well. A firm experiencing a steadily or rapidly increasing number of office workers are likely to desire office space not only for the existing number of workers but also for the anticipated new workers. In other words, the optimal amount of office space is not a function of the number of existing employees but the number of employees expected in the near future. Obviously, if the number of employees is not expected to change in the near future, then the number of existing employees by itself should determine the optimal amount of office space. Accordingly, this model assumes that the amount of absorption is determined by two factors, namely the employment level and growth in period t. A presumption is that the current employment growth is a reasonably good proxy for the expected change in the number of employment.

Combining these two determinants and assuming a linear relationship, the optimal amount of occupied space in period t is:

$$OS_t^* = EMP_t(w + \beta_h \frac{\Delta EMP_t}{EMP_t}) \qquad . \qquad (5)$$

where β_h represents an amount of additional desired occupied space attributed to the expected employment growth in the near future per current employment growth.

The actual absorption in period t, ΔOS_t, is

$$\Delta OS_t = \alpha(wEMP_t + \beta_h \Delta EMP_t - OS_{t-1}) + u_t \qquad (6)$$

Basically, Equation (6) specifies that the absorption in period t is determined by an adjustment of occupied space to its optimal level. By estimating α, one can easily calculate w and β_h. If β_h were close to zero, then Equation (4) is sufficient and the need for its specification does not exist.

The underlying rationale of Equation (6) is intuitively simple. As discussed earlier, the adjustment rate α is expected to be very low given the high adjustment costs associated with office ownership. In fact, the magnitude of the adjustment rate affects the magnitude of the other two coefficients. The coefficient w measures the amount of desired occupied space per existing employee. One can hypothesize that

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w is expected to be higher in the owner-occupant office market than that in the rental office market since the user firms have to bear the risk of demand shocks since the adjustment rate is so low. Conversely, if the adjustment rate were relatively high (i.e., the user firms can reconfigure their office space holdings easily), then w can be relatively low. The magnitude of coefficient β_h measures the amount of office space desired primarily due to the anticipated need for office space in the near future. If, as hypothesized, the adjustment rate were low, then β_h is expected to be relatively high. On the other hand, if the adjustment rate were high, then one would expect β_h to be zero or close to zero since the user firms can absorb only the amount of additional space they need for the current period.

4.2.2 The Demand for Rental and Owner-Occupied Space

In the previous section, the level of and growth of office employment are assumed to determine the amount of owner-occupied office absorption. The amount of absorption for rental office space, on the other hand, is assumed to be determined by expected rental costs in addition to the level of and growth of employment. The reason for explicitly including the expected rental costs is that as rental rates increase, the cost of housing the employees increases, which induces the absorption level to decline in order to offset the additional burden of higher rental costs. The optimal occupancy is then specified as:

$$OS_t^* = EMP_t(w + \beta_h \frac{\Delta EMP_t}{EMP_t} + \beta_r EL_t) \tag{7}$$

where EL_t denotes expected rental rate in period t, and the coefficient β_r is expected to be negative.

The advent of an active rental market in conjunction with owner-occupied office space allows the office users to meet their office needs more effectively. Because the rental market provides short-term space, readily available stock of vacant space, and much simpler acquisition and disposition transactions, it can absorb demand shocks such that the office users are able to shift the risk of under-utilization to the rental firms. In effect, the office users are able to arrive at and maintain the optimal space utilization level much easier. Therefore, one can theorize that the gap between OS_t^* and OS_{t-1} is minimal, and if not, the gap is expected to close quickly. In other words, the adjustment rate is expected to be higher than that of the owner-occupant market.

Combining the gap between the actual and optimal space occupancy, the employment growth, and the expected rental cost, the amount of optimal absorption can be specified as:

$$OS_t^* - OS_{t-1} = wEMP_t + \beta_h \Delta EMP_t + \beta_r EL_t EMP_t - OS_{t-1} \tag{8}$$

and the actual change in the occupied space in period t, ΔOS_t, is

$$\Delta OS_t = \alpha(wEMP_t + \beta_h \Delta EMP_t + \beta_r EL_t EMP_t - OS_{t-1}) + u_t \qquad (9)$$

If, as hypothesized, that the rental market allows firms to maintain OS_t close to $w*EMP_t$ (i.e., the utilization level is maintained at or near its optimal level) due to lower adjustment costs, the terms $w*EMP_t$ and OS_{t-1} of Equation (9) may drop out. The resulting equation becomes, not the stock adjustment model, but a flow model. Then the absorption level in period t is determined by a constant function of the additional expected rental costs along with the current employment growth as:

$$\Delta OS_t = \alpha(w\Delta EMP_t + \beta_r EL_t \Delta EMP_t) + (1-\alpha)\Delta OS_{t-1} + u_t \qquad (10)$$

If Equation (10) were, in fact, a reasonable estimation, then it can be generalized by relaxing an assumption that α is constant for all t. In addition, the estimated rental costs variable does not need to be constrained by α. By separately specifying the ΔEMP_t variable for current and past periods, Equation (10) can be converted into:

$$\Delta OS_t = \beta_c + \sum_{g=0}^{t} w_g \Delta EMP_{t-g} + \beta_r EL_t (EMP_t - EMP_{t-g-1}) + u_t \qquad (11)$$

where β_c is a constant.

Equation (11) is an unrestricted distributed lag formulation such that the partial

adjustment coefficient need not be constant. While the cost of using the

unrestricted form is that the lagged regressors tend to be highly correlated, high

complementarity between the number of office employees and the amount of office

space suggests that the lags are likely to be very short so that the multi-

collinearity should not be a problem.

4.3   Estimation Strategies

In an attempt to arrive at a relevant measurement of office employment,

Wheaton's [1987] estimates of office employment as a percentage of total

employment by seven industry sectors (Table 1) are considered. One adjustment in

estimating the office employment is made here. Instead of using the services

sector's office-to-total-employment ratio of 25.2 percent without the health

industry, a ratio of 36 percent is used on the entire services sector in lieu of the

first five sectors' office employment. This change is made for three reasons: First,

since the first five sectors' office employment make up only a minor proportion of

the total employment, measuring the office employment growth based on only the

FIRE and Services (FS) sectors, which make up almost 90 percent of all office

employment growth over the last 40 years, is assumed to be more relevant in

estimating the absorption levels. Second, it does not seem reasonable to assume

that the ratios of office to total employment in Table 1 for the first five sectors

have remained constant over the sample period, since the number of non-office

employees may be more volatile than that of the office employment. Third, office

employees in these sectors can easily move back and forth from non-office buildings

(i.e., industrial buildings, mobile offices, and warehouses that contain office-like space) to office buildings. Also, using FS sectors' office employment is consistent with the previous studies of the office market.

Table 1

Office to Total Employment Ratio by Industries

Industry Sectors	Office to Total Employment Ratio
Mining	15%
Construction	3%
Manufacturing	7%
Transp., Communication, & Utilities (TCU)	6%
Trade	8%
Finance, Insurance, & Real Estate (FIRE)	100%
Services (w/o health industry)	25%

Source: Wheaton [1987]

Based on the above estimation, Figure 14 illustrates the total office employment between 1947 and 1990. The office employment level has increased from approximately 3.5 millions in 1947 to about 17 millions in 1990. During this period, employment has grown almost fivefold, which is even higher than the rate that the office stock increased.

Given the total office employment, the annual growth in the office employment (i.e., the change in office employment) between 1948 and 1990 is shown in Figure
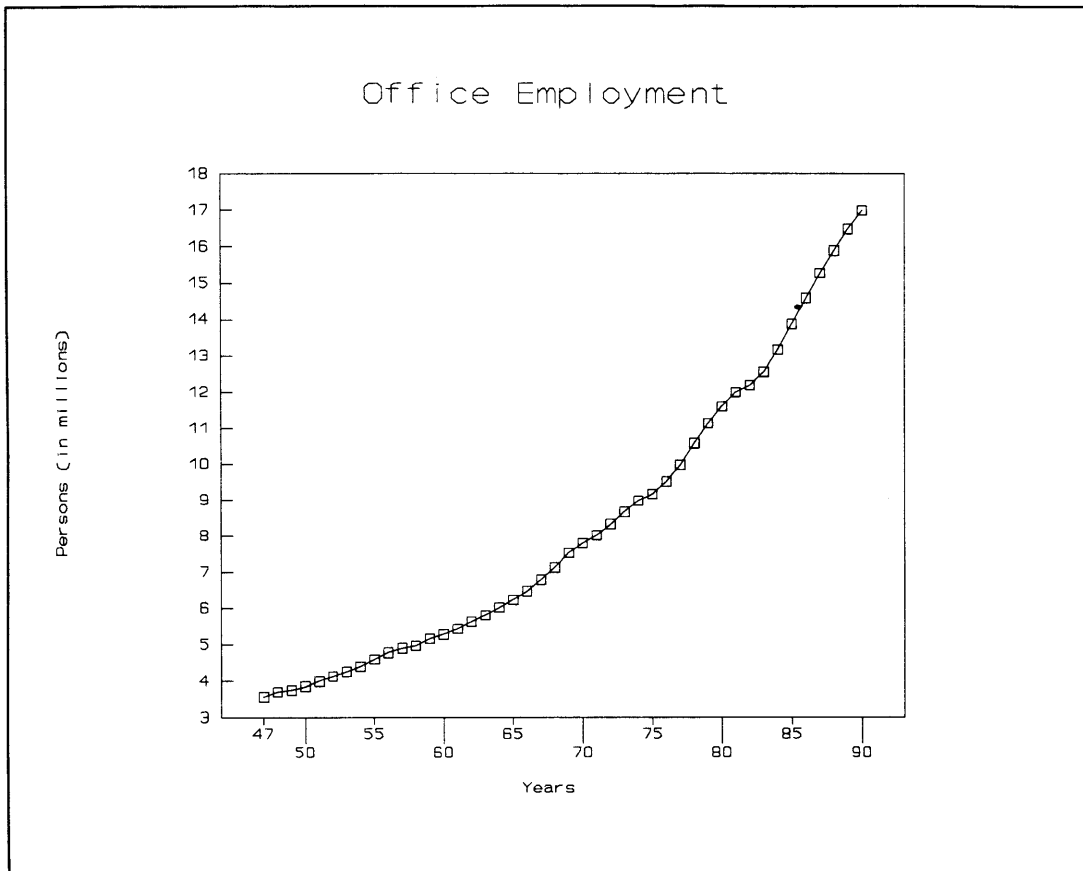
Figure 14

15. Until the early 1960s, the office employment growth was relatively stable at

around 120,000 persons per year except those years (specifically, 1949 and 1958)

when the economy was in a recession. During the 1960s, the employment growth

increased steadily from about 100,000 to 400,000 persons per year. However,

between 1970 and 1990, the employment growth turned very volatile. While the

average growth rate since 1970 is higher than that prior to 1970, the annual

growth rates during the 1970s and 1980s are not extraordinarily high compared to

the previous 20 years as evidenced by Figure 16. Nevertheless, the employment

growth cycles appear to be far more dramatic and systematic in the last two

decades. In 1971, 1975, and 1982, the employment growth dipped below 200,000

persons per year. Whereas, in 1978 the growth reached over 600,000 persons per year, and again, in the mid-1980s, a peak in excess of 700,000 persons per year was reached.

Office Employment Growth

[Figure: Line plot titled "Office Employment Growth" with y-axis "Persons (in thousands)" from 0 to 800, and x-axis "Years" from 48 to 90, showing employment growth data points connected by lines.]
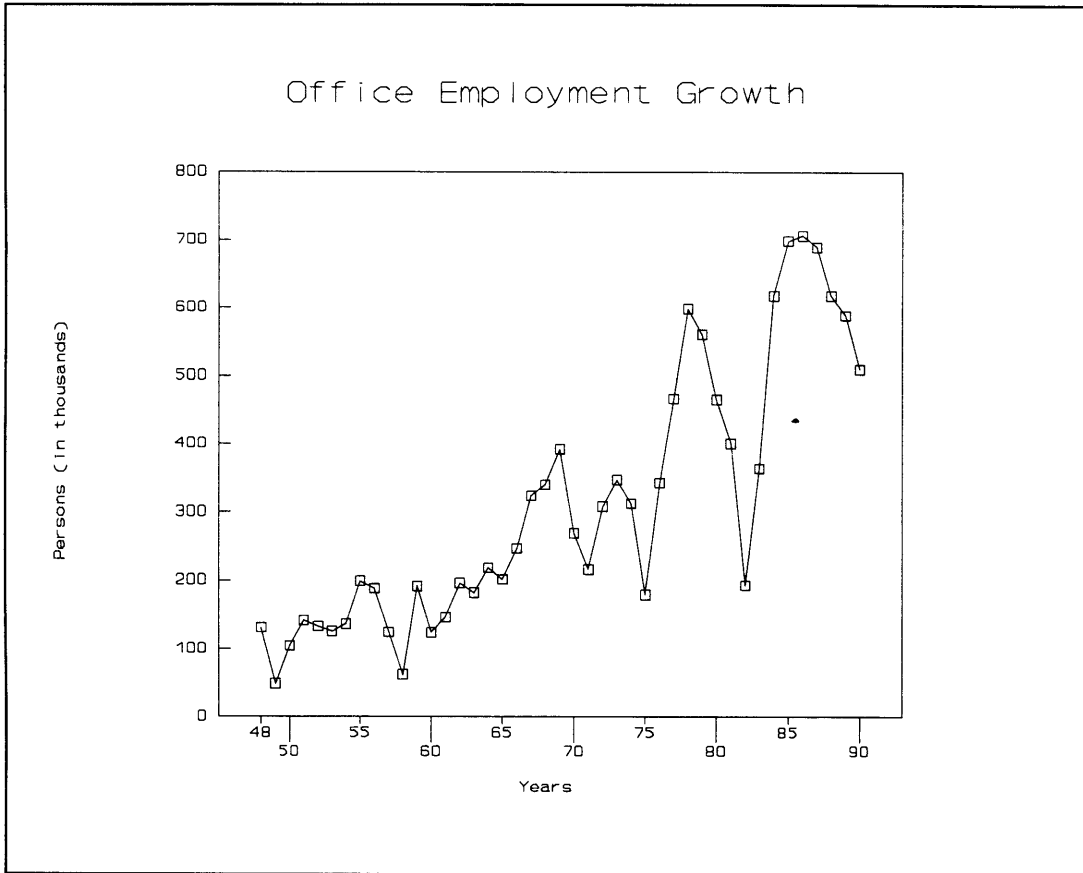
Figure 15

The occupied stock series, shown in Figure 17, is easily derived from the gross stock and vacancy rates time-series data. Between 1947 and 1990, the occupied stock increased from about $100 billion to about $360 billion. While the occupied stock has accelerated during this period, it did not increase as fast as the gross stock (see Figure 3 in Chapter 2) due to the rising vacancy rates, particularly in the 1980s.
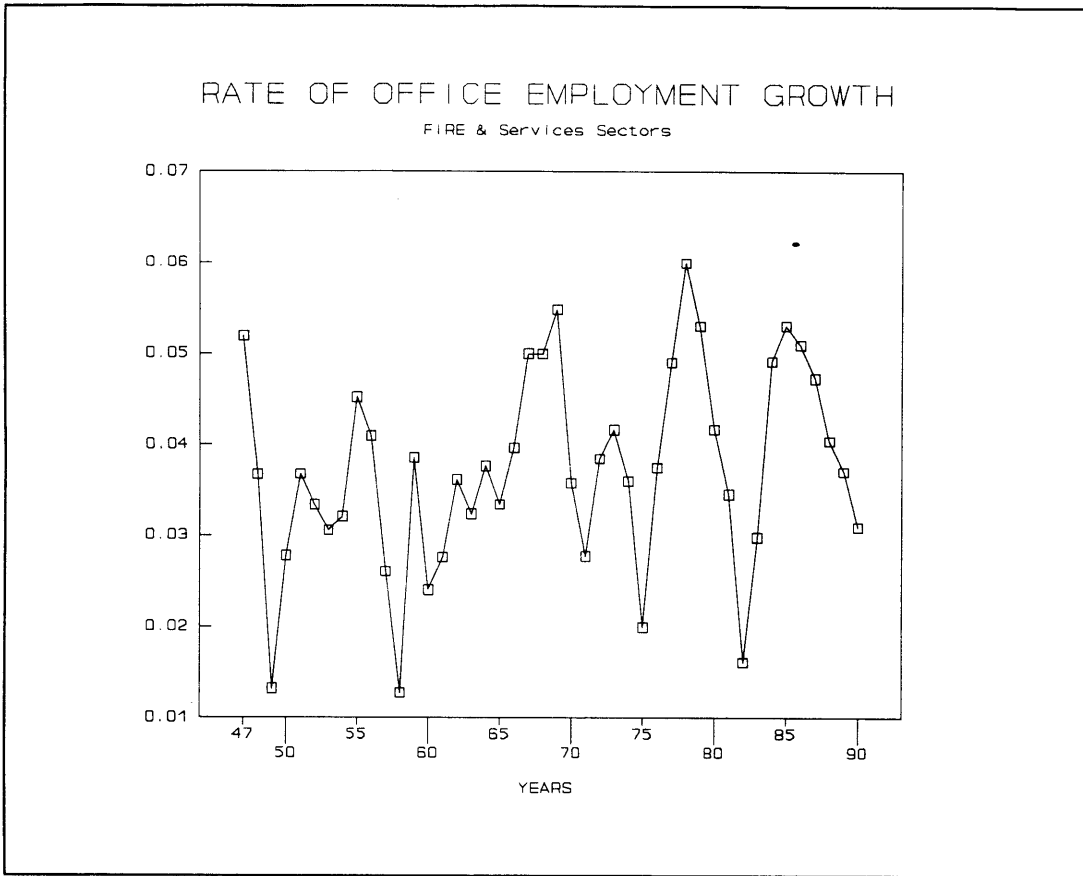
Figure 16

As illustrated in Figure 18, the absorption series exhibited no general trend. The average absorption rate during the 43-year period examined was about 2.8 percent with a standard deviation of 2.1 percent. Until 1955, absorption remained negative. Since then, it increased gradually, reaching a local peak at around $8 billion in 1968. During the early- and mid-1970s, the level of absorption declined considerably and then by the late-1970s it rose sharply, reaching as high as $15 billion. The 1980s experienced a relatively stable absorption around $13 billion except in 1983 when it dropped below $2 billion. The recession of 1982 probably contributed to this dramatic drop.

Occupied Office Stock
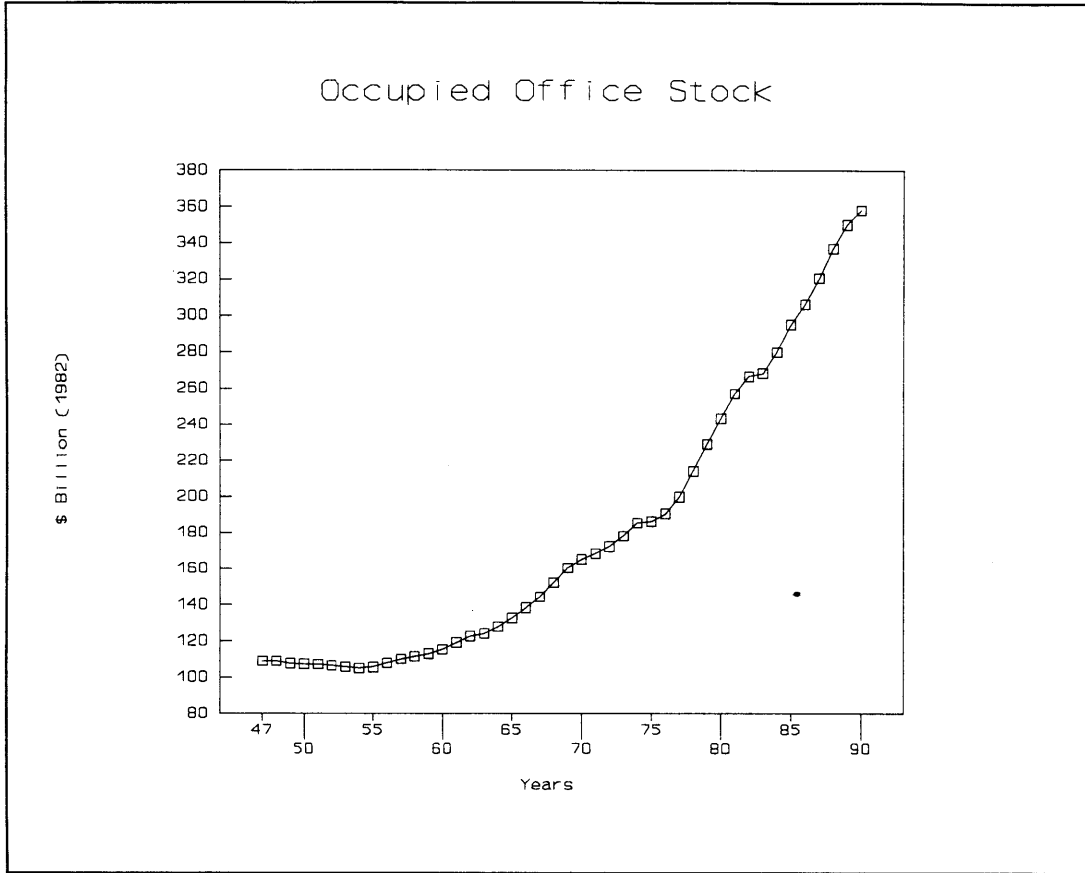
Figure 17

The expected rental rate variable is derived as follows. BOMA collects data on annual average rental revenues per square foot. Dividing this series by occupancy rates, the average rental rates, denoted AL_t, paid by tenants can be obtained. Since the average rental rate series does not reflect the marginal rental rate series -- which is desirable but unfortunately not available -- the expected rental rate series is estimated based on the trend over the previous two years as follows:

$$EL_t = AL_{t-1} * [1 + (AL_{t-1} - AL_{t-3})/AL_{t-3}] \tag{12}$$

The estimated expected rental rates (per square foot) have risen gradually between

Office Absorption

(Figure: Y-axis labeled "$ Billion (1982)" ranging from -2 to 18; X-axis labeled "Years" ranging from 48 to 90)
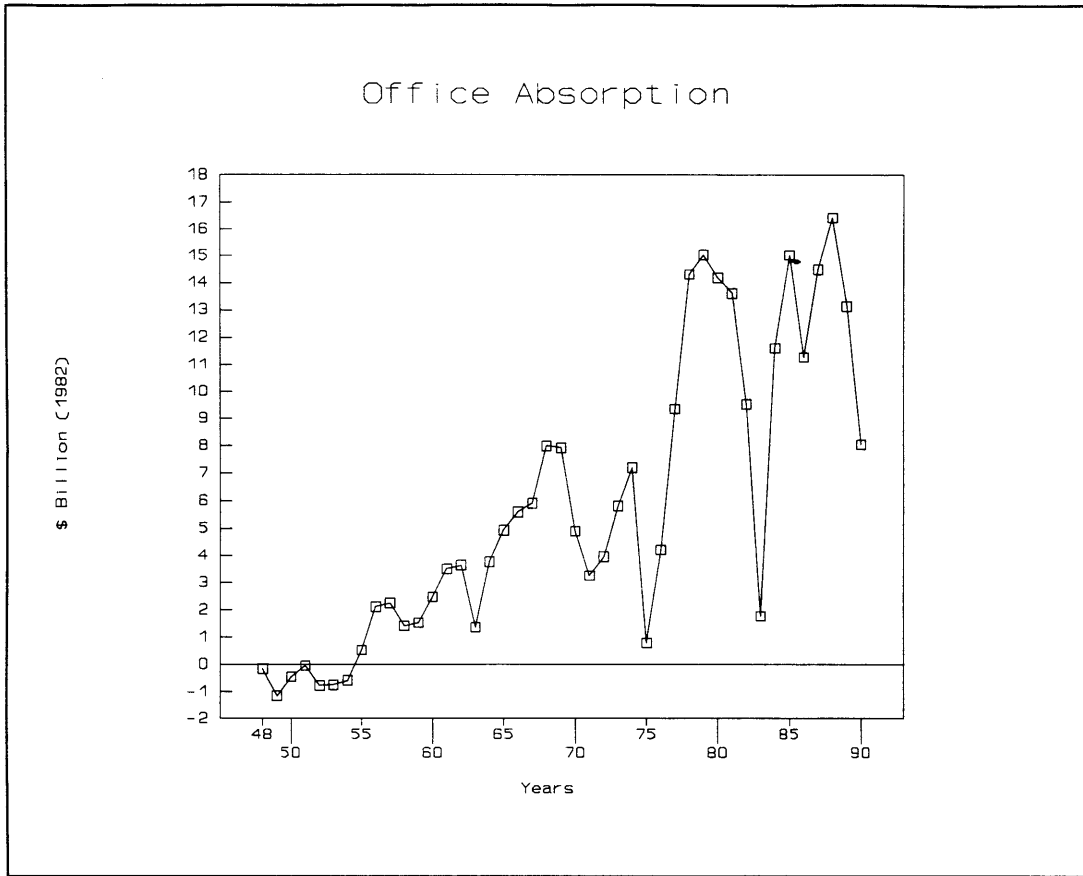
Figure 18

1950 and the early 1970s from about $11 to about $14. However, after the early

1970s, the rates turned very volatile. For instance, from a $14 range in the early-

1970s, the rate dropped to about $10 in 1980 and peaked in 1986 at about $17

followed by a major drop in 1987 at about $12.70.

The data necessary to estimate all the equations in this chapter are listed in Table

2. The absorption, occupied stock, and expected rental rates are in 1982 constant

dollars.

Table 2

Data for Office Demand Estimations

Year	ΔOS_t ($MM)	EMP_t (1,000)	ΔEMP_t (1,000)	OS_{t-1} ($MM)	EL_t ($/SF)
1948	(147)	3,703	131	108,938	N/A
1949	(1,148)	3,752	49	107,790	N/A
1950	(449)	3,857	104	107,342	N/A
1951	(34)	3,998	142	107,307	10.83
1952	(757)	4,132	133	106,550	12.11
1953	(735)	4,258	126	105,815	10.54
1954	(572)	4,395	137	105,243	10.51
1955	527	4,594	199	105,770	11.44
1956	2,113	4,782	188	107,883	11.95
1957	2,248	4,907	125	110,131	12.79
1958	1,412	4,969	63	111,543	12.91
1959	1,534	5,161	192	113,077	12.75
1960	2,485	5,285	124	115,562	12.39
1961	3,517	5,431	146	119,079	12.66
1962	3,653	5,628	196	122,732	12.29
1963	1,373	5,810	182	124,105	12.40
1964	3,784	6,029	219	127,888	13.54
1965	4,948	6,230	201	132,836	14.05
1966	5,610	6,477	247	138,446	13.05
1967	5,914	6,801	324	144,361	12.63
1968	7,985	7,141	340	152,345	13.80
1969	7,925	7,533	392	160,270	13.35
1970	4,914	7,802	269	165,184	12.11
1971	3,264	8,019	217	168,448	13.06

1972	3,967	8,327	308	172,414	13.53
1973	5,816	8,675	347	178,230	13.41
1974	7,195	8,987	312	185,426	14.65
1975	798	9,166	179	186,224	14.34
1976	4,222	9,509	343	190,445	11.63
1977	9,361	9,976	467	199,807	11.21
1978	14,319	10,575	599	214,125	11.89
1979	15,045	11,135	561	229,170	12.87
1980	14,192	11,600	465	243,362	11.58
1981	13,625	12,001	400	256,987	10.01
1982	9,533	12,194	193	266,520	11.34
1983	1,768	12,558	364	268,288	13.12
1984	11,610	13,176	618	279,897	13.75
1985	15,039	13,875	699	294,937	15.25
1986	11,271	14,582	707	306,208	16.14
1987	14,501	15,272	690	320,708	17.22
1988	16,439	15,890	618	337,148	12.69
1989	13,151	16,479	589	350,298	13.00
1990	8,051	16,988	510	358,349	15.39

Sources: BEA, BOMA, CB Commercial, U.S. Bureau of Labor Statistics

4.4   Estimation Results

Initially, Equations (4), (6), and (9) are empirically tested for a full sample period between 1951 and 1990 assuming that no structural change has occurred in the demand for office space. Secondly, to test whether the advent of an active rental market has changed the behavior of office market, the sample period is split into

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two subperiods (i.e., 1951 to 1970, and 1971 to 1990) and the equations are then

tested for the two subperiods. Thirdly, variations of these equations are also tested

to determine the impact of varying assumptions about the adjustment rates.

Lastly, Equation (11) is empirically tested to determine whether the unrestricted

distributed lag formulation for the second subperiod improves the estimation.

Table 3

Regression Results of Equation (4)

Dependent Variable: Absorption

Variables	Period 1951-1990	Subperiod 1 1951-1970	Subperiod 2 1971-1990
Constant	1,033 (0.936)	-5,392 (-1.97)	-9,483 (-3.022)
EMP_t	7.959 (7.375)	3.49 (4.00)	15.73 (5.74)
OS_{t-1}	-0.358 (-6.402)	-0.092 (-1.56)	-0.703 (-5.4)
u_{t-1}	0.607 (3.659)		0.836 (2.66)
No. of Observ.	39	20	19
Corrected R^2	0.823	0.846	0.715
DW	1.79	1.49	2.06

Source: Author

The empirical results based on Equation (4) are shown in Table 3. The t-statistics

are listed below coefficients in parenthesis. The estimation of absorption level for

the full sample period and two subperiods shows that Equation (4) explains its

variations reasonably well. All the coefficients, except the constant, are statistically significant at the five percent level.

For the full sample period, the estimated coefficients of w and α are \$22,200 and 35.8 percent, respectively. The value of an average office building is estimated to be about \$105 (in 1982 dollars) per square foot (a value derived from construction cost data by R. S. Means) and a typical office space occupied by an office worker is estimated to be 200 square feet (an average between 1985 and 1990 according to BOMA). By multiplying these figures, one can estimate that approximately \$21,000 should be invested in office space per office worker. The estimate of the desired office investment per office employee is approximately \$22,200 (in 1982 dollars), which is very close to the expected value of \$21,000. The adjustment rate for the full period suggests that about one-third of the desired absorption is achieved in the first year.

Examination of the estimation results between the full sample period and the two subperiods indicates that the coefficients have not been stable over the 40-year period and suggests that the office market must have experienced a structural change as the rental market became active. An application of the full sample period's coefficients can lead to an erroneous conclusion since the coefficients are not stable.

The estimation results of the two subperiods highlight the remarkable difference in the adjustment rate between the two subperiods. The estimates of α for Subperiod

1 and for Subperiod 2 are 9.2 percent and 70.3 percent, respectively. The estimates of w have dropped dramatically over the two subperiods -- it dropped by about 40 percent from \$37,935 to \$22,385. It is truly inconceivable that the estimates of α and w could have changed so drastically over the two subperiods.

Table 4

Regression Results of Equation (6)

Dependent Variable: Absorption

Variables	Period 1951-1990	Subperiod 1 1951-1970	Subperiod 2 1971-1990
Constant	82.68 (0.08)	-2,662 (-0.95)	-8,250 (-2.14)
EMP_t	4.518 (3.74)	3.296 (4.12)	13.105 (3.09)
ΔEMP_t	17.548 (3.98)	10.506 (2.12)	6.80 (0.83)
OS_{t-1}	-0.217 (-3.73)	-0.123 (-2.20)	-0.59 (-3.11)
u_{t-1}	0.492 (2.58)		0.767 (2.26)
No. of Observ.	39	20	19
Corrected R^2	0.835	0.872	0.681
DW	2.05	1.64	2.14

Source: Author

The estimation results of Equation (6), presented in Table 4 above, explain partially the dramatic increase in the adjustment rate.

The statistical fit of these estimations is very close to that of Equation (4) estimations as indicated by nearly identical corrected R^2 values. A comparison of the results for Subperiods 1 and 2 indicates, as hypothesized and consistent with Equation (4) results, that Equation (6) explains the level of absorption significantly better for Subperiod 1 than for Subperiod 2. Also, the estimated value of office absorption per office employee, w, for the full period is $20,820, and for the first and second subperiods are $26,797 and $22,212, respectively. The drop in the optimal amount of occupied space per employee over the two subperiods is more reasonable. Also, for the full period, the estimated w is slightly lower in Equation (6) than that in Equation (4).

In comparing Equations (4) and (6), a more relevant issue is the estimation of α and β_h. For the full sample period, $\alpha = 0.217$ and $\beta_h = \$80,866$. First, the estimated adjustment rate in Equation (6) is significantly lower than that ($\alpha=0.358$) estimated in Equation (4). Second, the estimated value of β_h is almost four times as high as the estimated value of w. This suggests that the user firms actually absorb significantly more space in anticipation of future needs. Also, the estimated value of β_h and its statistical significance explain how the estimated value of α and w can be lower simultaneously in comparison to Equation (4) results. These results imply clearly that using the existing number of employees by itself, as in Equation (4), can be misleading. As hypothesized, the change in the number of office employees affects significantly the amount of office space desired and absorbed.

Not surprisingly, as with Equation (4) results, these coefficients are unstable over the two subperiods. For Subperiod 1, the estimated coefficients of α and β_h are 0.123 and \$85,415, respectively. Interestingly, the estimated value of α in Equation (6) is slightly higher relative to that of Equation (4).

For Subperiod 2, the estimated value of α increased to 0.59 and β_h have decreased significantly to \$11,525. Such a high value of α suggests that much of the gap between OS^* and OS_{t-1} is closed in the first year. Also the fact that β_h is statistically insignificant suggests that the user firms do not absorb more than a necessary amount of space in anticipation of future needs. But rather, they absorb office space as the need for space is actually recognized. In other words, the flow model appears to be appropriate for this subperiod. It appears to be reasonable to attribute the active rental market with its relatively low costs of adjustment to the rise in the adjustment rate and to the decline in β_h.

For both subperiods, similar to the full sample period results, the estimated values of w, α, and β_h are different enough that one cannot assume that Equation (3) is appropriate. To further verify that a single adjustment rate equation does not produce reliable results, a variation of Equation (4), known as the Koyck Transformation, can be estimated. Subtracting a one-period lag of Equation (3) from Equation (3) yields the optimal absorption level, which is specified as:

$$\Delta OS_t^* = OS_t^* - OS_{t-1}^* = wEMP_t - wEMP_{t-1} \tag{13}$$

As with the previous models, specifying a constant adjustment coefficient α into Equation (13) yields:

$$\Delta OS_t = \alpha OS_t^* - \alpha OS_{t-1}^* = \alpha w(EMP_t - EMP_{t-1}) - \alpha(OS_{t-1} + OS_{t-2}) \qquad (14)$$

which is simply,

$$\Delta OS_t = \alpha w \Delta EMP_t + (1 - \alpha)\Delta OS_{t-1} \qquad (15)$$

The result of regressing Equation (15) is presented in Table 5. The t-statistics are listed below coefficients in parenthesis.

Table 5

Regression Results of Equation (15)

Dependent Variable: Absorption

Variables	Period 1951-1990	Subperiod 1 1951-1970	Subperiod 2 1971-1990
Constant	-1,556 (-2.310)	-1,052 (-1.388)	-2,042 (-1.063)
ΔEMP_t	17.063 (6.631)	12.187 (2.482)	18.147 (4.383)
ΔOS_{t-1}	0.368 (4.050)	0.587 (3.972)	0.354 (2.526)
No. of Observ.	40	20	20
Corrected R^2	0.841	0.825	0.678
Durbin h Stat.	0.549	1.414	0.198

Source: Author

The statistical fit of this equation for the full period and the two subperiods is reasonably close to that of Equation (4) results. Since the lagged dependent variable is included in this equation, Durbin h-statistic is used to test the presence of serial correlation. At the five percent level, the critical value is 1.645 and all three regression results produced h statistic less than 1.645 such that the null hypothesis of no serial correlation cannot be rejected.

The estimated coefficient of the optimal office investment per office employee is $26,994 for the full period and $29,508 and $28,091 for Subperiods 1 and 2, respectively. Except for Subperiod 1, these values are substantially higher than those of Equation (4) results or the expected $21,000. Also, the full period's and Subperiod 1's estimated adjustment rates are much higher than those of Equation (4), and Subperiod 2's adjustment rate is marginally lower than that of Equation (4). In comparison to Equation (6) results, all three estimated adjustment rates are higher. Specifically, for the full period, it is 63.2 percent and for Subperiod 1 and for Subperiod 2, they are 41.3 and 64.6 percent, respectively. Since, in theory, Equation (15) is identical to Equation (4), these discrepancies in the empirical findings between the two equations cast doubts about validity of either equation. Rather, these results confirm an earlier hypothesis that the optimal occupied space cannot bear a constant proportionality to the number of office employees as assumed in both Equations (4) and (15). Clearly, Equation (6), which is a more general model of Equations (4) and (15) is a more realistic formulation assuming that office investment is characterized closer by the putty-clay model than the putty-putty model.

Table 6

Regression Results of Equation (9)

Dependent Variable: Absorption

Variables	Period 1951-1990	Subperiod 1 1951-1970	Subperiod 2 1971-1990
Constant	-2,795 (-2.60)	-3,391 (-1.42)	-8,259 (-2.80)
EMP_t	3.37 (3.53)	0.069 (0.05)	6.194 (1.98)
ΔEMP_t	20.32 (5.08)	9.87 (2.34)	18.12 (2.36)
$EL_t EMP_t$	-0.069 (-3.78)	0.145 (2.70)	-0.082 (-3.45)
OS_{t-1}	-0.104 (-2.22)	-0.051 (-0.94)	-0.21 (-1.48)
No of Observ.	40	20	20
Corrected R^2	.86	.91	.78
DW	1.75	1.80	2.10

Source: Author

More importantly, consistently lower corrected R^2's found for Subperiod 2 suggest

that Equations (4), (6), and (15) provide relatively poor explanatory power during

the period of active rental market. The effect of the expected rental costs, in

addition to the employment level and growth, is explored by regressing Equation

(9). The empirical results based on Equation (9) are shown in Table 6. The t-

statistics are listed below coefficients in parenthesis.

For the full sample period, the result indicates that all the regressors are

statistically significant at the five percent level and all the coefficients have the expected signs. While the estimated coefficients seem to be reasonable and explain the variations in the absorption rate well, they are not stable nor reliable as suggested by the conflicting or divergent results in comparing the two subperiods. Notwithstanding the instability of these coefficients, the estimation results are discussed briefly to understand the reasonableness of the model.

The speed of adjustment, α, is approximately 10.4 percent, which is significantly lower than 21.7 percent estimated with Equation (6). The estimates of w and β_h are approximately \$32,404 and \$195,385, respectively. These estimates are substantially higher than the expected value presumably due to the effects of negative constant and β_r. The estimated β_r at -0.663 suggests that, assuming a constant EMP_t / OS_{t-1} ratio at 0.0476, a single standard deviation rise in the expected rental costs induces about 0.5 percent drop in the absorption rate ($\Delta OS_t / OS_{t-1}$) which represents approximately 13.3 percent of the average absorption rate over the full sample period.

Subperiod 1's estimation results show the inconsistency resulting from including the expected rental costs variable during the period when the rental market accounted for only a minor part of the overall office market. First, the current employment level and lagged stock variables are statistically insignificant. Second, none of the estimated coefficients makes much sense -- w = \$1,353, β_h = \$193,529, and β_r =2.84. The main problem of the Subperiod 1 results is that the sign of β_r is positive (opposite of what it should be). The cause of the problems is that rental

rates have risen as the utilization level of the occupied office space has been increasing gradually during this subperiod. Intuitively, the rising utilization level acted as though vacancy rates were declining, which, quite rationally, allowed the rental rates to increase. Because of the high collinearity between the EL_t and EMP_t variables (the correlation coefficient is approximately 66 percent), the EL_t*EMP_t variable becomes almost perfectly correlated (the correlation coefficient is in excess of 98 percent) with the EMP_t variable. Thus, the estimated coefficients for EMP_{t-1} and OS_{t-1} have become statistically insignificant.

For Subperiod 2, the statistical fit of the model improved moderately and all the estimated coefficients appear reasonable: w = \$29,495, β_h = \$86,286, and β_r = -39.2 percent. The estimated value of w is significantly higher than the expected value of \$21,000. This may be a result of a combination of the negative constant and the negative impact of the rental costs variable. The estimated value of β_r confirms the hypothesis that the expected rental costs have a negative effect on the absorption level. Furthermore, the current employment level is barely significant at the five percent level and the lagged occupied stock variable is insignificantly different from zero at the five percent level. These results suggest, as hypothesized, that the gap between OS_t and $w*EMP_t$ may not be significant during this subperiod such that the flow model specified in Equation (10) may produce a more efficient estimation.

The resulting estimation of regressing Equation (10) for Subperiod 2 is shown in Table 7.

Table 7

Regression Results of Equation (10)

Dependent Variable: Absorption

Variables	Subperiod 2 1971-1990
Constant	-3,626 (-2.02)
ΔEMP_t	43.39 (4.03)
$EL_t \, \Delta EMP_t$	-1.57 (-2.49)
ΔOS_{t-1}	0.332 (2.70)
No of Observ.	20
Corrected R^2	.754
DW	2.50

Source: Author

The above estimation implies that $\alpha = 0.668$, $w = \$64,955$, and $\beta_r = -2.35$. The estimated adjustment rate, α, is almost as high as that of Equation (9). However, the estimated w is about three times the expected value presumably due to the negative effect of the additional expected rental costs variable and the constant. Specifically, the impact of the average value of the rental costs (-2.35*6,225=-14,630) offsets about 90 percent of the average excess portion of the estimated w (44*459=20,196) plus the constant (-3,626).

Since the estimation results of Equation (10) show a relatively better fit over those

of Equation (9), Equation (11) is empirically tested to determine whether the estimated adjustment rate α can be safely assumed to be constant at around 0.668. The result of Equation (11) for Subperiod 2 is:

$$\Delta OS_t = -4,499 + 27.87\ \Delta EMP_t + 32.91\ \Delta EMP_{t-1} - 1.09\ EL_t(EMP_t - EMP_{t-2})$$
$$(-3.32)\quad (5.05)\qquad\qquad (6.25)\qquad\qquad (-4.62)$$

Corrected R^2 = .863   DW = 2.36

Not surprisingly, only two years of employment growth variable needed to be specified, which validates the supposition that the number of office employment and the amount of occupied space are highly complementary. The fact that the estimation of both w_g's are reasonably close to each other suggests that the adjustment rate is not distributed geometrically; rather it is distributed almost equally over a two-year period. Again, the estimated w_g's are almost three times as high as the expected value. Given that the absorption level is almost twice as volatile as the employment growth level, the user firms appear to exhibit some speculative behavior in which additional space is acquired during a period of high employment growth. Clearly, the active rental market with a sufficient amount of vacant space allows the firms to acquire space with greater flexibility; however, the mid- and long-term nature of lease agreements influences the firms to behave based on their expectations. Just as importantly, Equation (11) allows the current estimated rental costs to affect the absorption rate completely within a single period rather than forcing α to spread its effect over time. These changes in the formulation resulted in an improved statistical fit of Equation (11) over Equation (10).

Interestingly, similar coefficients for w_g's suggest that a sum of the two employment growth variables, rather than a separate specification, can be used to get essentially the same results as above. The regression result of this is:

$$\Delta OS_t = -4,576 + 30.52 \ (EMP_t - EMP_{t-2}) - 1.09 \ EL_t(EMP_t - EMP_{t-2})$$
$$ (-3.44) \quad (7.75) (-4.72)$$

Corrected R^2 = .87   DW = 2.37

The above equation suggests that the impact on the absorption rates by variations in the employment is substantially greater than by those of rental rates. At the average employment growth level in Subperiod 2, a single standard deviation rise in the rental rate ($1.78 per square foot) reduces the absorption level by about 18.5 percent of its mean and 36 percent of its standard deviation. On the other hand, at the average expected rental rate, one standard deviation rise in the employment growth increases the absorption level by about 57 percent and 114 percent of its mean and standard deviation, respectively. These findings suggest that the demand for office space is not likely to be affected significantly by changes in the rental rates only.

4.5   Concluding Remarks

The most important contribution of this chapter is an explicit analysis of the owner-occupants and the lessees who demand office space, and demonstration that the provision of rental space over the last 20 years has altered the demand for office space structurally. In analyzing the demand for office space over the last 40

years, several phenomena emerge.

First, office employment growth is indeed a direct determinant of office absorption. During the full-sample period, the absorption level moved in proportion to the employment growth level, holding all else constant. From the government policy point of view, the demand for office space can be fostered primarily through increased employment in the FIRE and Services firms, which use the office space the most. In fact, in equilibrium, the relationship between office employment and the desired office stock is so close that one can expect approximately $21,000 (in 1982 dollar) in office investment per office employee in the 1990s.

Second, in the absence of active rental market, the desired amount of occupied space is jointly determined by the current office employment growth, which is estimated at around $85,400 per employee, and the level of office employment, which appears to be relatively constant at around $26,800 per employee. The actual absorption level is determined by an adjustment to reach the desired amount of occupied space at a rate around 12.3 percent. This equation was able to explain about 87 percent of variations in the level of absorption between 1951 and 1970. Since the office buildings' long life cycle does not match the unstable office employment behavior coupled with very high adjustment costs, the user firms appear to desire more than a necessary amount of space to act as a buffer in anticipation of a future rise in office demand. With such a low adjustment rate, a significant gap between the actual and the desired occupied space can occur, thereby posing a serious problem. For example, in the late-1940s and early-1950s,

the levels of absorption were negative even though the office employment growth rates were positive. This can only be explained by unusually low office utilization levels during this period. That is, firms already owned a significant amount of under-utilized office space that they did not have to acquire additional office space to accommodate the new office employees.

Third, the active rental market allowed the user firms to reach and maintain their optimal occupied space far more effectively. This was possible by shifting the risk of disequilibrium from the user firms to the lessors. Therefore, the level of absorption can be estimated by the changes in office employment and changes in expected rental costs over the past two years. In fact the statistical fit of the equation is remarkably good as evidenced by a corrected R^2 at 87 percent. A side-effect of the active rental market, beside the obvious vacancy cycles, is that the absorption rates have continued to be volatile as firms speculate on expected demand and rental rates. Presumably, firms respond to lower (higher) rental rates by absorbing more (less) space than necessary. Similarly, the firms tend to absorb more (less) office space per employee during a period of high (low) employment growth.

Chapter 5

The Supply of Office Space

5.1   Introduction

Since the office market is assumed to be composed of a series of investments made by owner-occupant firms primarily for their own uses and by lessors for the rental market, the model presented in this chapter includes two independent sets of incentives that are assumed to determine office investment behavior. The owner-occupant firms are assumed to behave appropriately to meet their own demand for office space, subject to their wealth limitations. Therefore, similar to the demand equation, a flexible accelerator model is used to estimate the owner-occupant firms' investments.

The lessor firms, on the other hand, are assumed to have incomplete and/or imperfect information (or, more specifically, have only past information on the lessees' demand function and on the rental market) and thus tend to behave slowly or overreact to publicly available information. Therefore, the rental office investment model is a variation of the traditional cobweb model. In estimating the price of office space, neo-classical approach is used to calculate the user-cost-of-capital (i.e., equilibrium capitalization rate) along with absorption and vacancy rates and net operating income. The main differences in calculating the

equilibrium capitalization rate for the office buildings as oppose to traditional approaches are that office buildings are purchased with highly leveraged mortgages and with expected holding period which is substantially shorter than the expected life of the buildings. A number of researchers (for example, Gordon, Hines, and Summers [1986], Hendershott and Ling [1984A and 1984B], Fisher, Lentz, and Stern [1984], and Fisher and Lentz [1986]) have studied the incentives to leverage and to trade. However, these studies focus only on the long-run effects based on simulations.

In empirically testing the model, the net (rather than) gross investment series is used. The basis for using the net investment rather than the gross investment figures is that, over the last 40 years, the ratio of replacement investment to the past year's gross stock has not been even remotely stable as the traditional theories on replacement assume. As mentioned in Chapter 2, the ratio of replacement investment to gross investment ranged from nearly 100 percent in the late-1940s and early-1950s to 11 percent in the mid-1980s. Such a dramatic decline in the replacement rate is explained by a gradual but consistent decline in the average age of office stock over time. Realistically, the timing of and the level of replacement investment depends on various economic factors, such as the building age profile, the costs of funds, land, and construction, and the expected market conditions. Notwithstanding the limitations of the BEA's data on replacement investment, it is far better to use these data than to assume a constant fraction of the past year's stock.

5.2   The Theory

5.2.1   The Owner-Occupant Investment Equation

The investment model for owner-occupant office space follows a variation of the
flexible accelerator model described in Chapter 4. Since the owner-occupant firms
are assumed to behave rationally, and since office employment is the key
determinant of the demand for office space, the optimal amount of stock, denoted
S_t^*, is:

$$S_t^* = xEMP_t \qquad . \qquad (16)$$

where x, similar to w in the demand model, is a fixed office stock to employment
ratio for all t. Based on the empirical findings in Chapter 4, x is likely to be
around \$38,000.

Including a constant stock adjustment rate, denoted ϕ, for all t, the investment
amount, denoted I_t is simply the difference between the optimal stock in period t
and the actual stock in period t-1, which is expressed as:

$$I_t = \phi xEMP_t - \phi S_{t-1} + u_t \qquad . \qquad (17)$$

The stock adjustment rate, ϕ, is likely to be around 9 percent for Subperiod 1

based on the empirical findings in Chapter 4.

5.2.2 The Rental Office Investment Equation

The investment model for the rental market is a variation of the traditional cobweb model. The impetus to apply the cobweb model comes from the cyclical nature of the rental market volatility as evidenced by the vacancy rate cycles. The traditional cobweb model explains that the cyclical fluctuations of prices and quantities in opposite directions are caused by inconsistencies resulting from the current period's price determining demand and a past period's price determining supply. In other words, rental office space is limited to a past level of absorption and market price. If the demand function is assumed to be relatively inelastic compared to the supply function, ever-widening divergences from equilibrium are expected as evidenced by the increasing amplitude of the vacancy cycles over time. No empirical evidence of inelastic demand curve and elastic supply curve exists for the office market; however, studies on rental housing (e.g., DiPasquale and Wheaton [1992B], and Hanushek and Quigley [1980]) suggest that demand-rent elasticity is around -0.4 and -0.6 and that supply-rent elasticity is around 6.8. Since the office and residential rental markets are assumed to exhibit relatively similar behavior, one may conclude that these elasticities are a reasonable approximation for the office market as well.

The office price is assumed to be the key determinant of the rental office investment level for the same reasons as the underlying theory of Tobin's q model,

Feldstein's [1982] reduced form equation, and the traditional rent-gradient models (e.g., Wheaton [1982]) -- investment is made on the basis of the level of profits or expected profits. Presumably, the expected profitability is reflected in the market price of the office stock. One can reasonably assume that the cost of construction has been relatively stable in real dollars since the correlation coefficient between the annual CPI change and construction cost change, based on R. S. Means data, is about 80 percent over the last 44 years. Also as shown in Figure 1 in Chapter 2, the GDP and non-residential structures implicit price deflators have been very close to each other. Therefore, the construction cost index, as a proxy for the replacement cost, need not be specified.

One can postulate that office investment occurs as follows. Given a market price for office space, the maximum price at which land can be purchased in the competitive market can be determined by simply subtracting the relatively stable construction costs. If the market price of land is lower than the maximum price that the firm can afford to pay, then the firm can arbitrage the price differential of the land prior to and after the development simply by constructing the office building. Alternatively stated, as the office price rises, undeveloped land in the urban edge or under-developed land within the urban boundary can be converted into new office use as the increased price of office space justifies paying a higher land price demanded by the land owner. Presumably, unless the office market price rises beyond the land price demanded by the land owner plus the cost of construction, the investment will not occur; hence the land would continue to be used for alternative purposes or left vacant.

Real expected market price index of office space during period t is denoted as P_t, and the optimal investment level, I^*_t, is assumed to be proportional to a market price of the lagged stock:

$$I^*_t = a_0 + a_1 P_{t-g} S_{t-g-1} \tag{18}$$

where g represents the time lags. Due to the extremely long gestation period in developing an office building, considerable lags are expected in the investment behavior. Often, lags last years in the real estate industry. The actual investment level for the rental space is:

$$I_t = \phi I^*_t + (1-\phi) I_{t-1} \tag{19}$$

Inserting Equation (19) into Equation (18) yields:

$$I_t = \phi(a_0 + a_1 P_{t-g} S_{t-g-1}) + (1-\phi) I_{t-1} + u_t \tag{20}$$

If there were a reasonably accurate time-series on office price level, empirically testing the model would be relatively easy. However, since no such data exist, this thesis develops an alternative method to estimate the expected market price series.

The expected market price is assumed to be composed of three parts. The first

component is expected equilibrium price, denoted q_t, which is calculated under the steady state assumption. In addition to q_t, just as Wheaton and Torto [1993] pointed out in their rental rate adjustment model, P_t differs from q_t, because expected absorption, denoted j_t, and vacancy, denoted v_t, rates are assumed to disturb the market price away from the equilibrium price:

$$P_t = P(q_t, j_t, v_t) \tag{21}$$

Holding q_t and v_t constant, if j_t were to increase, then P_t will rise as the supply of office space cannot adjust quickly enough to bring the market into equilibrium. In other words, firms are likely to anticipate a higher rental rate in the near future until the new investments are triggered by the higher price. Conversely, if j_t were to decrease, then P_t would drop as the demand price, the price that firms are willing to pay, drops since the competition for the available office space is expected to drops. This causes the firms to anticipate a lower rental rate in the near future. Similarly, a higher (lower) v_t, causes lessors to accept a lower (higher) rental rate in order to bring the vacancy rate down (up) to the desired level.

Further assuming that P_t is a linear function of j_t, v_t, and q_t, the net investment can be estimated as:

$$I_t = \phi(a_0 + a_j j_{t-g} + a_v v_{t-g} + a_q q_{t-g}) S_{t-g-1} + (1-\phi) I_{t-1} + u_t \tag{22}$$

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All the variables in Equation (22) except q_t have been discussed already in Chapters 2 and 4 and the following section describes the estimation strategies for q_t.

5.3 Estimation Strategies for Equilibrium Price Index

The market price of office buildings is typically analyzed as the observed net operating income divided by the observed market capitalization rate. The observed net operating income incorporates the direct effects of variations in rental rates, vacancy rates, and operating expenses over time. The series on the net operating income, which was converted to constant 1982 dollars, come from BOMA's annual report on office buildings. This report appears to provide reasonable time-series data except during the early-1980s, when the real operating expenses dropped considerably from about $7.80 to $6.80. In nominal dollars, the net operating income jumped by nearly 60 percent just between 1980 and 1981 as shown in Figure 19. Three possible explanations for such a jump are: 1) the rising vacancy rates in the first half of the 1980s reduced the operating expenses; 2) the operating expenses were insensitive to the high rates of inflation in the early-1980s; and 3) a prevalent inclusion of the operating expenses pass-thru provision shifted the burden of the nominal increases in the operating expenses away from lessors to lessees.

Notwithstanding these explanations, the questionable nature of the operating expenses time-series warrants testing the rental income time-series in lieu of the

Nominal NOI vs CPI
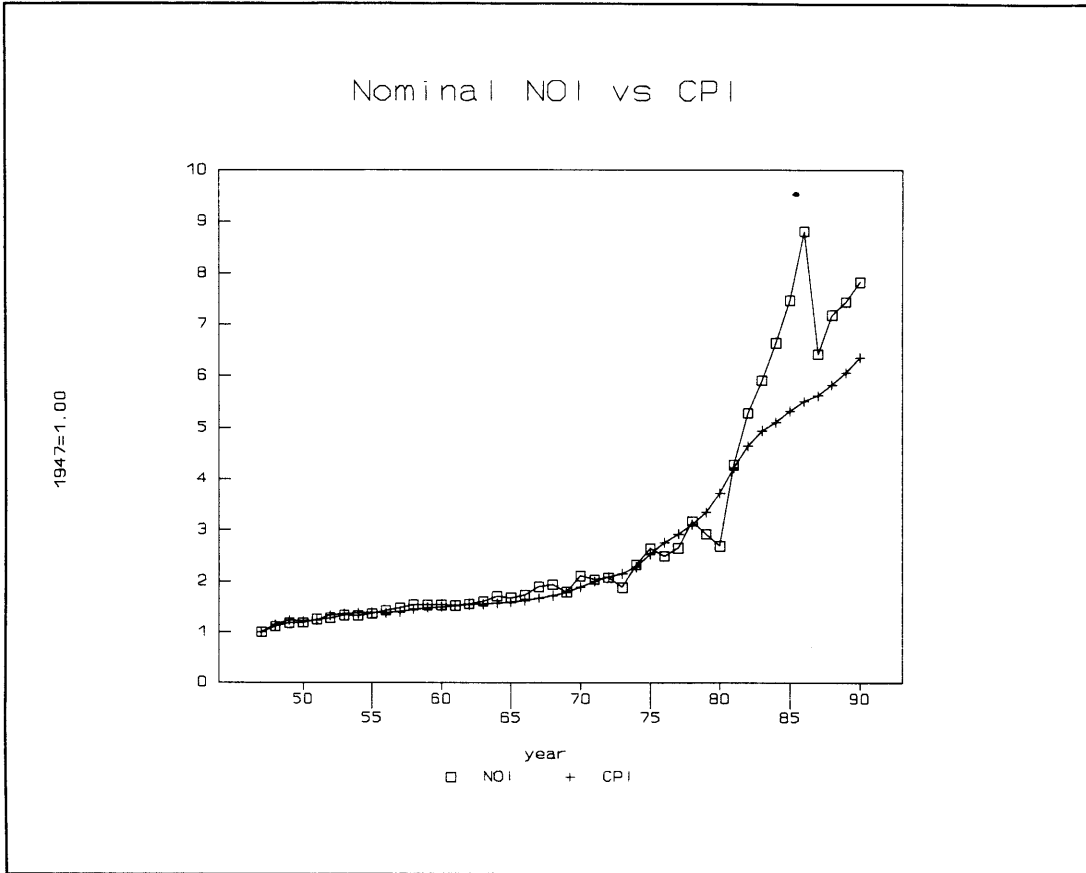
Figure 19

net operating income time-series. Under the traditional assumption, the net operating income is a constant fraction of the rental income. Therefore, these two approaches are examined to arrive at the equilibrium price index.

While some data on the observed net operating income are available, the observed market capitalization rate time-series is difficult to obtain. The American Council of Life Insurance Companies (ACLI) is the only source of the capitalization rate time-series. However, it calculates the series based on artificial net operating income data, which assumes that a building is operating under full (usually 95 percent) occupancy. Due to the lack of reliable data on the market capitalization

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rate, the equilibrium capitalization rate is calculated based on the neo-classical model to estimate the equilibrium price.

The equilibrium capitalization rate is derived from the neo-classical model with necessary modifications to adapt to the peculiarities of the office market. The model begins with a very simple analysis, which assumes restrictive conditions, and is developed into a more general one.

Net operating income, denoted C, is defined as gross rent less operating expenses. Hall and Jorgenson's [1967] user-cost-of-capital model suggests that the price of a building can be estimated as a present value of future cash flows. In equilibrium, the price, q (for simplicity of expression, the subscript will be deleted), is:

$$q = \int_0^\infty C e^{(\pi - \delta)t} e^{-r't} dt \qquad (23)$$

where $r'=$ risk-adjusted nominal discount rate (before-tax),

π = constant expected inflation rate, and

δ = constant expected economic depreciation rate.

Equation (23), under the steady state assumption, states that the net operating income, C, increases by a constant inflation rate and decreases by a constant economic depreciation rate. Practically, firms may formulate the expected rise or fall in the net operating income by analyzing past movement of the net operating

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income series (i.e., a distributed lag formulation). However, as shown in Figure 19, in the early-1980s, the nominal net operating income rose tremendously rendering q to become negative, which is, in practice, impossible. In reality and based on rental rate adjustment theories, the net operating income is also influenced by the expected market conditions (i.e., difference between actual and optimal vacancy rates in period t). During a period when a significant amount of excess vacancy exists, the net operating income is expected to fall or rise only moderately. In contrast, a period of under-supply will experience a rapidly rising net operating income. As pointed out earlier in Equation (21), the absorption and vacancy rates are assume to capture the variations in the real expected net operating income.

To estimate the expected inflation rate, the inflation rate series is measured in terms of the CPI (consumer price index). The CPI is assumed to be a good indicator of nominal wage rates, and prices of goods and services produced by firms. There are numerous studies (e.g., Feldstein and Summers [1977]) that predict the long-term inflation rate based on a distributed-lag regression and a rolling series of ARIMA (autoregressive integrated moving average) regressions. Since the expected inflation rate is unobservable, it is difficult to verify these models. In this thesis, a simpler approach is taken by assuming that typical firms calculate heuristically the expected inflation rate. The expected inflation rate is estimated by taking a simple average of the past four years' inflation rates.

This model assumes a constant depreciation rate over the life of the building. The depreciation rate consists of two components: an operating inferiority due to

technological advancement incorporated into newer buildings, and a deterioration due to normal "wear and tear." As stated earlier, in the short run, the supply of office space in a given market is assumed to be fixed. However, in the long run, the supply is adjusted by new construction, renovation, and deterioration and demolition of existing buildings. The critical point is that there exists a range of market rental rates, instead of a single market rental rate, commensurate with the different levels of qualities of buildings within the stock of buildings. For instance, it is assumed that a brand new building will command the highest market rental rate. Over time, the building will be marketed at a progressively lower rate because yet newer buildings, constructed with an operating-superiority, can command a higher rate, and because of gradual deterioration in the building.

The deterioration rate is influenced by the level of utilization and maintenance expenditures, which are themselves economic decisions in response to actual and expected market conditions. At a certain point in time, when the age of the building is sufficiently high, the building will have either a zero value or be demolished because it is generating no profit to its owner. Thus, more generally, the competition provided by the subsequent construction rate and the building's own deterioration rate directly affect the rate at which an existing office building depreciates.

Two empirical studies have attempted to estimate the rate of depreciation: Taubman and Rasche [1969] estimated the economic life of office buildings to be around 70 years with a geometrically increasing depreciation rate. In contrast,

Hulten and Wykoff [1981] estimated an average geometrically decreasing depreciation rate of 2.47 percent. In this thesis, consistent with most of the recent investment studies, Hulten and Wykoff's estimate is used as an approximation.

Solving Equation (23) for q gives:

$$q = \frac{C}{(r'-\pi+\delta)} \qquad (24)$$

The equilibrium capitalization rate, denoted R and defined as net operating income over the equilibrium price, is:

$$R \equiv \frac{C}{q} = r'-\pi+\delta \qquad (25)$$

Equation (25) shows that R is a positive function of the real discount rate and the depreciation rate. A rise in the real discount rate reduces the present value of future rental income, thus for an investor to earn a competitive social rate of return, either C has to increase or q has to decrease, holding all else constant. Similarly, as the depreciation rate increases, the expected life of a building becomes shorter, therefore holding C constant, q has to decrease, or holding q constant, C has to increase to maintain the market equilibrium.

The implicit assumptions made in the above equations are:

1. Firms do not pay taxes;

2. The cost of debt and equity is the same;

3. A building is held until its use expires and has no salvage value when its use expires.

These assumptions are relaxed below to build a general model, which is relevant to the office market.

5.3.1 The Effect of Taxes

The first assumption is relaxed to account for taxes and depreciation allowances, which yields Equation (23) to be expressed as:

$$q = \int_0^\infty (1-u)Ce^{(\pi-\delta)t}e^{-rt}dt + uq\int_0^T D_t e^{-r_f t}dt \qquad (26)$$

where u = marginal ordinary tax rate,

$\quad r$ = risk-adjusted nominal after-tax discount rate,

$\quad r_f$ = risk-free nominal after-tax discount rate,

$\quad T$ = depreciation period, and

$\quad D_t$ = depreciation allowances in time t.

The marginal ordinary tax rate is assumed to be the corporate tax rate applicable at the time the investment decision is made. Similarly, the depreciation period and the method of depreciation are based on the prevailing tax codes. The tax

codes, including the tax rate, are assumed to be constant throughout the investment horizon. Even though firms' investment behavior may change in anticipation of future tax policy changes, the actual outcome of political debates is assumed to be unpredictable enough to warrant the usage of existing tax codes.

The appropriate risk-adjusted nominal after-tax discount rate to apply will be discussed in the next section. In Equation (26), since the cost of debt and equity is assumed to be the same, one can use the prevailing after-tax interest rate.

The discount rate corresponding to the depreciation allowances is the same rate applied to the after-tax, risk-free rate since depreciation tax shields represent virtually riskless cashflows. The only risk, a possibility that a firm will become nontaxable, is very low for large firms. Hence, as pointed out by Summers [1986], a theoretically correct real discount rate is nearly zero instead of three to four percent assumed in most economic and finance literature.

The present value of depreciation allowances or capital consumption allowances, denoted z, is:

$$z = \int_0^T D_f e^{-r_f t} dt \tag{27}$$

Prior to 1954 and after 1981, a straight-line depreciation method was typically applied to office buildings. With the straight-line depreciation method, Equation (27) can be solved as:

$$z = \frac{(1 - e^{-r_f T})}{r_f T}$$ (28)

Between 1954 and 1981, a sum of the years' digits depreciation method was allowed to accelerate the depreciation schedule. With the sum of the years' digits method, the present value of depreciation allowance is:

$$z = \int_0^T \frac{2(T-t)}{T^2} e^{-r_f t} dt = \frac{2}{r_f T} [1 - \frac{1 - e^{-r_f T}}{r_f T}]$$ (29)

Adding the effect of taxes, Equation (25) can be restated to calculate the capitalization rate as:

$$R = \frac{(r - \pi + \delta)(1 - uz)}{(1 - u)}$$ (30)

Equation (30) introduces two additional variables, namely z and u, that affect R. The present value of depreciation allowances is, in turn, affected by two variables: T and r_f. Holding all else constant, a shorter depreciation period (i.e., a lower T), raises the present value of the depreciation allowances, z, thereby the equilibrium capitalization must be lower. This explains the motive behind tax-induced investment incentives (by lowering the user-cost-of-capital) such as accelerated depreciation methods. A lower steady-state inflation rate also lowers r_f, which

translates into a higher z, and the ultimate impact is that the equilibrium

capitalization becomes lower. Therefore, one can conclude, based on Equation (30),

that either a shorter (longer) depreciation period or a lower (higher) inflation rate

decreases (increases) the equilibrium capitalization rate, holding all else constant.

The effect of the marginal ordinary tax rate, u, is a little more complicated. A

higher u increases the after-tax present value of depreciation allowances, uz, which

reduces R; however, since $(1-u)$ is the denominator in Equation (30), a higher u

also increases R. In almost all reasonable situations, the present value of

depreciation allowances is less than one, therefore, a higher (lower) ordinary tax

rate increases (decreases) the equilibrium capitalization rate, holding all else

constant.

To show the impact of differences in T, π, and u, on the equilibrium capitalization

rate, consider the following calculations. Assuming a base case in which $r = 9.4$

percent, $r_f = 5.7$ percent, $u = 34$ percent, $\delta = 2.47$ percent, $T = 31.5$ years, and $\pi =$

4.5 percent, then the calculated uz (i.e., the after-tax present value of depreciation

allowances) is 15.79 percent and R is 9.4 percent. If T drops from 31.5 years to 15

years, then uz rises to 22.85 percent and R drops to 8.61 percent. Suppose π

increases from 4.5 percent to 10 percent and, accordingly, r_f and r rise to 11.2

percent and 14.9 percent, respectively. Then uz drops to 9.35 percent and R rises

to 10.12 percent. Lastly, if u were to increase to 50 percent from 34 percent, which

would lead to r_f at 6.1 percent and r at 11 percent, then uz and R would increase to

22.2 percent and 13.96 percent, respectively.

Based on above analysis, many macroeconomists have argued that high inflation rates discourage capital investment and tax legislations such as the ERTA of 1981, which reduced the statutory tax rates and accelerated depreciation schedules, encourage capital investment. However, when analyzing office user-cost-of-capital, other factors, discussed in the next two sections, must be considered.

5.3.2 The Effect of Debt Financing

The second assumption can be relaxed to consider the difference in the cost of debt and equity used to finance the acquisition. Debt financing is probably the most crucial component of the office investment decision. First of all, a typical loan-to-value ratio of office mortgages is substantially higher than that of debt available to purchase other non-residential assets. Data from ACLI show that the average loan-to-value ratio of office building mortgages over the last 25 years has been about 72 percent, which is almost twice as high as the average debt-value ratio for all industries found in Fullerton and Gordon [1983]. Second, interest on debt is tax deductible; therefore, the incentive to maximize debt, as long as the weighted average cost of funds is lower, is significant. Third, typical mortgages are amortizing loans, thereby allowing such high loan-to-value ratios, that an estimation of the cost of funds is more involved than that of interest-only loans.

Consider a level-payment mortgage with a loan amount equalling θq, a maturity date of M, and a fixed interest rate of i. The payment P is expressed as:

$$P = \theta q [i/(1 - e^{-iM})] \qquad\qquad (31)$$

To account for the debt incurred, the Equation (28) is modified as:

$$(1-\theta)q = \frac{(1-u)C}{(r-\pi+\delta)} + uzq - (1-u)P\int_0^M e^{-rt}dt - uP\int_0^M e^{-i(M-t)}e^{-rt}dt \qquad (32)$$

Since the third term of RHS of Equation (32) is the present value of principal and interest, the fourth term, the present value of principal, is deducted to arrive at interest portions of the payment, which is tax deductible.

Equation (32) can be solved to calculate the capitalization rate, which is now:

$$R = \frac{(r-\pi+\delta)(1-uz-\lambda\theta)}{(1-u)} \qquad\qquad (33)$$

where $\lambda = (1-\lambda')$ and

$$\lambda' = \frac{(1-u)i(1-e^{-rM})}{r(1-e^{-iM})} + \frac{uie^{-iM}(e^{(i-r)M}-1)}{(i-r)(1-e^{-iM})} \qquad (34)$$

Equation (34) implies that if $r=(1-u)i$, then $\lambda'=1$ and $\lambda=0$; thus financing does not matter and the capitalization rate reduces to Equation (30). However, as long as

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r>(1-u)i, debt financing affects the capitalization rate. Modigliani and Miller [1958] argued that the cost of equity and debt is the same if one ignores the cost of bankruptcy and taxation. However, in reality, issuing more debt increases the riskiness of both the debt and equity of the issuing firms such that firms limit the use of debt financing. For example, the debt ratio of nonfinancial firms has been traditionally about one-third. The main reasons that office buildings are typically financed with such high debt ratio are: 1) typical mortgages are an amortizing debt so that the principal amount is gradually paid off; and 2) as Myers [1977] argues, lenders can take advantage of the relatively active secondary market in office buildings in the event that a borrower defaults on the mortgage.

Portfolio theories show that equity is riskier than debt and that, in equilibrium, the cost of equity is higher than that of debt. It is assumed that the risk-adjusted nominal after-tax cost of capital must exceed the nominal after-tax cost of debt by a constant risk premium, denoted ρ, as:

$$r=(1-u)i+\rho \tag{35}$$

To calculate the risk premium requires rather complicated measurements of a proportion of the equity yield that is paid out as dividends, which is taxable at individual tax rates, and the rest retained, which is subject to the capital gains tax rate in the future. The retained earnings due to inflation are also subject to the capital gains tax rate. Since estimating the risk premium is beyond the scope of this thesis, an assumption of seven percent is made.

Beside the financial risk arising from a high loan-to-value ratio, two major peculiarities of office buildings justify the relatively high risk premium. First, office buildings are characterized by their lumpiness or indivisibility. When a firm needs to dispose of or to acquire a property to relocate, expand, or contract, it is typically faced with an all-or-nothing decision. Even if the firm wants to purchase or sell only part of a building, often it has no choice but to purchase or sell the entire building because of its indivisibility. Similarly, even if a lessee wants to lease adjoining space or sublease out a part of existing leased space, it may have to wait until the existing lease expires. This creates an inefficiency in the office market since the indivisibility acts as a market barrier against: (1) smaller firms that cannot enter into large transactions to purchase an entire building due to financial constraints; and (2) firms with adequate financial capacity that do not desire to take on greater risk from over-investing in office buildings. In other words, budget constraints are important considerations in the real estate asset investment decision-making. In the residential market, condominiums have become a major part of the urban areas to overcome the indivisibility limitations. However, in the office market, office condominiums have never been a significant part of the urban office supply.

Second, the heterogeneous nature of real estate assets and incomplete information about assets are also major causes of the inefficiency in the real estate market. Not only do the individual assets differ physically but markets are affected by the local economy and participants in the market have varying objectives and expectations. Clearly, the heterogeneity implies that information or expertise

about the market is extremely important. However, decentralized trading with a series of pairwise negotiations to determine the market prices suggests that the participants must make decisions based on incomplete knowledge of the market. Only the firms that have accurate information or expertise will have a comparative advantage and be more likely to realize the expected return on their investments. These inefficiencies serve as a market barrier that discourages potential firms from entering the market, since they must incur additional information costs as a part of the transactions costs and/or some premium to account for the uncertainty of the information in the form of higher discount rates.

The above features account for the high degree of risk in office building investments. The risk is generated primarily by the wide distribution of the outcome of the future value of the property. The other factors, the expected inflation rates, tax rates, and real interest rates present a certain degree of uncertainty. However, the magnitude of risk created by these factors is substantially included in the long-term interest rate.

The series on interest rate is obtained from Moody's high-grade long-term corporate bond yield. The loan-to-value ratio is assumed to be 72 percent and the mortgage term is held at 25 years based on the ACLI data. Based on Equations (38) and (39), the value of λ, which is invariant of θ, averaged around 65 percent over the last 40 years. Combining the assumed parameter of θ at 72 percent, a reduction in the equilibrium capitalization rate due to borrowing is quite considerable.

To show the impact of differences in the loan-to-value ratios on the equilibrium capitalization rate, consider the following calculation based on 1990's estimated parameters. Assuming that i = 9.4 percent, r = 13.2 percent, u = 34 percent, M = 25 years, δ = 2.47 percent, T = 31.5 years, and π = 4.48 percent, then the calculated λ is 44.54 percent. If θ were to drop from 72 percent to 33 percent, then R increases from 8.86 percent to 11.8 percent. The above analysis suggests that high leverageability of office buildings allows debt financing to reduce the user-cost-of-capital significantly.

5.3.3   The Effect of Trading

The third assumption can be relaxed to account for the incentives to trade properties. Trading is another important activity in the real estate market since many of the firms optimize the investment holding period for three reasons. As long as inflation rates are higher than depreciation rates, (1) additional depreciation allowances are obtained; (2) accrued capital gains are realized; and (3) additional debt can be assumed. Unlike equipment, office buildings can be depreciated over and over as long as trading occurs. The consequence of sub-optimal trading to the initial wealth is substantial. By trading too late, the firm forgoes the additional depreciation allowances available and postpones the realization of accrued capital gains from trading. Alternatively, by trading too early, the firm incurs additional transactions costs from frequent trading, which in turn lowers the investment rate of return. If the transactions costs were minimal,

far more frequent trading activities are expected to occur.

Hendershott and Ling [1984A] developed a dynamic programming model in which the optimal trading time is estimated. During the ERTA tax period, assuming low inflation rates (six percent or lower), they determined the optimal holding period to be 15 years. Assuming high inflation rates (higher than six percent), the optimal holding period was the useful life of the building, which was assumed to be 70 years.

Hendershott and Ling's calculated holding period seems to be over-estimated for the high inflation rates scenario because their model did not account for the third incentive to trade which is to achieve the optimal loan-to-value ratio. An amortizing loan, and the rising nominal market value of the building result in lower loan-to-value ratio over time. The main effect of increasing equity is a reduced rate of return on equity. Insofar as the costs of refinancing or obtaining additional funds to maintain the optimal loan-to-value ratio are lower than the costs of trading the property, it may appear that the incentive does not exist. However, if the firm desires to maintain an optimal leverage ratio, the declining book value relative to the rising market value inhibits acquisition of additional financing or refinancing. The incentive to maintain an optimal leverage ratio is to balance the tax incentive to use debt finance against the associated real costs such as bankruptcy costs, monitoring costs, and agency costs. The most effective method of re-establishing the optimal loan-to-value at the property level and the leverage ratio at the firm level seems to be trading.

Suppose n is the expected holding period, u_c is the capital gains tax rate, the market value of the building q increases by π and decreases by δ, and the transactions cost of trading is 5 percent of the market value. The expected value of the building in period n is:

$$q_n = (0.95) q_0 e^{(\pi - \delta)n} \tag{36}$$

Then the after-tax present value of the depreciation allowances and the recapture of excess depreciation, denoted Δ, is:

$$\Delta = u \int_0^n D_t e^{-r_f t} dt - u_c [q_n - (1 - \int_0^n D_t dt)] e^{-rn} \tag{37}$$

The first term is the depreciation allowances until the building is traded and the second term is the capital gains tax on the difference between the market value and the book value. Assuming a straight line depreciation and that the holding period n is less than the depreciation period T, Equation (37) can be solved as:

$$\Delta = \frac{u(1 - e^{-r_f n})}{r_f T} - u_c [(.95) e^{(\pi - \delta)n} - (1 - n/T)] e^{-rn} \tag{38}$$

If the holding period were greater than the depreciation period, then Equation (37) is:

$$\Delta = \frac{u(1-e^{-r_fT})}{r_fT} - (.95)u_c e^{(\pi-\delta-r)n} = uz - (.95)u_c k \tag{39}$$

where $k = e^{(\pi-\delta-r)n}$.

Given the holding period n, without the debt financing, the user cost of capital for a single transaction is:

$$q = \int_0^n (1-u)Ce^{(\pi-\delta-r)t}dt + \Delta q + kq \tag{40}$$

and solving for the equilibrium capitalization rate R gives:

$$R = \frac{(1-\Delta-k)(r-\pi+\delta)}{(1-u)(1-k)} \tag{41}$$

Just as the holding period n that is less than the depreciation period T affects the present value of depreciation allowances, the debt financing incentive λ needs to be modified to reflect n number of payments and a loan balance at the end of n periods if the mortgage maturity date M were greater than the holding period n. Including the debt financing into Equation (40) gives:

$$(1-\theta)q=\int_0^n (1-u)Ce^{(\pi-\delta-r)t}dt+\Delta q+q_n e^{-rn}-\lambda_n'-a_n\theta q \qquad \textbf{(42)}$$

The term $\lambda_n{}'$ in Equation (42) represents the interest portion of the present value of the n payments, which is:

$$\lambda_n'=(1-u)P\int_0^n e^{-rt}dt-uP\int_0^n e^{-i(M-t)-rt}dt \qquad \textbf{(43)}$$

And solving Equation (43) yields:

$$\lambda_n'=\frac{(1-u)i(1-e^{-rn})}{r(1-e^{-iM})}+\frac{uie^{-iM}(e^{(i-r)n}-1)}{(i-r)(1-e^{-iM})} \qquad \textbf{(44)}$$

The term a_n in Equation (42) is the ratio between the present value of the loan balance and the initial loan amount, which is:

$$a_n=[1-\frac{P\int_0^n e^{-iM}e^{it}dt}{\theta q}]e^{-rn}=[1-\frac{(e^{-iM})(e^{in}-1)}{(1-e^{iM})}]e^{-rn} \qquad \textbf{(45)}$$

Solving Equation (42), the capitalization rate for a single transaction is:

$$R = \frac{[1 - \Delta - k - \theta(\lambda_n - a_n)](r - \pi + \delta)}{(1 - u)(1 - k)} \tag{46}$$

where $\lambda_n = 1 - \lambda'_n$.

Assuming constant π and δ over the life of the building and that the loan-to-value ratio θ, mortgage term M, and fixed interest rate i remain constant at every transaction, optimal trading will occur every n period. Under these assumptions, the depreciation allowances now denoted Γ and the net benefit of debt financing now denoted Λ are:

$$\Gamma = \int_0^\infty \Delta [e^{(\pi - \delta - r)}]^{nt} dt = \frac{\Delta}{(1 - k)} \tag{47}$$

and

$$\Lambda = \int_0^\infty (\lambda_n - a_n)[e^{(\pi - \delta - r)}]^{nt} dt = \frac{\lambda_n - a_n}{(1 - k)} \quad \cdot \tag{48}$$

The capitalization rate is:

$$R = \frac{(1 - \Gamma - \theta\Lambda)(r - \pi + \delta)}{(1 - u)} \tag{49}$$

Predictably, the capitalization rates in equations (50) and (53) are the same since the underlying variables are assumed to be constant over the life of the building

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including the holding period.

Clearly, the optimal holding period varies according to the depreciation schedule, interest rates, expected inflation rates, and, of course, the expected net operating income. In most cases, the optimal holding period is exactly the depreciation period. However, in practice, many investors do not appear to hold on to office buildings that long since tax rules and the office market conditions can change unexpectedly. A survey by Real Estate Research Corp. [1985] shows that most investors' expected holding period was ten years. The estimation of the capitalization rate is based on an expected holding period of 15 years, which is slightly longer than the 10 years used by Fisher, Lentz, and Stern [1984], and Fisher and Lentz [1986], and 13 years used by DiPasquale and Wheaton [1992B].

The equilibrium capitalization rate calculations are quite sensitive to the holding period assumptions. Based on the same 1990's parameter assumptions used in the previous section, in which the calculated equilibrium capitalization rate was 8.86 percent, and further assuming that the capital gains tax rate is also 34 percent, the transactions costs are 5 percent of the sale price, and the holding period is 31.5 years, the equilibrium capitalization rate, R, drops slightly to 8.80 percent from 8.86 percent. However, assuming that the holding period is set at 15 years, R increases to 9.32 percent. In contrast, assuming 1982's parameters (i.e., $T = 15$ years, $u = 46$ percent, $u_c = 28$ percent, $\pi = 10.33$ percent, $i = 13.03$ percent, $r = 14.04$ percent, $r_f = 7.06$ percent, $\delta = 2.47$ percent, and $M = 25$ years), the equilibrium capitalization rate drops by about one-half from 4.56 percent with an

infinite holding period to 2.76 with a 15-year holding period.

Table 8 shows the investment amount, rental income, net operating income, equilibrium capitalization rate, and equilibrium price between 1948 and 1990. The data necessary to estimate the equilibrium capitalization rate are in Appendix A.

Table 8

Data for Investment Estimations

Year	Invt (1982 $MM)	NOI ($/sf)	Cap. Rate (%)	Price ($/sf)	Stock (1982 $Bil)	Rental Income ($/sf)
1948	75	4.22	6.38	66.19	110.410	10.31
1949	(551)	4.15	6.38	64.99	110.485	10.04
1950	160	4.22	6.33	66.70	109.934	10.37
1951	(429)	4.41	6.31	69.93	110.094	10.90
1952	(1,162)	4.16	5.51	75.46	109.665	10.40
1953	(363)	4.25	5.15	82.67	108.503	10.59
1954	190	4.20	2.86	146.9	108.140	10.69
1955	1,219	4.29	4.95	86.57	108.330	10.98
1956	2,073	4.50	5.30	84.80	109.549	11.47
1957	2,267	4.59	5.05	90.73	111.622	11.71
1958	2,666	4.64	4.49	103.3	113.889	11.77
1959	2,725	4.50	4.72	95.38	116.555	11.61
1960	3,073	4.46	4.68	95.30	119.280	11.79
1961	3,790	4.36	5.14	84.97	122.353	11.59
1962	4,284	4.39	6.14	71.48	126.143	11.70
1963	4,177	4.50	6.14	73.20	130.427	11.89

1964	4,860	4.72	6.65	70.99	134.604	12.12
1965	5,159	4.55	6.46	70.52	139.464	11.91
1966	4,968	4.66	6.55	71.12	144.623	11.96
1967	4,888	4.94	6.41	77.10	149.591	12.50
1968	5,800	4.89	5.69	85.98	154.479	12.48
1969	6,843	4.34	5.36	81.05	160.279	12.21
1970	6,664	4.85	5.87	82.67	167.122	12.45
1971	7,731	4.43	5.25	84.31	173.786	12.18
1972	9,207	4.33	5.41	79.95	181.517	11.98
1973	10,439	3.80	5.62	67.62	190.724	12.29
1974	9,548	4.43	4.91	90.27	201.163	12.13
1975	5,828	4.52	4.00	113.0	210.711	11.85
1976	5,296	3.91	3.18	123.0	˙216.539	11.48
1977	5,218	3.93	3.00	131.2	221.835	11.54
1978	6,326	4.43	4.33	102.3	227.053	12.08
1979	9,129	3.78	4.69	80.72	233.379	11.57
1980	12,321	3.12	4.30	72.67	242.508	10.96
1981	15,399	4.40	5.07	86.80	254.829	11.29
1982	19,783	4.92	4.89	100.6	270.228	11.58
1983	17,130	5.19	5.72	90.70	290.011	11.87
1984	19,651	5.64	8.99	62.72	307.141	12.35
1985	24,323	6.09	9.41	64.70	326.792	12.89
1986	20,722	6.92	8.65	80.05	351.115	13.43
1987	17,845	4.96	8.85	55.99	371.837	11.83
1988	18,487	5.35	9.12	58.67	389.682	12.47
1989	17,467	5.32	8.49	62.72	408.169	12.69
1990	14,326	5.34	7.81	68.44	425.643	12.65

Sources: BEA, BOMA, and Author

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The investment series in the second column and stock series in the sixth column have already been discussed in Chapter 2. Since the equilibrium price series is a direct function of the net operating income and the equilibrium capitalization rate series, the movement of its underlying factors are discussed first. The net operating income was relatively stable at around $4.50 per square foot until the mid-1960s. Thereafter, it declined erratically through 1980 when it bottomed out at about $3 per square foot. It rose sharply between 1980 and 1986 reaching a peak at around $7.00 per square foot -- an average of 20 percent increase per year. In 1987, the net operating income dropped almost 25 percent in a single year. The following three years experienced a stable net operating income at around $5.30.

The equilibrium capitalization rate series indicates clearly the direct impact of variations in expected inflation and interest rates, and tax policies. For example, the capitalization rate dropped from 5.14 percent in 1953 to 2.86 percent in 1954 as a result of the accelerated depreciation allowed for the first time. In the next year, it returned near the previous level as the expected inflation rate dropped. In 1962, it jumped by one percent (almost a 20 percent increase from the 1961 level) primarily due to an extended depreciation period. Starting in 1964, rising inflation rates caused the capitalization rate to decline gradually, reaching as low as 3 percent in 1977. During the early-1980s, a combination of high inflation rates and a shortened depreciation period kept the capitalization rate very low. In the mid- and late-1980s, an unfavorable change in tax policies, low inflation rates, and high interest rates propelled the capitalization rate as high as 10.5 percent in 1988.

The equilibrium price series exhibits no cyclical movement like that of the vacancy rate series. Between 1948 and 1958, the price increased gradually from $65 to $103 per square foot, with the exception of 1954 when it jumped to almost $150 per square foot. This jump was largely a result of a drop in the capitalization rate. From the late-1950s to 1962, the price declined steadily to a low of $70 per square foot and stabilized there until 1966. Between 1967 and 1973, the price rose close to $90 and then dropped back to $67. Thereafter, it rose and dropped sharply twice, resulting in two peaks and troughs as both net operating income and the capitalization rate turned volatile. Between 1973 and 1977, the price doubled, peaking at $130, and then fell almost 40 percent by 1980. The price increased by almost $30 per square foot between 1980 and 1982 only to fall as low as $56 per square foot in 1987, and thereafter, increased slowly to almost $70 per square foot in 1990.

Finally, the rental income series in the last column shows that it increased steadily from about $10 in 1949 to about $12.50 in the late-1960s. Thereafter, it declined gradually to about $11 by 1980. As with the net operating income series, in the period between 1980 and 1986 the rental income increased dramatically to about $13.50. Since then, it dropped to about $12 in 1987 and rebounded moderately to about $12.65 by 1990. While the movement of the rental income series is similar to that of the NOI series, the former is substantially smoother. One would expect this to occur since the net operating income series is affected by variations in the operating expenses.

5.4 Estimation Results

As with the demand model, Equations (17) and (22) are empirically tested for a full
sample period between 1951 and 1990 initially assuming that no structural change
in the investment behavior has occurred. And then, the sample period is split into
two subperiods (1951 to 1970 and 1971 to 1990) to determine whether the
estimated coefficients for the full period are stable. Table 9 shows the results of
the estimation of Equation (17) with an AR(1) correction and t-statistics are below
coefficient in parentheses. All the regressions exhibited serial correlation, thus the
AR(1) correction was necessary.

Table 9

Regression Results of Equation (17)

Dependent Variable: Investment

Variables	Full Period (1951-1990)	Subperiod 1 (1951-1970)	Subperiod 2 (1971-1990)
Constant	-5,468. (-2.26)	-3,290. (-1.60)	-7,764. (-0.81)
EMP_t (in 1,000)	3.865 (2.80)	3.81 (4.80)	4.60 (1.43)
S_{t-1}	-0.101 (-1.81)	-0.116 (-2.43)	-0.125 (-1.10)
Corrected R^2	.92	.96	.77
ρ	0.714	0.564	0.708

Source: Author

For the full sample period, Equation (17) appears to explain the variations in the level of investment reasonably well. However, in comparison to the results of a demand model in Equation (4), the estimated adjustment rate, $\dot{\phi}$, is quite low at 10.1 (α is 35.8) percent and the stock to office employment ratio, x, is surprisingly high at \$38,267 (w is \$22,000). Presumably, the negative constant found in Equation (17) has contributed to these differences.

As with the demand equations, the estimation results between Subperiods 1 and 2 are strikingly different. This inconsistency appears to confirm the hypothesis that there has been a structural change in the investment behavior over the 40 years. As hypothesized, in Subperiod 1, when the owner-occupant space dominated the office investment market (both in demand for and in supply of), Equation (17) is found to explain the variations in the level of investment almost completely. Similar to the full sample results and Equation (4) results for Subperiod 1, the estimated ϕ is at 11.6 percent and x is at \$32,845. The Subperiod 2 results show that none of the variables are statistically significant at the five percent level and the statistical fit of the equation drops considerably in comparison to that of Subperiod 1 estimation.

A variation of Equation (17) follows the neo-classical approach, in which a lagged equilibrium capitalization rate, R_{t-1}, is tested to examine whether it is a significant determinant of the investment level. The empirical result is presented below in Table 10. For all three periods, the coefficients for the equilibrium capitalization rate variable are statistically insignificant at any reasonable level, and the other

coefficients are almost identical to those of Equation (17) results. Even lagging the equilibrium capitalization rate three years did not produce a measurable change in either coefficients' magnitude or t-statistics. These findings appear to validate the high complementarity hypothesis between office employment level and office stock for the owner-occupant space at least in Subperiod 1.

Table 10

Regression Results of Equation (17) plus Equilibrium Capitalization Rate

Dependent Variable: Investment

Variables	Full Period (1951-1990)	Subperiod 1 (1951-1970)	Subperiod 2 (1971-1990)
Constant	-6,389. (-2.27)	-3,132. (-1.82)	-8,12 5. (-0.84)
EMP_t (in 1,000)	4.105 (2.82)	4.23 (5.28)	4.66 (1.41)
R_{t-1}	21,883. (0.63)	9,737. (0.58)	28,501. (0.46)
S_{t-1}	-0.113 (-1.88)	-0.140 (-2.85)	-0.132 (-1.11)
Corrected R^2	.91	.96	.75
ρ	0.71	0.40	0.69

Source: Author

The empirical results of the rental investment model, Equation (22) which is based on Tobin's q theory, is presented in Table 11. A three-year lag on the absorption and vacancy rates and the equilibrium price produced the best fit. This may appear to be a rather long lag compared to other aggregate investment

studies. However, considering the long gestation period inherent in the

nonresidential real estate market, this does not seem unreasonably long. For

example, Wheaton's [1987] , and Wheaton and Torto's [1990] studies found lags

between two and three years appropriate in estimating absorption and construction

rates of the office and industrial property markets.

Table 11

Regression Results of Equation (22)

Dependent Variable: Investment

Variables	Full Period (1951-1990)	Subperiod 1 (1951-1970)	Subperiod 2 (1971-1990)
Constant	-931. (-2.61)	-353. (-9.43)	-1,274. (-1.19)
q_{t-3} $^*S_{t-4}$ (in 1,000)	0.209 (6.96)	0.082 (0.96)	0.224 (4.96)
$v_{t-3}{}^*S_{t-4}$	-0.061 (-3.85)	0.043 (0.46)	-0.060 (-2.71)
$j_{t-3}{}^*S_{t-4}$	0.338 (6.48)	0.149 (1.15)	0.351 (4.37)
I_{t-1}	0.60 (9.55)	0.77 (4.21)	0.58 (6.48)
Corrected R^2	.97	.95	.93
DW	2.09	1.52	2.18

Source: Author

The estimation results of Equation (22) for the full sample period is exceptionally

good. All the estimated coefficients have the expected signs and are statistically

significant at the five percent level. The estimated adjustment rate is 40 percent

and the estimated coefficients for the price, vacancy, and absorption variables are 0.52, -0.15, and 0.85, respectively. Based on the these coefficients, the investment rate (I_t/S_{t-4}) is influenced most by variations in the absorption rate followed by the equilibrium price.

As with the empirical results of Equation (17), the estimated coefficients are not stable between the two subperiods. For Subperiod 1, the estimated coefficients for all the variables except the lagged investment level are statistically insignificant and the coefficient for the vacancy variable has the opposite sign. Moreover, Durbin h statistics for this subperiod is 1.89, which is higher than the critical level of 1.645 such that the null hypothesis of no serial correlation can be rejected. Apparently, the lagged investment variable is explaining much of the variations in the investment level.

In contrast, the estimation results for Subperiod 2 are quite insightful in explaining the ways in which office investment has been made. The coefficients for all the variables, except the constant, are statistically significant at the five percent level and have correct signs. The most important finding for Subperiod 2 is that, as with the full sample period, the lagged absorption and equilibrium price have a positive impact and the lagged vacancy has a negative impact on the level of investment. The estimated coefficient for the adjustment rate is 42 percent, which appears to be reasonable when compared with earlier results. The estimated coefficients for the equilibrium price, vacancy, and absorption variables are 0.533, -0.143, and 0.836, respectively. The magnitude of coefficients for these

variables suggests that variations in the equilibrium price variable has the greatest effect on the investment rate (I_t/S_{t-4}). Specifically, one standard deviation increase in the equilibrium price causes about a 1.84 percent rise in the investment rate, which represents about 123 percent and 39 percent of its standard deviation and mean value, respectively. If the absorption rate were to rise by one standard deviation, the investment rate would increase by about 1.52 percent. On the other hand, if the vacancy rate were to fall by one standard deviation, the investment rate would increase by about 0.7 percent.

As a variation of Equation (22) for Subperiod 2, a separate estimation of the coefficients for the capitalization rate and the net operating income variables which make up the equilibrium price, along with the vacancy and absorption variables is performed. This test determines whether the capitalization rate variable or the net operating income variable has a greater influence on the investment level. To be consistent with Equation (22), a reciprocal of the capitalization rate series is used. Also to determine the individual importance of the equilibrium capitalization rate and the net operating income series on the investment level, regressions are performed without either NOI_{t-3} or $1/R_{t-3}$. The results of the estimates are presented in Table 12.

When the equilibrium price series is decomposed into the capitalization rate and the net operating income series, the effect of variations in both variables are found to be significant. Furthermore, the magnitude of their coefficients suggests that the variations in the equilibrium capitalization rate affects the investment rate

much more than those in the net operating income. A single standard deviation change in the capitalization rate causes a change in the investment rate by about 32 percent of its mean value and 100 percent of its standard deviation. In contrast, one standard deviation change in the net operating income affects investment rate by about 21 percent of its mean value and 66 percent of its standard deviation.

Table 12

Regression Results of Equation (22) with a Separate Specification of NOI and R

Dependent Variable: Investment ·

Variables	Subperiod 2 (1971-1990)	Subperiod 2 (1971-1990)	Subperiod 2 (1971-1990)
Constant	-3,183. (-2.49)	888. (0.57)	-1,439. (-1.05)
$NOI_{t-3} *S_{t-4}$ (in 1,000)	6.20 (2.88)	3.606 (1.08)	
S_{t-4}/R_{t-3} (in 1,000)	0.964 (4.94)		0.827 (3.58)
$v_{t-3}*S_{t-4}$	-0.160 (-3.30)	-0.129 (-1.68)	-0.036 (-1.32)
$j_{t-3}*S_{t-4}$	0.262 (3.46)	0.188 (1.59)	0.283 (3.08)
I_{t-1}	0.48 (4.56)	0.76 (5.42)	0.67 (6.89)
Corrected R^2	.936	.83	.904
DW	2.23	1.42	2.11

Source: Author

Also the other variables exhibited non-trivial changes relative to the empirical

results of Equation (22). The estimated adjustment rate increased by 10 percent from 42 percent to 52 percent. The estimated coefficients for the vacancy variable doubled from -0.14 to -0.31 and the absorption variable dropped from 0.836 to 0.50. Interestingly, these changes occurred without any measurable change in the statistical fit of the equation.

The third column of Table 12 shows that without specifying the equilibrium capitalization rate, 1) all the variables except the lagged investment level become statistically insignificant at the five percent level, 2) the statistical fit of the equation drops considerably, and 3) the estimated adjustment rate also drops to 24 percent. Furthermore, the durbin-h statistics is 1.66 which suggests that a serial correlation is present.

The last column of Table 12 shows that leaving out the NOI variable does not alter the statistical fit of the equation significantly. Two major changes are that the estimated adjustment rate drops to 33 percent and that the vacancy variable is statistically insignificant. Interestingly, the estimated coefficients for vacancy and absorption variables are nearly identical to those found in Equation (22) results.

The implication of the above results is that the investment level is very sensitive to the capitalization rate even without the *NOI* variable and not the reverse. Alternatively said, one cannot assume that *NOI* is a good proxy for price in absence of price data, and ignoring the variations in the capitalization rate can lead to seriously incorrect estimations.

As pointed out earlier, the *NOI* series is somewhat suspicious because the operating expenses (in real dollars) declined so much during the inflationary period. To determine whether the statistical insignificance of the *NOI* variable is due to this possible inconsistency of the BOMA data, the *NOI* series is replaced by the rental income series, denoted *RI*, and the resulting equation with and without the equilibrium capitalization rate variable are presented in Table 13 below:

Table 13

Regression Results of Equation (22) with a Separate Specification of RI and R

Dependent Variable: Investment

Variables	Subperiod 2 (1971-1990)	Subperiod 2 (1971-1990)
Constant	-9,971. (-2.74)	-6,385 (-1.24)
$RI_{t-3}*S_{t-4}$ (in 1,000)	7.30 (2.48)	6.89 (1.61)
S_{t-4}/R_{t-3} (in 1,000)	0.84 (4.23)	
$v_{t-3}*S_{t-4}$	-0.28 (-2.76)	-0.29 (-1.94)
$\dot{j}_{t-3}*S_{t-4}$	0.10 (0.93)	0.03 (0.22)
I_{t-1}	0.34 (2.17)	0.55 (2.51)
Corrected R^2	.93	$\cdot$ .85
DW	1.81	1.34

Source: Author

The second column of Table 13 shows that in comparison to an earlier equation

with the *NOI* variable (the second column in Table 12) , the estimated adjustment

rate is somewhat higher at 0.66 (as opposed to 52 percent), the estimated

coefficient for the equilibrium capitalization rate variable drops modestly from 1.85

to 1.28, and the vacancy variable changes from -0.31 to -0.42. However, the most

significant change is that the absorption variable becomes statistically

insignificant. This suggests that expected changes in the rental income are

sensitive to changes in the vacancy rate but not in the absorption rate. As with

the equation using *NOI*, the investment rate appears to be more sensitive to

variations in the equilibrium capitalization rate. Specifically, a single standard

deviation change in the equilibrium capitalization rate affects the investment rate

by about 1.8 times as much as that in the rental income (1.06 percent vs. 0.6

percent).

As shown in the last column of Table 13, a regression without the equilibrium

capitalization rate variable results in a poor statistical fit (including a serial

correlation) as with an earlier equation using *NOI* variable. The statistical

insignificance of all the variables except the lagged investment level appear to

further validate the earlier hypothesis that the equilibrium capitalization rate is

critical in estimating the investment level.

5.5   Concluding Remarks

In this chapter, two sets of investment models have been formulated specifically for

owner-occupant space and rental space. Owner-occupant firms are theorized to

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behave appropriately to their own demand functions and the empirical evidence, for a subperiod between 1951 and 1970, shows that parameters of the investment equation, based on the accelerator model, are quite similar to those of the demand equation presented in the preceding chapter. Specifically, the current employment level and stock adjustment rate were able to explain much of the variations in the investment level. In particular, neither the equilibrium price nor the equilibrium capitalization rate (lagged between one and three years) were found to be statistically significant. This confirms the appropriateness of applying the accelerator model, which hinges on a critical assumption that the optimal office stock is proportional to the office employment level. Additionally, the statistical insignificance of the equilibrium price, vacancy rate, and absorption rate variables appears to support the claim that rental investment was not a significant component of the office market in the 1950s and 1960s.

Without a doubt, the 1970s and 1980s saw a drastic and structural change in the provision of office space. The investment model for this subperiod, reflecting the advent of an active rental market, was developed based on the traditional cobweb model, which postulates that the previous period's price determines the current investment rate. The equilibrium price time-series was developed carefully based on some necessary assumptions, which may be somewhat restrictive. However, they are believed to be reasonable and far more realistic than the assumptions made in the aggregate investment models.

The empirical results of the investment model for the second subperiod indicate

that indeed the lagged equilibrium price, vacancy rate, absorption rate variables are statistically significant in determining the investment level. Also, as hypothesized, the lag is considerably long (i.e., three years) and the estimated adjustment rate is quite low at around 42 percent. This is a clear confirmation of the well-known problem in the rental office market, which is, that supply is never completely adjusted so that persistent booms and busts are inevitable as the economy experiences expansions and contractions.

When the estimated equilibrium price variable is decomposed into the net operating income and equilibrium capitalization rate variables, both variables are found to be statistically significant. While the equilibrium capitalization rate by itself (i.e., without NOI) is statistically significant and produces just as high an R^2 as with NOI, dropping the equilibrium capitalization rate renders the estimated coefficient for NOI, vacancy rate, and absorption rate statistically insignificant and an R^2 drops considerably. Based on this finding, it is inappropriate to assume that price proportional to NOI and that the level of NOI can determine the investment level without specifying the capitalization rate. Recognizing possible inaccuracies with the operating expenses data used to calculate the net operating income series, the rental income series was used under the traditional assumption that net operating income is a constant fraction of rental income. The rental income variable was also found to be statistically insignificant at the five percent level without the equilibrium capitalization rate. However, the rental income variable along with the equilibrium capitalization rate and vacancy rate can explain the variations in the investment level exceptionally well.

The statistically significant equilibrium capitalization rate series highlights the importance of the interaction of tax policies, expected inflation, and market interest rates in determining the future office investment rates. After developing and empirically testing the rental adjustment model in the next chapter, Chapter 7 provides a series of simulations based on various tax rules and macroeconomic conditions.

Chapter 6

The Rental Adjustment Model

6.1   Introduction

In Chapters 4 and 5, a model of the demand for and supply of office space has been

developed and to close the system, a model of the rental adjustment is developed in

this chapter. The traditional rental adjustment model (e. g., Rosen and Smith

[1983], Hekman [1985], Shilling, Sirmans, and Corgel [1987], Frew and Jud [1988],

Wheaton [1987], Wheaton and Torto [1988], Jud and Frew [1990], Glascock,

Jahanian, and Sirmans [1990]) theorizes that the rental rate change is

proportionate to the difference between actual and structural vacancy rates. Many

of these studies assume that the optimal vacancy rate equals the long-term

structural vacancy rate, which is assumed to be a constant, such that the rental

adjustment is specified as:

$$\frac{L_t - L_{t-1}}{L_{t-1}} = \gamma(v^* - v_{t-1}) \qquad (50)$$

where L_t = real rental rates in period t,

v^* = a constant optimal vacancy rate,

v_t = actual vacancy rates in period t, and

γ = the rental adjustment rate.

As pointed out by Wheaton and Torto [1993], Equation (50) does not lead to a stable dynamic system since any continued but stable excess vacancy will lower the rental rate forever rather than allowing the rental rate to remain stable at a lower level. More recently, based on search theories, Wheaton and Torto [1993] specified an alternative rental adjustment model as:

$$L_t - L_{t-1} = \gamma(v^s + \alpha_1 h_{t-1} + \alpha_2 v_{t-1} - L_{t-1}) \tag{51}$$

where h_t = an absorption to stock ratio in period t, and

v^s = a constant structural vacancy rate.

Applying their hedonic rental rate indices, they regressed Equation (51) over the 1979-1991 period and found remarkably good empirical results (R^2's ranged between 0.36 and 0.75), and that the absorption to stock ratio and lagged rental rate variables are statistically significant. Their study suggests that the rental adjustment rates range from a high of 55 percent to a low of 23 percent per year and the equilibrium rental rates range between $10 to $29, depending upon the metropolitan areas and the level of tightness of the markets.

While Equation (51) provides an improved theoretical basis over the traditional rental adjustment model, a shortcoming of the equation is that the equilibrium rental rate, denoted L_t^*, is determined by, beside a constant, the one-year lagged

absorption to stock ratio and vacancy rate. Based on this specification, the equilibrium rental rate is not affected by the expected current and near-term supply adjustments. First, even if a spot market (i.e., rental agreements for a single year) were considered, both informed lessors and lessees can reasonably anticipate the current supply adjustment since the construction gestation period is considerably long. Thus, a lagged investment level would influence the current expected vacancy rate. For example, holding all else constant, during a period of high investment rates, the equilibrium rental rate must be lower than that of a low investment rate period. Presumably, lessors and lessees would use this information in their bargaining strategies.

Second, given that typical lease agreement terms range between five- and ten-years, the lessors and lessees must consider not only the expected current vacancy rate, but also the entire path of expected vacancy rates from the current year to the end of the lease term. For example, in a seriously over-built market with virtually no new construction and positive absorption rates in the foreseeable future, the equilibrium rental rate for a single year is expected to be significantly lower than that for a mid- to long-term lease. Otherwise, a lessor who contracts for a series of short-term leases at the spot rent will receive higher rental revenues over a lessor who contracts for a mid- to long-term lease at the current spot equilibrium rental rate. In a competitive market, such a rent differentiation cannot be sustained and will be arbitraged away.

Recognizing that the equilibrium rental rate must reflect the expected level of

current and near-term functions of demand and supply, a rental adjustment model
is developed and empirically tested in the following sections.

6.2 The Theory

6.2.1 The Optimal Vacancy Rate

In order to understand the rental adjustment, a theoretical argument for the
existence of the optimal vacancy rate in the spot rental market needs to be
understood first. In the spirit of Blinder's [1982] theoretical work on the optimal
inventory holding for capital goods, the optimal vacancy rate is disaggregated into
two components, namely long-run structural and short-run expected growth
vacancy rates:

$$v_t^* = v_t^s + v_t^g \qquad (52)$$

where v_t^* = the optimal vacancy rate in period t,

v_t^s = the long-run structural vacancy rate in period t, and

v_t^g = the short-run expected growth vacancy rate in period t.

For the office market to operate smoothly, even in the absence of long-run growth,
a minimum amount of vacant space is necessary to accommodate a stabilized level
of tenant turnovers and relocations. In addition to the minimum level of vacancy,
some amount of vacant space is needed for the long-run growth in demand for

office space, which make up the long-run structural vacancy rate. This long-run structural vacancy rate is likely to be an increasing function of the rate of tenant turnovers and the level of specificity of office space sought and offered in the market. Wheaton and Torto [1988] pointed out that the tenant turnover has increased and the average length of lease has shortened during the last two decades. Although, Jud and Frew [1988] found the optimal vacancy rate sensitive to the atypicality of apartments, considering that typical office space requires a considerable amount of tenant improvements, the atypicality is not expected to matter much.

In addition to the higher lease turnover rates, there is an even greater reason for an increasing structural vacancy rate during the 1970s and 1980s. As pointed out in Chapter 2 and analyzed in Chapters 4 and 5, the reliance on the rental office market (demand for and supply of), as opposed to the owner-occupant market, has increased dramatically during this period. Since the rental office market has assumed an increasing role in providing the buffer space the user firms used to provide internally, it is reasonable to assume that the structural vacancy rate has increased over time. Assuming that v_t^s has increased linearly over time,

$$v_t^s = a_0 + a_1 t \tag{53}$$

For lessors to sustain the long-run structural vacancy rate, they must be able to charge a rental rate that is commensurately higher than the rate that clears the market so that the firms are sufficiently compensated for the carrying costs of the

vacant space. In a competitive market in which the individual lessors and lessees are price-takers, the market rental rate is given irrespective of the rate of vacancy a lessor may maintain. Therefore, the competition will force the lessors to maintain the long-run structural vacancy rate at its minimum level.

The second component of the optimal vacancy rate, the short-run expected growth vacancy rate, is intended to accommodate the demand shocks. In the absence of the short-run expected growth vacancy rate, the lessors can only respond to demand shocks for office space by adjusting the supply of office space or the rental rates charged to lessees. However, a long gestation period of construction process prevents the lessors from adjusting the supply and the mid- to long-term nature of typical leases limits the amount of the rental revenues that can be adjusted quickly. Specifically, in the short-run, the stock is virtually fixed so that lessors must maintain some amount of vacant space to profit from situations in which positive demand shocks occur. If the shocks are transitory, the vacancy rate will drop briefly without a significant rise in the investment rate or price since the rise in the demand for office space in this period will be offset by a drop in the next period's demand. On the other hand, if the shocks are more permanent, a rise in the market price will fuel an increased rate of investment and the vacancy rate will increase to reflect a higher level of expected demand shocks. Clearly, there exist significant carrying costs associated with maintaining vacant space, and, therefore, the carrying costs limit the amount of vacant space that the lessors can maintain profitably.

The amount of the short-run expected growth vacancy is assumed to be: 1) an increasing function of the expected demand shocks, which is proxied by a lagged absorption to stock ratio; and 2) a decreasing function of expected new construction completions, which is proxied by a lagged investment rate. Assuming a linear relationship and setting the lag at one period, v_t^g is:

$$v_t^g = a_2(h_{t-1} - i_{t-1}) \tag{54}$$

where $i_t = I_t / S_{t-1}$

For example, in a rapidly expanding economy, the expected demand shocks have to be higher than those of a slowly expanding economy since lessees are likely to be seeking a greater amount of vacant space to occupy. Conversely, in a recessionary economy, they are expected to be negative or very low as firms dispose of unnecessary space owned or leased. However, higher expected demand shocks, by themselves, do not necessarily represent a higher short-run expected vacancy rate. Precisely because the supply adjustment necessitates relatively long lags, past investment decisions can affect the current short-run expected growth vacancy rate. Suppose the economy is rapidly recovering from a recession (as in the late 1970s) in which the demand shocks are relatively high and the current investment rates are considerably low, v_t^g is likely to be quite high. In contrast, the economy moving into a recession (as in the late-1980s) experiences low or negative demand shocks along with high investment rates, which suggests that v_t^g should be negative. Between these two extreme situations lies the ideal case in which the

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demand shocks are completely anticipated, irrespective of their magnitude, and are offset by the same amount of investment. In this case, the optimal vacancy rate is exactly the long-run structural vacancy rate, since v_t^g is zero. In fact, this is the implicit assumption made by Wheaton and Torto [1988], who specified a linearly rising optimal vacancy rate.

Thus, assuming that the lessors are value-maximizing, there exists an optimal amount of vacant space, which is a sum of the long-run structural and short-run expected growth vacancy rates, that maximizes the rental revenues and, therefore, the value of the office buildings. As the optimal vacancy rate rises (falls) due to a rise (decline) in the short-run expected growth vacancy rate, the rental rate must also rise (fall) to compensate for the additional (reduced) carrying costs of the increased (decreased) optimal vacancy rate.

6.2.2 The Equilibrium Rental Rate

Given the optimal vacancy rate, the amount of deviation between the optimal vacancy rate and the actual vacancy rate is assumed determine the equilibrium rental rate. If the actual vacancy rate were lower (higher) than the optimal vacancy rate, then the rental rate will move up (down). Therefore, the equilibrium rental rate is an increasing function of the optimal vacancy rate and a decreasing function of the actual vacancy rate. Assuming a linear relationship, the equilibrium rental rate, denoted L_t^*, can be expressed as:

$$L_t^* = a_0 + a_1 t + a_2(h_{t-1} - i_{t-1}) - a_3 v_{t-1} \tag{55}$$

Notice that Equation (55), without explicitly specifying the investment rate, is identical to the optimal rental rate specified in Equation (51) by Wheaton and Torto.

It is important to note that Equation (55) specifies the optimal rental rate for a constant lease term. By varying the length of a lease term, denoted T, to arrive at the optimal rental rate, denoted $L_t^*(T)$, one has to calculate L_t^* not only for the current year but also for the next T-1 years. Using the options theory, Grenadier [1993] derived $L_t^*(T)$, and, based on numerical simulations, he shows that the magnitude of deviation between v_t^* and v_{t-1} principally determines the shape of the term structure assuming that v_t^* does not change suddenly. There are three possible shapes over time: 1) if $v_t^* - v_{t-1}$ were positive (i.e., undersupply), new investment will be added to the current state of supply and the shape should be downward sloping; 2) if $v_t^* - v_{t-1}$ were negative (i.e., oversupply), a probability that new investment will occur is very low and the shape should be upward sloping; and 3) in between these two extreme conditions, if near-term supply increases were likely, then the shape could show a single hump. The shape of the term structure is crucial since the difference in $L_t^*(T)$ between a high and a low excess vacancy will decline as T increases.

Incorporating a constant partial adjustment rate, denoted γ, for all t, the change in the rental rate is:

$$L_t - L_{t-1} = \gamma(L_t^* - L_{t-1}) \tag{56}$$

and substituting Equation (55) into Equation (56),

$$L_t - L_{t-1} = \gamma[a_0 + a_1 t + a_2(h_{t-1} - i_{t-1}) - a_3 v_{t-1} - L_{t-1}] \tag{57}$$

6.3   Estimation Strategies

Theoretically, the appropriate rental rate series should reflect the marginal rental

rate. However, since no time-series on the marginal rental rate (going as far back

as 1970 needed for the second subperiod analysis) is publicly available, this thesis

relies on the average rental rate provided by BOMA. A major problem posed by

the usage of the average rental rate is that rental rates set forth in previous years

are included in the current average rental rate. The empirical implications of this

is that: 1) while Equation (57) specifies one-year lagged variables to determine the

equilibrium rental rate, appropriate lags will have to extend in excess of one year;

and 2) the year-to-year variations in the average rental rates will be much lower

than those of the marginal rental rates, which will lead to a higher rental

adjustment rate.   As shown in Figure 20, the current average rental rate does not

appear to be negatively correlated to the one-year lagged vacancy rate and the

rental rate series is not as volatile as the vacancy rate series. Also, while Wheaton

and Torto [1993] show that the marginal rental rate has fallen dramatically in the

1980s, the average rental rate series does not suggest any significant decline at

least by 1990.
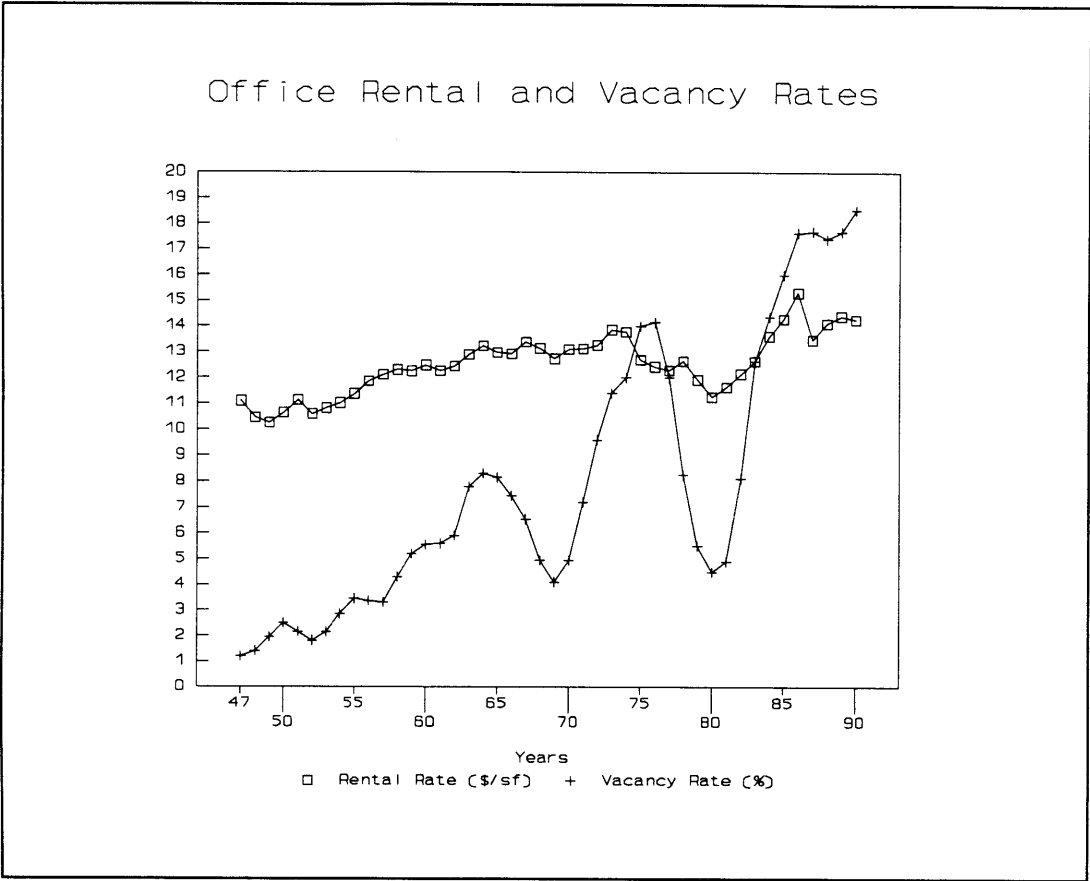
Figure 20

Table 14 presents all the variables needed for an empirical test, between 1971 and

1990, of Equation (57).

Table 14

Data for Rental Adjustment Estimations

Year	L ($/sf)	v (%)	h (%)	i (%)
1971	13.12	0.0720	1.83	4.45
1972	13.25	0.0960	2.13	5.07
1973	13.87	0.1140	2.99	5.47
1974	13.79	0.1200	3.55	4.75
1975	12.70	0.1400	0.37	2.77
1976	12.43	0.1415	1.95	2.45
1977	12.29	0.1200	4.33	2.35
1978	12.65	0.0825	6.58	2.79
1979	11.93	0.0550	6.64	3.91
1980	11.25	0.0450	5.91	5.08
1981	11.63	0.0490	5.32	6.04
1982	12.15	0.0810	3.41	7.32
1983	12.65	0.1265	0.58	5.91
1984	13.61	0.1435	3.71	6.40
1985	14.29	0.1600	4.51	7.44
1986	15.31	0.1765	3.15	5.90
1987	13.46	0.1770	3.90	4.80
1988	14.11	0.1740	4.23	4.74
1989	14.39	0.1770	3.21	4.28
1990	14.25	0.1855	1.87	3.37

Sources: BOMA, CB/Commercial, BEA, and Author

6.4   Estimation Results

Equation (57) is estimated for the second subperiod between 1971 and 1990 and presented in Table 15. Since the dependent variable is the change in average rental rates rather than marginal rental rates, various lags have been empirically tested and the equation that produced the best statistical result is presented. The t-statistics are presented below the estimated coefficients in parentheses.

Table 15

Regression Results of Equation (57)

Dependent Variable: Change in Avg. Rental Rate

Variables	1971-1990
constant	0.031 (0.017)
t (time)	0.075 (3.41)
$h_{t-4} - i_{t-2}$	0.251 (3.49)
v_{t-4}	-8.98 (-3.10)
L_{t-1}	0.029 (0.20)
Corrected R^2	0.61
DW	3.25

Source: Author

The empirical results based on Equation (57) show that all the estimated coefficients except the lagged rental rate have the expected signs and are

statistically significant at the five percent level. And as expected, the lags are considerably long. However, the problem of statistically insignificant adjustment rate suggests that, given the average rather than the marginal rental rate series, the traditional rental adjustment model (i.e., Equation (50)) may be sufficient and more appropriate to explain the movement of rental rates. The regression results based on Equation (50), in which the optimal vacancy rate follows Equation (52), is presented in Table 16 below. The t-statistics are presented below the estimated coefficients in parentheses. Due to presence of serial correlation, the estimation results with an AR(1) correction is also provided.

Table 16

Regression Results of Equation (50)

Dependent Variable: Percentage Change in Avg. Rental Rate

Variables	OLS	AR(1)
constant	0.031 (1.76)	0.028 (3.04)
t (time)	0.006 (4.08)	0.006 (7.63)
$h_{t-4} - i_{t-2}$	0.017 (4.80)	0.015 (7.21)
v_{t-4}	-0.705 (-3.66)	-0.689 (-6.80)
Corrected R^2	0.66	0.78
DW	3.20	
ρ		-0.62

Source: Author

The results in Table 16 suggest that, indeed, Equation (50) with the trending

structural vacancy rate and short-run expected growth vacancy rate as the optimal

vacancy rate explains the rental movement quite well. The estimated coefficients

based on OLS are nearly identical to those with the AR(1) correction. The

estimated adjustment rate is about 70 percent per year. Since the average rental

rate is used and the lag is four years, such a high adjustment rate is not so

surprising. Ignoring the effect of the short-term expected growth vacancy rate, in

which the structural vacancy rate is simply rising over time (i.e., Wheaton and

Torto [1988]), the estimated structural vacancy rate increased from 5.2 percent to

21.2 percent between 1971 and 1990. In other words, the structural vacancy rate

increased by 0.8 percent per year, which is 2.3 times that of Wheaton and Torto's

estimate at 0.34 percent. The reason that the estimated structural vacancy rate

appears so high is that the average short-term expected growth vacancy rate has

been negative during the 20-year period at (-1.09*0.0245=-0.027). Considering the

average v^g, the estimated optimal vacancy rate drops closer to those levels found by

Wheaton and Torto (at 7 percent to 16 percent between 1968 and 1986). But

because the value of estimated short-term growth is so volatile, one standard

deviation change in it can change the optimal vacancy rate by five percent.

Based on the above estimations, the movements of the estimated optimal and

actual vacancy rates are illustrated in Figure 21. It is quite evident that the mid-

1970s was a period of excess vacancy and the early-1980s was a period of severe

office shortage.

Est. Optimal vs Actual Vacancy Rates
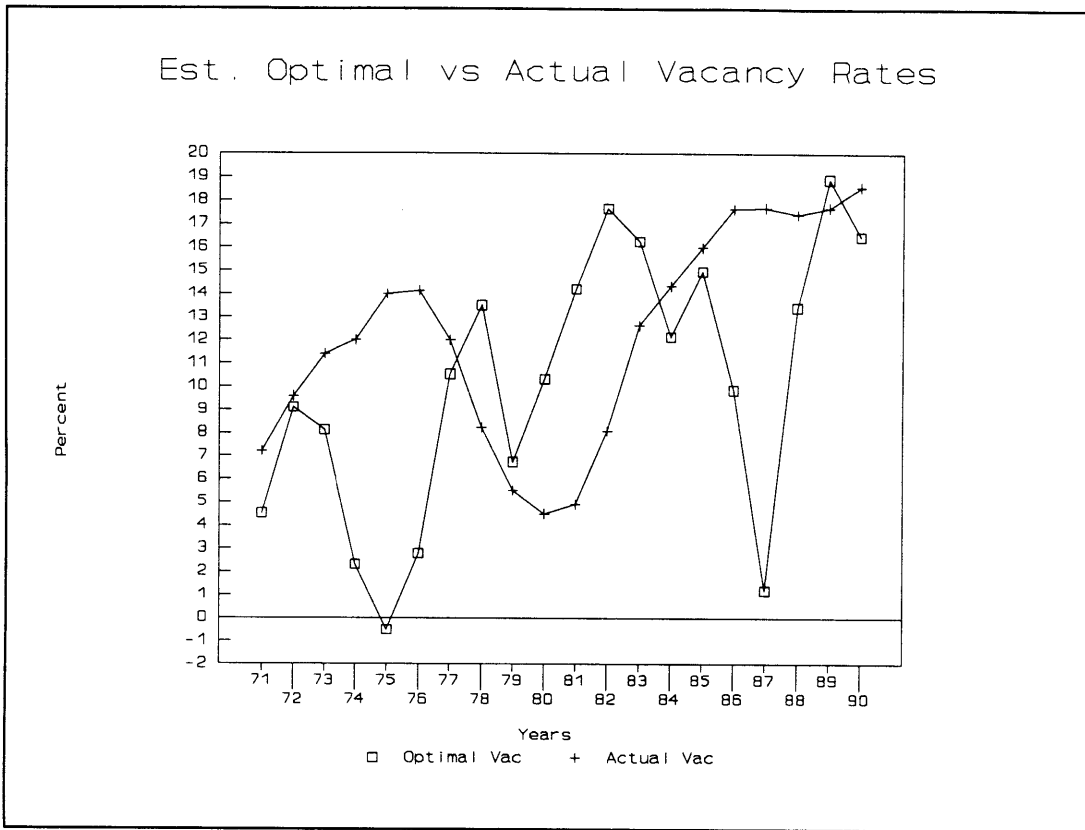
Figure 21

6.5   Concluding Remarks

In this chapter, the search-theory based rental adjustment model developed by
Wheaton and Torto has been extended to include expected current and near-term
supply adjustments in specifying optimal vacancy rates. The traditional
specification that the equilibrium rental rate is a decreasing linear function of the
excess vacancy rate, which is the difference between the optimal and actual
vacancy rates, is maintained.

Almost all the past studies have provided sufficient argument for a long-run

structural vacancy rate. Following Wheaton and Torto [1988], the long-run structural vacancy rate is assumed to rise linearly over time. The main reason for the trending is to account for the growing demand for the rental office space as oppose to the owner-occupied space from office user firms. Both Wheaton and Torto [1993], and Gabriel and Nothaft [1988] have pointed out that during a period of high absorption rate, the optimal vacancy rate, and therefore, the equilibrium rental rate must increase as the competition for office space becomes tighter. The underlying rationale behind including the expected current and near-term supply adjustment, which is proxied by a lagged investment rate, is that as additional office space is expected to enter the rental market, the need for vacant space diminishes. Thus, holding all else constant, during a period of high investment rates, the optimal vacancy rate and the equilibrium rental rate must drop. In fact, if the demand shocks were perfectly anticipated such that the investment rates matched the demand shocks, then the optimal vacancy rate will remain at the long-run structural rate, and, therefore, the equilibrium rental rate should also remain stable.

Since a marginal rental rate time-series is not available, an average real rental rate series from BOMA is used in the empirical testing of the rental adjustment model. The average series, in comparison to the marginal series, is expected to exhibit less variations and to reflect decisions made in the past based on past market conditions. However, the empirical results show that the actual rental rate adjusts not to the equilibrium rental rate but rather to the optimal vacancy rate as with the traditional rental adjustment model. One possible explanation for such

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finding is that the average rental rate series deviate considerably from the marginal rental rate series.

Based on the traditional rental adjustment model, as expected, the coefficient for the lagged vacancy rate has a negative sign, and the short-term expected growth rate and time variables' coefficients have a positive sign. The estimated coefficients suggest that the optimal vacancy rates exhibit a cyclical movement where a trough was reached in 1975 at -0.5 percent and in 1987 at 1.5 percent, and a peak was reached in 1982 at 17.5 percent and in 1989 at 19 percent.

Chapter 7

Tax Policy, Inflation, and Office Investment Behavior

7.1   Introduction

The traditional justification for the use of tax devices such as a liberalized depreciation schedule and lower tax rates to stimulate capital investment is based on a belief that firms will invest more if the goods can be purchased at a lower after-tax cost of capital. Put another way, a lower cost of capital, holding all else constant, results in a rise of desired level of capital stock to increase the productivity of labor, which in turn results in a rise in the net investment. Empirically, many macroeconomists have estimated the effect of various tax policies over the last 40 years by calculating the effective tax rates, which is commonly defined as the percentage difference between the net marginal products of capital before and after taxes.

Invariably, these researchers (for example, Feldstein and Jun[1986]) conclude that a high (low) inflation rate and the U.S. tax rules that tax nominal capital gains and that allow depreciation based on the historical value of assets cause the effective tax rate to rise (drop), which induces the firms to decrease (increase) their capital investment. For the same reasons, a sudden rise in the inflation rate (as in the mid-1970s) reduces the gap between the effective tax rate for short-lived (i.e.,

equipment) and long-lived assets (i.e., structures), which is believed to result in a

shift in the investment from short-lived to long-lived assets. In fact, many

economists have attributed the failure of U.S. economic policy to provide easy

money for encouraging investment in the 1960s and 1970s to the rising rate of

inflation.

7.2   The Adjustments in the Property and Capital Markets

In order to understand the impact of tax policy and inflation rates on the office

market, one has to understand the dynamic movement of the property market as

well as the capital market. In the short-run, rental rates, along with price and

vacancy rates, adjust so that these two markets can be reconciled. The effect of

vacancy rate on the rental adjustment is particularly important since the supply

adjustment occurs with significantly long lags.

Figure 22, adapted from Hendershott and Ling [1984B] (a similar analysis is also

provided by DiPasquale and Wheaton [1992A]), illustrates the long-run equilibrium

condition between the property market and the capital market. The top-left hand

graph shows the rental rate to price ratio. The dotted line represents the market-

clearing rental rate (denoted L^{mc}) to price (denoted P) ratio, which is analogous to

the equilibrium capitalization rate, R, as discussed in Chapter 5. For L^{mc}/P and R

to be equivalent, one has to assume that: 1) the net operating income is a constant

fraction of the rental income, and 2) the future stream of rental income is known

with certainty (e.g., the rental income increases by a constant inflation rate and
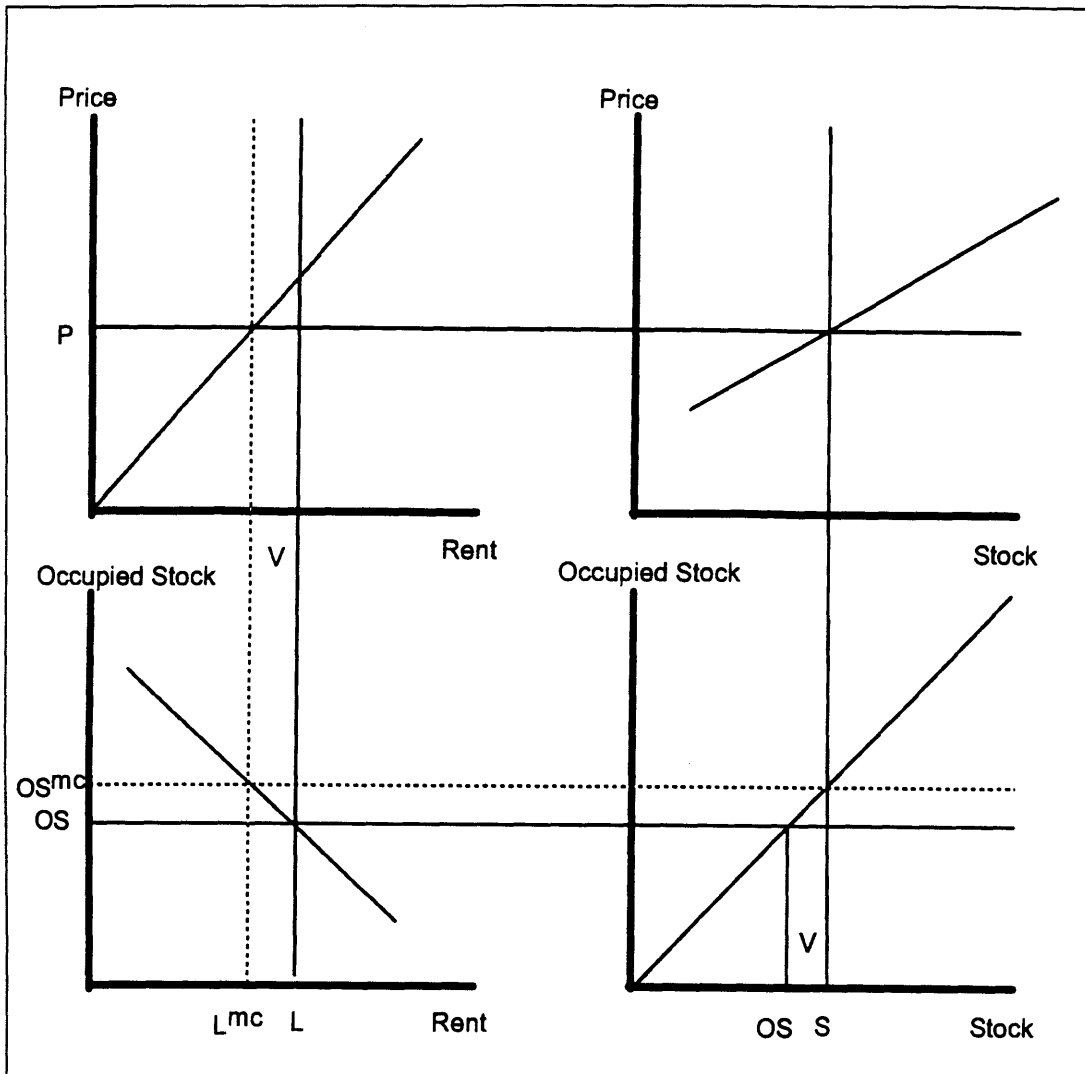
Figure 22

decreases by a constant economic depreciation rate). Since vacancy (denoted v)

exists, L^{mc} is unobservable. Rather, lessees are charged a market rental rate,

denoted L, which is represented by the solid line. The market rental rate is

proportionally higher than the market-clearing rental rate depending upon the

slope of the demand curve (i.e., the demand elasticity with respect to rent);

however, for the vacancy to exist, L^{mc} has to be less than $L*(1-v)$. In equilibrium,

the actual vacancy rate is assumed to be the optimal vacancy rate; however, the

market appears to suffer from a constant state of disequilibrium.

Following Equation (7) in Chapter 4, the demand curve is a decreasing function of the rental rate, which is shown in the bottom-left hand graph. The occupied stock, denoted OS, is determined by the rental rate at L rather than at L^{mc}. Since L is higher than L^{mc}, OS is, accordingly, lower than OS^{mc}, which is the amount of office space demanded if the vacancy did not exist. Again, for the vacancy to exist, the actual rental payment (i.e., $L*OS$) has to be greater than the market-clearing rental payment (i.e., $L^{mc}*OS^{mc}$). Of course, as the economy expands and the number of office employees increases, the demand curve will shift upward.

The top-right hand graph shows, as specified in Equation (18) in Chapter 5, that the supply curve is an increasing function of price. Given $\dot{P}$ from the top-left hand graph, the stock, denoted S, which includes both vacant and occupied spaces, is determined. Similar to the demand curve, the supply curve will shift to the right as the economy expands. DiPasquale and Wheaton [1992A] specified investment (i.e., construction) rather than stock in the x-coordinate assuming that negative investment cannot occur, that is if P were to fall below the construction cost (i.e., the replacement cost), no construction will occur. In essence, their graph is simply the top-right hand graph without the portion left of the vertical line at S.

The bottom-right hand graph shows a demand-supply relationship. The diagonal dotted line is at a 45 degree angle where the stock equals the occupied space, which is, by definition, the market-clearing line -- the horizontal dotted line, representing OS^{mc}, and the vertical solid line, representing S, intersect at this diagonal dotted line. Since the actual occupied stock is at OS, the difference

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between S and OS reflects the vacancy.

Based on Figure 22, the impact of exogenous changes in the demand curve and the equilibrium capitalization rate on the office market can be analyzed. First, suppose a positive demand shock occurs as a result of an unexpected rise in the number of office employees. Immediately, the demand curve in the bottom-left hand graph would shift upward, holding L constant. This reduces the amount of vacant office space in the market (i.e., the difference between OS and S in the bottom-right hand graph drops) since the amount of supply is assumed to be constant in the short-run.

The implication of a lower vacancy rate is that L^{mc} increases and, R being constant, a higher price is expected. In fact, the sudden rise in the absorption rate causes the office market to over-react under expectations that the high absorption rate observed in the current period would continue to remain at the high level in the near future. As a result, the price becomes even higher than the level justified by the current levels of supply and demand, and the equilibrium capitalization rate. Even though the price increases rather quickly, a higher level of investments justified by the higher price occurs with a long delay. Meanwhile, a lower vacancy rate without an immediate supply adjustment causes the market rental rate to rise gradually. Presumably, the rental rate would adjust to a higher level that brings the vacancy rate back to its optimal level (i.e., the solid vertical line representing L in the left hand graphs shifts to the right gradually).

Eventually, new office space is added to the existing stock; however, due to over-reactions by rental firms, there would be an over-supply of office space. In other words, the solid vertical line in the right hand graphs, representing S, would shift too far to the right. Naturally, too much of the additional office space would increase the vacancy rate beyond its optimal level. As excess vacancy rate increases, the market clearing rental rate also decreases, which in turn forces: 1) the market rental rate to decline in order to reduce the excess vacancy rate; and 2) the price to drop below the construction costs.

Second, the equilibrium capitalization rate can change as a result of changes in the interest rates, inflation rates, or tax laws. If the equilibrium capitalization rate were to drop unexpectedly, the diagonal line in the top-left hand graph would rotate counter-clockwise. The market rental rate would not change and only the price would move up to a point that the solid vertical line at L intersects with the new diagonal line. The resulting higher price triggers new investments and, after a delay, as the amount of office stock increases, excess vacancy emerges. Again, as excess vacancy rate increases, the market clearing rental rate also decreases, which in turn forces the market rental rate to decline in order to reduce the excess vacancy rate.

7.3   The Effects of High Leveraging and Trading

The nature of interaction between tax policy and the rate of inflation is so much more complex, or at least so different, for office investment that the above

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conclusions can be misleading. Indeed, a direct application of the assumptions made by those studies to the office market will result in mis-specification of the theoretical model, which will result in erroneous conclusions. As pointed out in calculating the capitalization rate in Chapter 5, high leveraging and trading of properties, are crucial elements in understanding the complete effect of monetary and fiscal policy. In order to measure the magnitude of these effects, the historical trends of the leverage incentives and the depreciation allowances are analyzed separately and then their combined effect is presented.

First, the incentive to incur debt varies because high (low) inflation rates and the deductibility of nominal interest costs imply that the real after-tax interest rates that firms pay is actually low (high). Figure 23 illustrates the net benefit of leveraging (i.e., Λ) between 1948 and 1990 based on Equation (48) in Chapter 5. One can observe clearly that during periods of relatively high inflation, the incentive to incur debt increased. Until the mid 1970s, fairly stable and low inflation rates (except in the early 1950s) and nominal interest rates did not alter the leverage incentive. However, in the second half of the 1970s and the early 1980s, when the inflation rates rose sharply, the leverage incentive jumped reaching an unprecedented rate of 81 percent in 1977. In the second half of the 1980s, the success of the Reagan administration's anti-inflationary policy reduced the inflation rates back to the early 1970s level. However, without a concurrent drop in the long-term interest rates, the leverage incentive soon dropped to the lowest level over the last 40 years. Since the loan-to-value ratio for office investments is over twice as high as the overall corporate leverage ratio, the

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leveraging incentive is far more significant in analyzing the true cost of capital for an office investment.

Net Benefit of Debt Financing (Lambda)
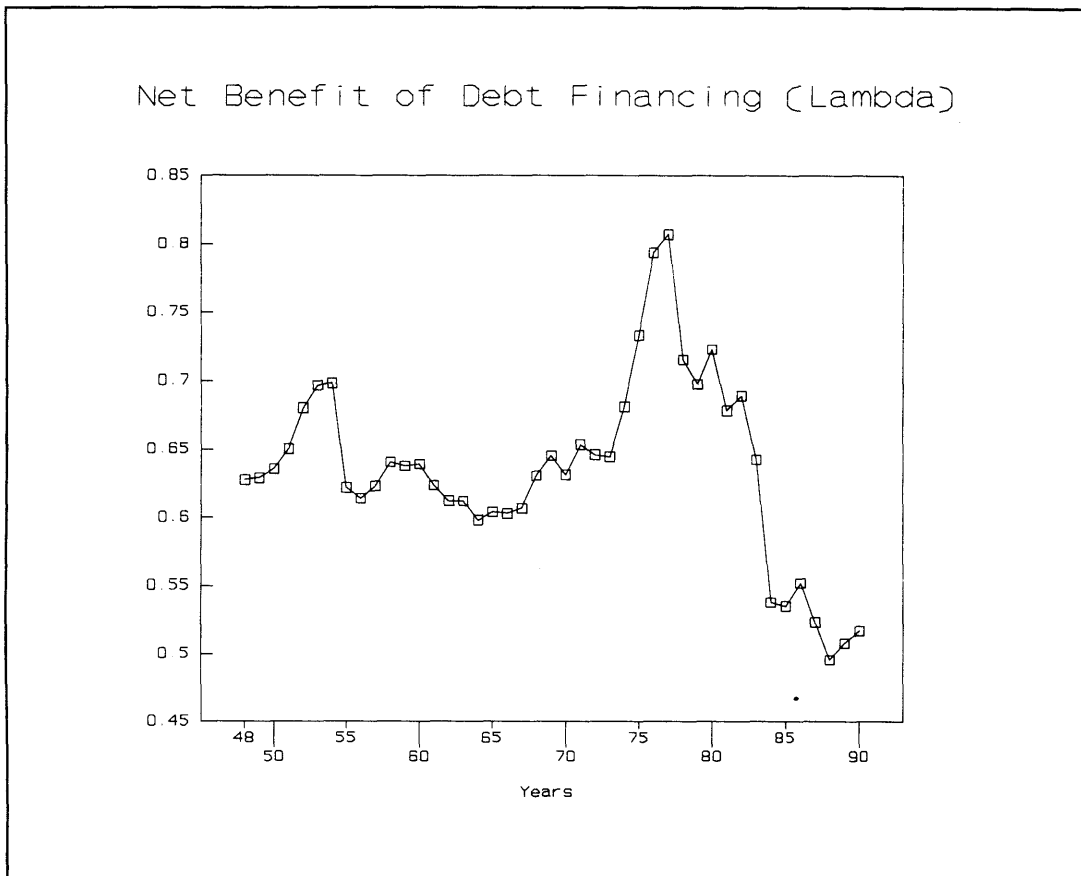
Figure 23

Second, the present value of depreciation allowances (i.e., Γ in Equation (47) in Chapter 5) based on a 15-year holding period has changed dramatically over the last 40 years as tax rules on depreciation and inflation and interest rates changed. Figure 24 shows that the provision of accelerated depreciation in 1954 led the depreciation allowances to jump by about 50 percent of 1953's level. Since then, the present value of depreciation allowances declined steadily until 1980. Notwithstanding the fact that the rising rate of inflation reduced the value of

Depreciation Allowances
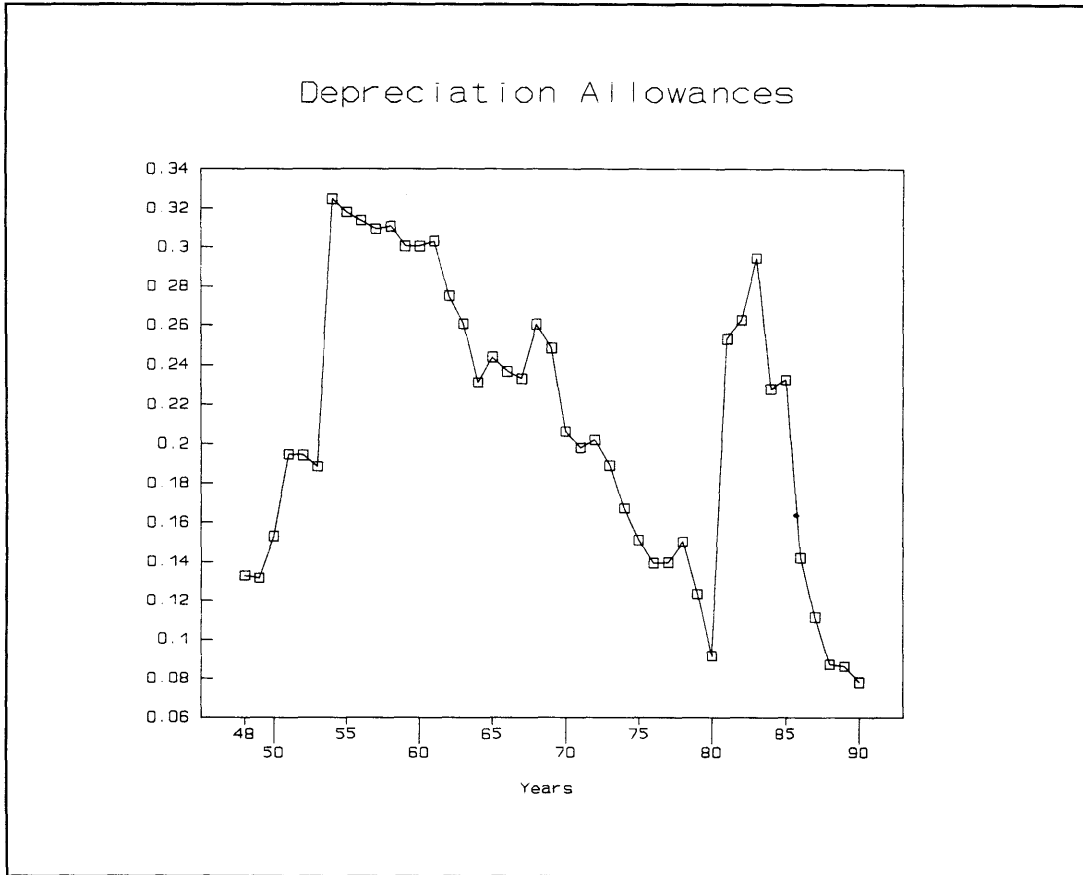
Figure 24

depreciation allowances, declining ordinary tax rates, rising capital gains rates,

and extending the depreciation period also contributed significantly to the decline.

In the first half of the 1980s, the effect of ERTA and TEFRA, and a drastic drop in

the inflation rates propelled the depreciation allowances to jump as high as 30

percent. By the enactment of TRA in 1986 and as a result of its negative impact,

much of the rise in the depreciation allowances generated by ERTA and TEFRA

disappeared. Even though the rate of inflation in the late-1980s was near the

early-1960s level, a significant drop in the ordinary tax rate, a rise in the capital

gains tax rate, and setting the depreciation period at 31.5 years with a straight-

line method had extremely negative effects on the present value of depreciation

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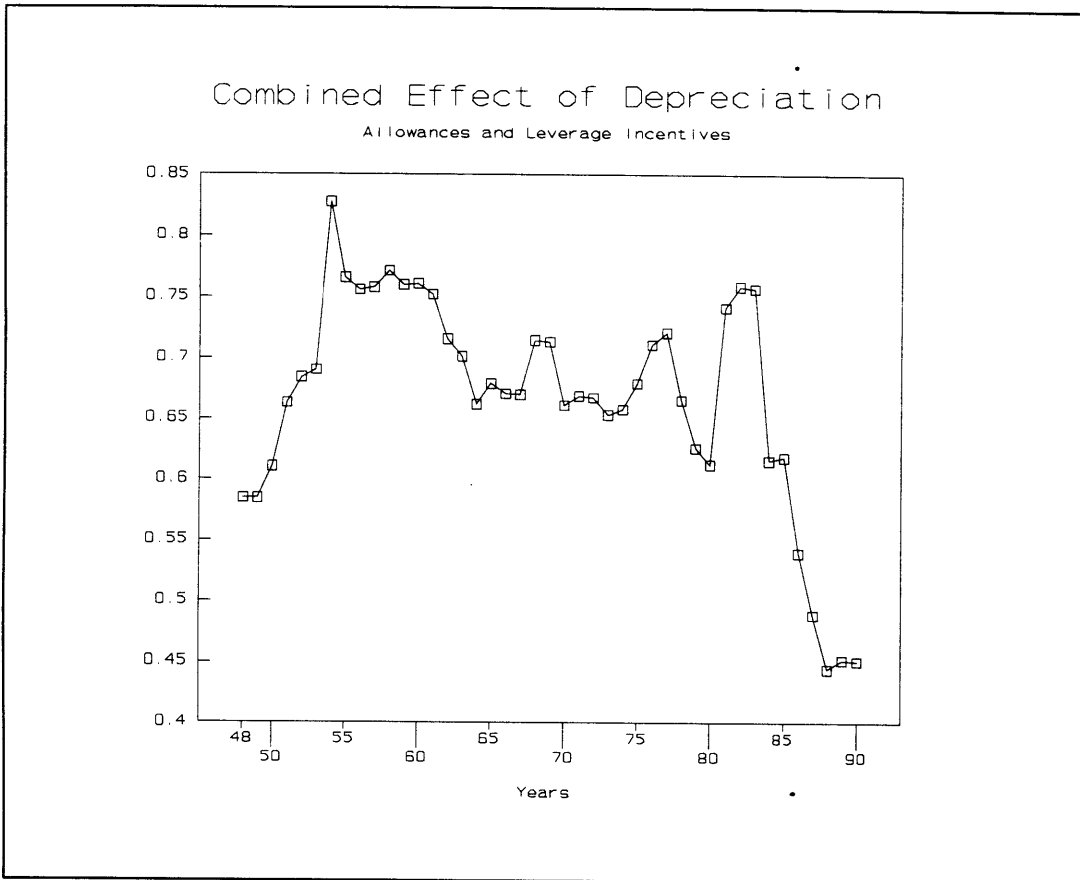
allowances.

Figure 25

The combined effect of the leverage incentives and the present value of

depreciation allowances can illustrate the interaction of the interest and inflation

rates, and tax policy. Figure 25 shows a sum of these two factors with an

assumption that the leverage ratio is set at 72 percent (i.e., $\Gamma + \theta\Lambda$ in Equation (49)

in Chapter 5).

In most cases, the increase (decrease) in the leverage incentives is offset by the

respective decrease (increase) in the depreciation allowances such that the resulting effect has been fairly stable. The notable exceptions are in the early-1950s and the late-1980s. In both periods, the significant changes in the after-tax real interest rates and tax policy appear to have been the cause. Specifically, in the early-1950s, the after-tax real interest rate dropped significantly due to a sharp increase in the inflation rate at the same time the accelerated depreciation scheme was introduced. On the other hand, in the late- 1980s, while the inflation rates dropped sharply, the interest rates remained relatively high, which resulted in historically high after-tax real interest rates. When the adverse effect of the high after-tax real interest rates is coupled with the even worse impact of TRA in 1986, a sharp increase in the cost of capital in the late-1980s is not so surprising.

7.4   Simulation Results

From the above illustrations one can deduce that the conventional belief, that lower inflation and lower statutory tax rates reduce the cost of capital is inapplicable in the office market. Conversely, in the office market the lowering of these rates increases the cost of capital and therefore results in quite the opposite investment responses. Table 17 shows the estimated capitalization rates based on various inflation and tax policy scenarios. The calculation assumes that the real interest rate is 4 percent (i.e., Strict Fisher hypothesis); the holding period is 15 years; risk premium is 7 percent; and the straight line depreciation method is used.

Table 17

Estimated Capitalization Rates based on Simulation Results

Variables	(1)		(2)		(3)		(4)	
Ord./C.G. Tax Rates (%)	34/ 34	34/ 34	50/ 50	50/ 50	34/ 34	34/ 34	50/ 28	50/ 28
Dep. Period (year)	31.5	31.5	31.5	31.5	39	39	39	39
Inflation Rate (%)	3	10	3	10	3	10	3	10
Cap. Rate (%)	8.56	8.30	8.09	7.21	8.92	8.57	8.29	6.53

Source: Author

The capitalization rates estimated in Table 17 indicate that higher inflation and ordinary tax rates actually lower the cost of capital. In the first scenario, at 34 percent tax rate for both ordinary and capital gains, and a 31.5 year depreciation period, the capitalization rate is 0.26 percent lower at a three percent inflation rate than at a 10 percent inflation rate. The difference in the capitalization rate between low and high inflation rates is much greater by almost one percent at the 50 percent tax rate, as shown by the second scenario. Of course, the capitalization rates for both inflation rates in the second scenario are lower than those in the first scenario as a result of higher tax rates.

Naturally, the third scenario, which extends the depreciation period from 31.5 years to 39 years, results in a higher capitalization rate for both low and high inflation rates. But the increase is significantly higher for the low inflation rate case. This implies that some of the negative impact of lower depreciation

allowances as a result of extending the depreciation period can be offset by a higher ordinary tax rate. The last scenario examines this case. A higher ordinary tax rate at 50 percent and a lower capital gains tax rate at 28 percent resulted in lower capitalization rates. As expected, the high inflation rate case produced a substantial drop -- nearly 2 percent -- in the capitalization rate. Clearly, a reduced capital gains (ordinary) tax rate has a significantly positive (negative) impact in lowering the capitalization rate.

It is evident that high leveraging and trading of office investment can result in just the opposite of the macroeconomic desired effect in the office market. For example, the ERTA of 1981 was enacted to stimulate the nonresidential investment level which had declined to 2.7 percent of GNP in the late-1970s. Many economists believed that high inflation rates in the mid- and late-1970s were responsible for the low investment rates. At the same time, the anti-inflationary policy in the early-1980s had drastically lowered the inflation rates. The combined effect of the ERTA tax rules and anti-inflationary economy was a huge drop in the effective tax rates, particularly for equipment, which also enjoyed investment tax credit. For the office market, the ERTA provided an unprecedented tax break, a part of which was offset by the drop in the inflation rates. Had the inflation rates not dropped in the 1980s, the capitalization rates would have dropped well below the level that was estimated in this analysis.

In contrast, the impact of TRA of 1986 was quite devastating to the office market. First of all, the inflation rates remained low at around 4 percent while the long-

term interest rates declined slowly. Secondly, a combination of a lower ordinary

tax rate and a higher capital gains tax rate forced the capitalization rates to move

up. Thirdly, extending the depreciation period from 19 years to 31.5 years

worsened the negative impact on the office market. These reasons explain how the

capitalization rates could have risen so sharply in excess of 10 percent in 1988.
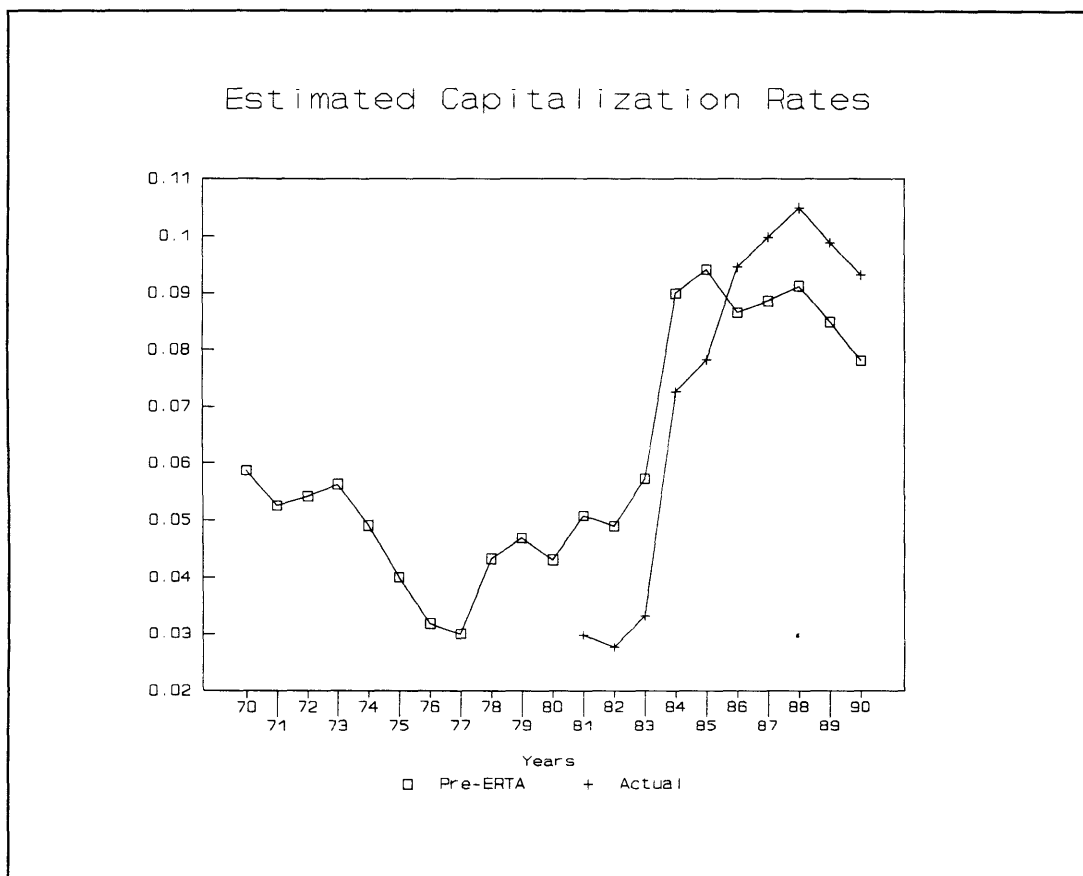

Figure 26

To illustrate what would have happened without the tax rule changes in the 1980s

(i.e., ERTA, TEFRA, and TRA of 1986), Figure 26 shows the movement of

estimated capitalization rates between 1970 and 1990. The pre-ERTA tax rules

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were assumed to continue throughout the 1980s and the level of interest and inflation rates were assumed to be undisturbed. Expectedly, the favorable tax rules in the first half of the 1980s lowered the estimated capitalization by about 2 percent. However, in the second half of the 1980s, the estimated capitalization rates after the enactment of TRA of 1986 were higher than those that would have prevailed had the pre-ERTA tax rules continued.

Considering just the impact on the office market, one can easily conclude that ERTA of 1981 was not necessary to boost the office investment because the high inflation rates and high absorption rates in the late-1970s themselves would have provided a sufficient amount of stimulus to foster high investment. Specifically, the capitalization and absorption rates in the late-1970s were hovering in the 4 percent and 7 percent level, respectively.

Since the rental investment occurs with a few years' lag, the investment rates in the early-1980s would have increased even without an enactment of the ERTA. Figure 27 shows the actual investment and two estimated investment levels between 1970 and 1990 applying the existing tax rules during the period versus assuming that the pre-ERTA tax rules applied throughout the 1980s. In calculating the investment levels, regression results based on lagged equilibrium capitalization rate, rental income, and absorption and vacancy rates were used. While using Equation (22) (i.e., including the estimated equilibrium price variable) would have produced a better estimation of the investment rates, the difficulty in estimating the net operating income makes the use of Equation (22) troublesome.

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Estimated Office Investment
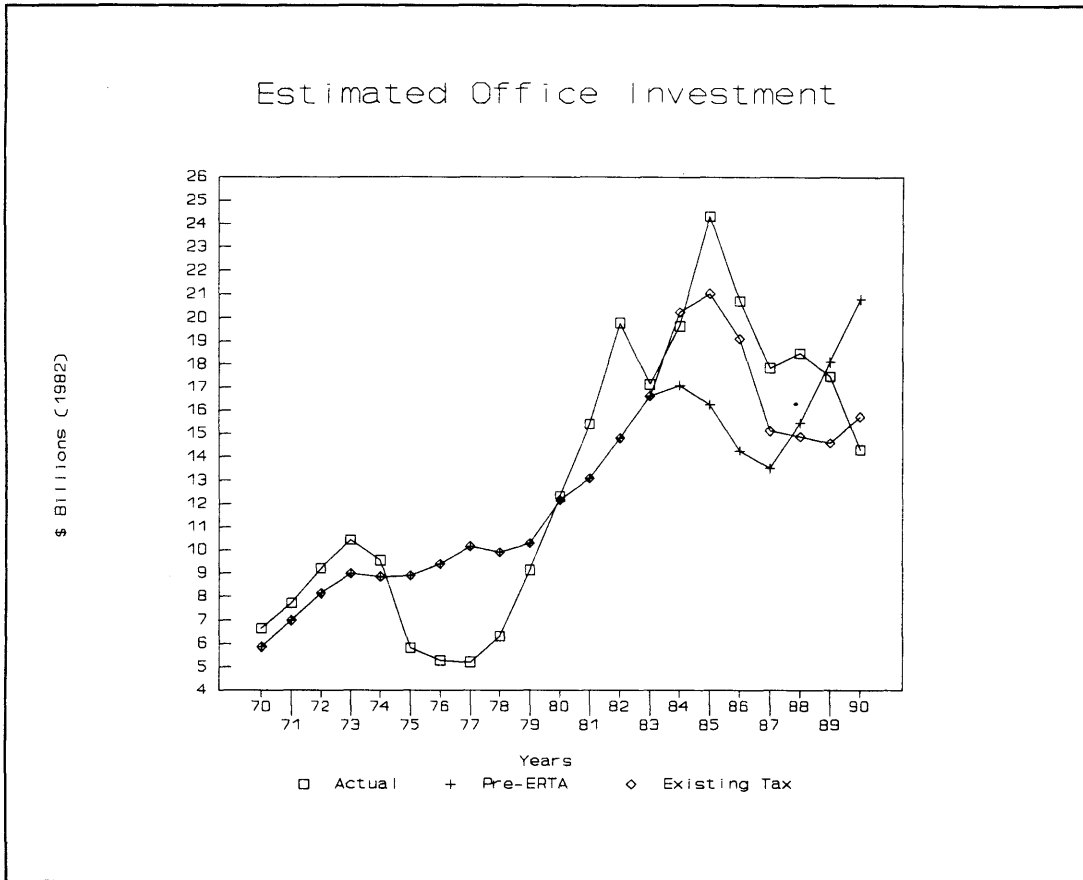
Figure 27

In the process of estimation, the employment growth levels, inflation rates, and interest rates were assumed undisturbed by the differences in the tax rules. However, lower investment levels for the pre-ERTA estimation in the mid- and late-1980s would have induced the vacancy rates to decline, which would force the rental rates and future investment rates to increase, holding all else constant. To reflect the rise in the rental rates, the rental rate variable was estimated based on Equations (50) and (52) in Chapter 6. Also, since the absorption level is negatively affected by rising rental rates, Equation (11) in Chapter 4 is applied to estimate the absorption levels. In other words, this simulation is based on general equilibrium analysis rather than partial economic equilibrium analysis.

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The above estimations suggest that much of the rise in the investment in the early-1980s would have occurred even without the ERTA. Nevertheless, the impact of the favorable changes in the tax rules prior to the TRA of 1986 is felt throughout the mid-1980s as indicated by the consistently lower investment levels under the pre-ERTA tax rules. However under the pre-ERTA tax rules, between 1988 and 1990, the investment levels are estimated to rise in response to lower vacancy rates in the mid-1980s. The long lags in the investment behavior are further evidenced by the lack of any sign (as of 1990) of a negative impact from the TRA of 1986. This delay suggests that the full impact of the TRA of 1986 is going to be felt in the early- and mid-1990s.

Another indicator of the poor timing of the tax policy changes in the 1980s is the vacancy rates. If the pre-ERTA tax rules were applicable in the 1980s, the simulation results show that the vacancy rates in the 1980s would not have been so high. Figure 28 illustrates the estimated vacancy rates based on hypothetical pre-ERTA tax rules, existing tax rules, and actual vacancy rates. The two estimated vacancy rates begin to deviate starting in 1984; however, by 1990, the higher investment levels in the late-1980s (1988, 1989, and 1990) offset the difference. More interestingly, for both the pre-ERTA and existing tax scenarios, the estimated vacancy rates would have exhibited the same cyclical behavior (although trending upward) as observed in the 1970s.

Estimated Vacancy Rates

Legend: □ Actual + Pre-ERTA ◊ Existing Tax
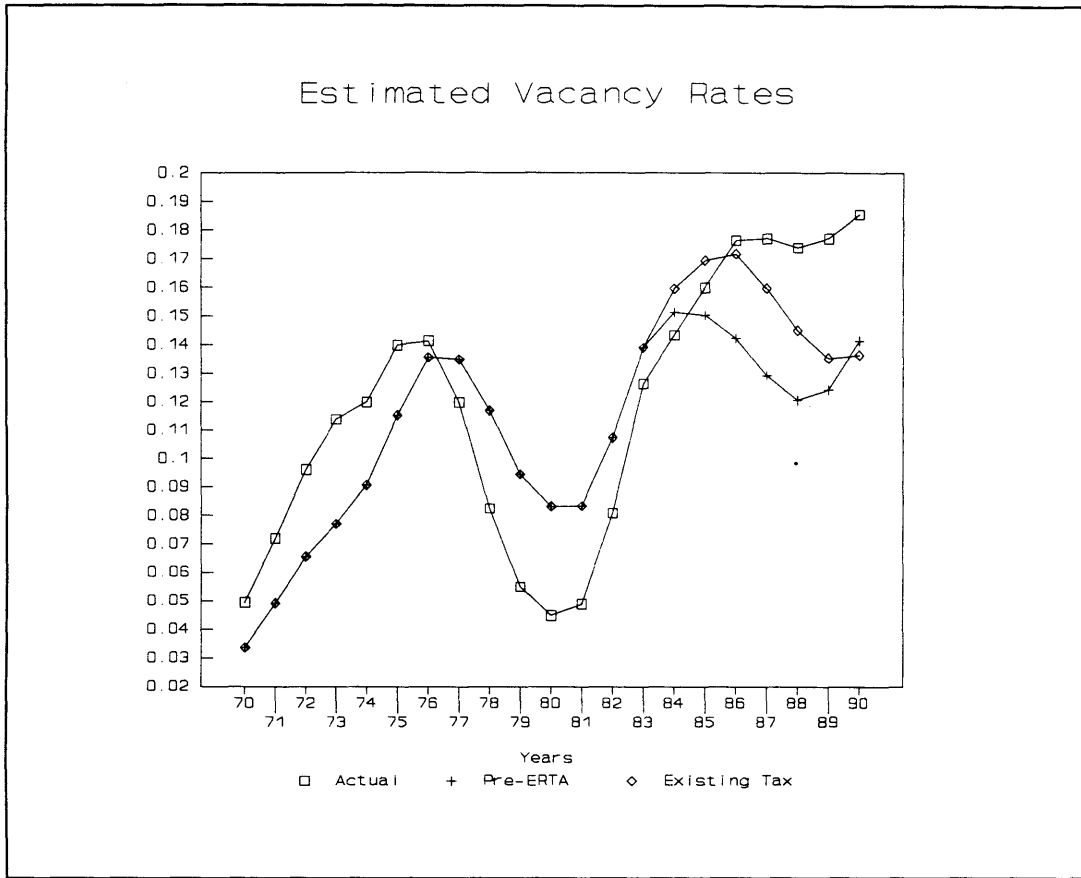
Figure 28

7.5   Concluding Remarks

Investment in commercial properties, especially office buildings, is typically made
with a high leverage ratio around 70 percent and an expected holding period that
is much shorter than the expected life of the properties. In this chapter,
estimations of the capitalization rate reflecting the two characteristics have shown
that the prevailing notion that high inflation and the U.S. tax rules interact to
discourage investment is erroneous for the office market. Of course, the
estimations necessitated some constraining assumptions that would be

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unreasonable under extreme conditions. However, within the boundary of conditions that prevailed over the last 20 years, those assumptions are reasonable and acceptable. On the basis of the estimated capitalization rates, one can conclude that the monetary and fiscal policy to stimulate overall capital investment may lead to undesirable effects on the office market.

Secondly, simulations performed in this chapter suggest that poor timing and frequency of changes in the tax rules in the 1980s have exacerbated the cyclical nature of the rental office market. With such a slow speed of supply responses, as estimated in Chapter 5, the complete effect of changes in tax rules cannot be detected at least for a few years, at which time the economic conditions would have changed. Beside the monetary and fiscal policy, another fundamental force driving the office investment is office employment level. Since the lag in the rental office supply adjustment is considerably long, a low investment in this year may be a response to a high vacancy a few years ago, rather than to the prevailing economic conditions.

The findings of this chapter foreshadow what to expect in the 1990s. Assuming that economic conditions continue to be sluggish, inflation rates remain low, real interest rates sustain at a relatively high level, and the depreciation period extends to 39 years, the net investment levels are likely to remain very low or negative as the excess supply is absorbed. Unless the office employment growth rate accelerates, lowering rental rates by itself will take a very long time to erode the excess supply of office space.

Chapter 8

The Determinants of Lease-Versus-Buy Decisions

8.1   Introduction

One of the salient characteristics of the office market discussed throughout the thesis is that, particularly over the last two decades, the reliance on the rental office market for providing office space has increased dramatically. For example, the amount of office investment made by firms in real estate and insurance carriers (REIC) industries surpassed consistently and significantly that of all other industries in the 1980s. In fact, the percentage of gross office stock owned by the firms in REIC industries nearly doubled in the 1980s. Specifically, the REIC's share of the gross office stock averaged around 25 percent between 1947 and 1980, and by 1990, it reached nearly 40 percent.

The coexistence of owner-occupants and renters in the office market, and especially the increasing demand for the rental office space, imply that there must exist substantive economic differences between the rental stream and the cost of office ownership, which determine the tenure choice. In this chapter, various theories on the determinants of the tenure choice are presented and these determinants are tested empirically to the extent that adequate data is available.

Leasing is differentiated from owning in various ways including economic, legal, and accounting aspects. Since this thesis is concerned with the economical aspect, the legal and accounting differences are discussed briefly here and the rest of the chapter is devoted to the economical differences. From the legal aspect, leases temporarily separate the ownership and use of property. During the term of the lease, the owner's interest is the right to reversion, which means that the use of the property reverts back to the owner at the end of the lease term. Therefore the difference between a lessor and a lender is that the former has ownership but not the use of the property and the latter has neither ownership nor the use of it. In the case of default, the lessor can claim all or a part of the unpaid rental payments and take back the use of the property whereas the lender has to undertake a lengthy foreclosure procedure to take the title (i.e., both the use and the ownership) of the property. Most of the office leases in these days include not only the use of the property but also services in exchange for rental payments. The services can include such items as utilities, janitorial, taxes and assessments, insurance, and maintenance. As these services costs have become unpredictable, the modern office lease contracts allow the lessors to pass through the services costs to their lessees. Hence the risk of rising services costs, which had been a responsibility of ownership, is now born by the lessees. In fact, the essential difference between the lessor and the lender is that the former has the right to and assumes the risk of salvage value or residual claim that the latter does not.

From the accounting perspective, rental payments are considered as operating expenses. In most cases, office leases, which are operating leases rather than

capital leases, are not capitalized under the liabilities side. The only place, outside of the income statement, where one can get some, but not always clear, indications of the magnitude of leasing activities is under a footnote, which shows the annual aggregate lease payment obligations for the next four years and a single number for the cumulative lease payment obligations beyond the fourth year. The ownership of an asset -- in particular real estate -- poses a greater problem for accounting purposes. First, value of the asset is reported at its historical value (i.e., the nominal price at which the asset was purchased) and the book value, which is the historical value less the accumulated depreciation. Clearly, these two values provide very little insight into the market value, which would reflect the true performance of the firms. Second, the disposal of real estate, for the firms whose primary business is not real estate, is typically considered as an extraordinary gain or loss which is reported separately from operating earnings. The practical implication of this separate reporting is that firms in the capital market, in particular securities firms, credit reporting firms, and banks, do not value operating and extraordinary earnings equally in evaluating past and future performance of the firms. That is, the extraordinary earnings are subjectively discounted or ignored altogether.

In economic terms, a casual observer may perceive the lease-versus-buy (LVB) decision as a simple capital budgeting problem which can be solved by applying present value techniques. However, the problem is anything but simple as evidenced by a substantial number of articles written on the subject. Much of the existing literature on the LVB analysis, considering primarily long-term financial

leases, sets non-financial factors equal and focuses on the effective marginal tax rates as the main source of asymmetries between a lessee and a lessor (e.g., Miller and Upton [1976], McConnell and Schalheim [1983], Myers, Dill, and Bautista [1976], Levy and Sarnat [1979], Schall [1974], Lewellen, Long, and McConnell [1976], Franks and Hodges [1978], Brealey and Young [1980], Bower [1973], Idol [1980], Gordon [1974]). By assuming away the non-financial differences, these studies conclude that firms whose effective tax rate is higher than that of a lessor should lease. While it is true that the effective tax rate can be an important determinant as long as all the relevant variables are correctly specified to calculate it, none of the existing models appears to provide a practical and operational LVB analysis applicable to the office market. In many cases, unreasonable assumptions are imposed in their models, and in some cases, conflicting results are found to be caused by diverging assumptions made in their models. The most notable controversy is the appropriate discount rate to use in the LVB analysis. Alternatively said, failure to model leasing behaviors properly has been to the fact that: 1) even if the non-financial factors are ignored, the effective marginal tax rate is not so easy to calculate given the complexity of assessing a firm's policy on debt and attitude toward risk in relation to the residual value, and more importantly, 2) the non-financial factors cannot be ignored because they influence the LVB decisions greatly.

The complexity of the LVB decision and the controversy among theorists cause serious confusion for the practitioners. A survey on corporate real estate leasing behavior by Redman and Tanner [1989] reveals that the U. S. companies do not

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behave in the ways that researchers have theorized. The most interesting result of the survey is that these firms view leasing to be advantageous over owning primarily because of 1) conservation of cash, 2) tax deductibility of lease payments, and 3) provision of off-balance sheet financing, in that order. Most of the theoretical researches so far have shown that these are irrelevant and in fact wrong reasons for firms to prefer leases over ownership. In Section 8.2, the equilibrium office rent equation, based on financial factors, is developed, and in Section 8.3, the sources of non-financial asymmetries between leasing and owning are presented.

8.2   The Equilibrium Office Rent Equation

Consider a lessor and a lessee in a competitive office market in which the lessee pays the lessor a net rent, denoted L_t, in time t for the use of a building during the term of the lease, denoted n. The lessor is assumed to pass through the servicing costs (e.g., operating expenses) to the lessee, thus the net rent is applicable. The competitive market assumption requires that the purchase price and the operating expenses be same between the lessor and lessee. Assuming further that: 1) firms do not pay taxes; 2) the cost of equity and debt is same; and 3) the term of the lease equals the useful life of the building and the salvage value is zero at the end of the useful life (i.e., a financial lease), the equilibrium rent is as follows:

$$\sum_{t=0}^{n} \frac{L_t}{(1+r')^t} = V_0 \tag{58}$$

where r' = the risk adjusted nominal discount rate (before tax), and

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V_0 = the value of the office building in period $t=0$.

Equation (58) is identical to Equation (23) in Chapter 5, if $L_t = C\ (1+\pi-\delta)^t$, where π and δ represent the expected inflation and economic depreciation rates, respectively. From the lessor's point of view, the discount rate, r', is a function of risk-free real interest rate, expected inflation rate, risk premia, which are based on the uncertainty of the inflation and economic depreciation rates, the probability that the lessee may default on the rental payment, and a compensation for the administration, monitoring, and processing costs imposed on the lessor. In other words, r' represents the lessor's lending rate. From the lessee's point of view, r' is the marginal interest rate on borrowing. Quite obviously, since the capital market is assumed to be competitive without transactions costs at this point, the lessee's borrowing rate is the same as the lessor's lending rate, therefore no value is created by the lease contract.

The first assumption can be removed by introducing marginal tax rate, u, and the depreciation allowances in period t, D_t, into Equation (58) as follows:

$$\sum_{t=0}^{n} \frac{L_t(1-u)}{(1+r_1)^n} = V_0[1 - u \sum_{t=1}^{T} \frac{D_t}{(1+r_2)^t}] \tag{59}$$

where r_1 = after-tax interest rate on borrowing $(1-u)r'$,

     T = depreciation period, and

     r_2 = risk-adjusted after-tax discount rate on depreciation allowances.

Assuming that $L_t = L_0 (1+\pi-\delta)^t$, Equation (59) can be solved as:

$$L_0 = \frac{V_0(1-uz)}{(1-u)k_n}$$

(60)

where

$$k_n = \frac{[1-(\frac{1+\pi-\delta}{1+r_1})^n]}{r_1-\pi+\delta}$$

(61)

and

$$z = \sum_{t=1}^{T} \frac{D_t}{(1+r_2)^t}$$

(62)

As long as the lessor's and the lessee's respective marginal tax rate, u, and the ability to utilize the depreciation allowances, z, are equivalent, firms should be indifferent as to whether to lease or to own. Since D_t is not likely to differ between the lessee and lessor, z can only differ by the non-equivalent rate of r_2 assumed by the lessor and lessee. The discount rate, r_2, is the after-tax, risk-free rate plus the amount of risk that a firm will become nontaxable. Therefore, considering large corporations -- whose likelihood of becoming nontaxable is virtually negligible -- the difference between the lessor's and lessee's z should be equivalent. However, those firms whose tax rates are low or zero should favor leasing over owning.

Based on this analysis, Miller and Upton [1976] argue that the peculiarities of the U. S. tax laws create asymmetry between lessor and lessee and that certain firms prefer to lease because they cannot take full advantage of the tax subsidies, which lower the effective marginal tax rate, provided to the owners. They, therefore,

assert that high-tax-rate firms are competitively advantaged to take the tax subsidies to offer leasing deals to low-tax-rate firms. If the marginal tax rate were the key determinant, then a firm should either lease or own all or a substantial portion of assets, including real estate assets. However, empirical findings appear to contradict this argument. Redman and Tanner [1989] reveal that close to 62 percent of firms surveyed both lease and buy real estate assets, 18 percent of the firms just lease, and 20 percent of the firms just buy. Ang and Peterson [1984] also find that the average tax rates of the firms that lease, versus the ones that do not, are not significantly different from one another. On the contrary, they find that the average tax rates of the firms that lease are consistently higher than those that do not. Certainly, these empirical findings do not substantiate the argument that the tax rate differential between lessors and lessees is the primary motive for leasing. As pointed out by Lewellen et. al.[1976], the tax effect depends on "the specific asset life (lease period), depreciation schedule, capitalization rate, and leverage possibilities" such that a high-tax-rate firm may find it to be financially prudent to be a lessee rather than a lessor.

The largest 20 firms' office tenure decisions from CB Commercial's National Tenant Data, which will be described later in Section 8.4, also show that many of the firms both lease and own office space. Table 18 lists those 20 firms with an aggregate size of 50,000 square feet or larger office space broken down by their tenure. It is quite evident that most of the firms have a reasonably balanced portfolio of owned and leased office space. Only three firms appear to lease or own substantially all of their office space. Also the average of the 20 firms' office

ownership rates is nearly 44 percent.

Table 18

Office Space Tenure Break-down by the Largest 20 Firms

FIRM	SF Leased (in 1,000)	SF Owned (in 1,000)	Percentage Owned
1	7,180	4,271	37.30%
2	6,764	4,258	38.63%
3	4,119	1,400	25.37%
4	2,638	1,757	39.98%
5	944	2,936	75.67%
6	316	3,294	91.25%
7	3,451	0	0.00%
8	1,059	2,309	68.56%
9	1,219	2,098	63.25%
10	3,169	0	0.00%
11	1,405	1,693	54.65%
12	1,120	1,812	61.80%
13	985	1,709	63.44%
14	1,882	812	30.14%
15	982	1,300	56.97%
16	1,015	1,046	50.75%
17	1,546	431	21.80%
18	408	1,241	75.26%
19	1,297	245	15.89%
20	990	551	35.76%
Total	42,489	33,163	43.84%

Source: CB Commercial

To relax the second assumption, the use of debt to finance the purchase can be incorporated into Equation (59) as was done in Chapter 5. Again, assuming a level-payment mortgage with a loan amount equalling θV_0, a maturity date of M, which is equal to or shorter than n, and a fixed interest rate of i, the payment P, is:

$$P = \theta V_0 \left[\frac{i}{1-(1+i)^{-M}} \right] \tag{63}$$

and

$$(1-u)L_0 k_n = V_0(1-\theta-uz) + (1-u)P \sum_{t=1}^{M} \frac{1}{(1+r_3)^t} + uP \sum_{t=1}^{M} \frac{(1+i)^{t-M-1}}{(1+r_3)^t} \tag{64}$$

where r_3 = the lessor's after-tax cost of borrowing.

The equilibrium rent can be expressed as:

$$L_0 = \frac{V_0(1-\lambda\theta-uz)}{(1-u)k_n} \tag{65}$$

where $\lambda = 1 - \lambda'$, and

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$$\lambda' = \frac{i}{1-(1+i)^{-M}} \sum_{t=1}^{M} \frac{1-u[1-(1+i)^{t-M-1}]}{(1+r_3)^t} \qquad (66)$$

At this point, the indifference between leasing and owning is not violated insofar as the lessor's and the lessee's respective borrowing rate, r_3 and i, and borrowing capacity, θ, are equivalent. But, firms with either a higher borrowing rate or a lower borrowing capacity than those of the lessors should prefer to lease rather than to own.

Lewellen et. al. conclude that the most significant factor contributing to the active leasing market is the "ineptitude" of the lessees to exploit their borrowing capacity to the fullest while the "enlightened" lessors take the full advantage of their borrowing capacity. In other words, they argue that lessees do not maximize θ to maximize the deductibility of interest payments. Of course, they are assuming that $r_3>(1-u)i$, so that maximizing debt is economically desirable. Admittedly, prevalent uses of secured debt coupled with the existence of a secondary market for office buildings lower the agency costs of issuing risky debt such that a relatively higher leverage ratio is allowed to finance office investment as opposed to issuing unsecured risky debt. To a certain extent, their argument is valid. However, they may be presumptuous to call those lessees "inept" given the complexity of a firm's leverage policy. The agency costs associated with issuing risky debt must be considered. For example, Myers [1977] demonstrates that those lessees may not be "inept" in exploiting their borrowing capacity, but rather, they do not borrow as much as they could in order to maximize their firms' value. He points out that a financial policy of maximizing debt may "reduce the present value of a firm holding

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real options by inducing a sub-optimal investment strategy or by forcing the firm and its creditors to bear the costs of avoiding the sub-optimal strategy." A more pertinent issue is whether lenders view a rental office building less risky than a comparable owner-occupant office building so that a greater borrowing capacity is available from the rental office building. If this were the case, then those "inept" lessees may not be so "inept."

Related to the above issue on the capacity to borrow is the amount of debt displaced by leasing contracts. A financial lease should be considered as a perfect substitute for secured debt. However, some (e.g., Miller and Upton) asserted mistakenly that every dollar of lease payment displaces exactly one dollar of debt capacity. This argument is based on a widely perceived but inappropriate notion that leases provide 100 percent financing, which is not available in the debt market even to the most credit-worthy corporations. On the other hand, market imperfections with respect to the lenders attitude toward tax- shield borrowing prevent owner/user firms from fully utilizing their tax shield borrowing opportunities. Myers et. al. [1976] , Idol [1980], Levy and Sarnat [1979], and McConnell and Schallheim [1983] analyzed LVB decision as lease versus buy and borrow decision and estimated that the ratio of debt payment displaced by a lease payment is probably less than one but greater than zero. Based on an experimental approach, Bayless and Diltz [1987] estimated the ratio to range from .94 for assets with a depreciable life of one year, to .75 for assets with a depreciable life of 20 years. Further empirical evidences are provided by office property lenders. Typically, in order for an office mortgage to be approved by a

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lender, the loan-to-value ratio must be lower than one (i.e., the ACLI data averaged 72 percent) and the debt service coverage ratio (net operating income over debt service) must be higher than one (i.e., the same ACLI data show that the average debt service coverage ratio was 1.3). Clearly this type of mortgage requirements validate the claim that the debt displacement ratio must be less than one.

The third assumption (i.e., the lease term equals the useful life of the asset), which is the most unrealistic assumption, can be relaxed by inserting the market value, V_n, the capital gains rate, u_c, the present value of book value, and the present value of mortgage balance. As in Chapter 5, the present value of the salvage value, V_n, is assumed to be exogenously determined, even though, in reality, the level of maintenance will affect the salvage value. More importantly, the salvage value is also determined by the market conditions (the level of supply and demand) as well as expected inflation, interest, and tax rates in period n. In fact, this introduces the most critical feature of a lease agreement. By contracting a lease agreement, the user firm is, in essence, buying a call option with an expiration period n and a zero exercise price. On the other side, the lessor purchases the office building and sells the call option and assume the risk of the salvage value.

Also assuming that the direct out-of-pocket transactions costs are proportional to the market value by τ, the ratio between V_n and V_0, denoted v_n, is:

$$v_n = \frac{(1-\tau)(1+\pi-\delta)^n}{(1+r_4)^n} \qquad \text{(67)}$$

where the discount rate, r_4, is a rate that is commensurate to the level of

uncertainty of the market value V_n and the risk-free interest rate. The option

pricing model suggests that the uncertainty component of r_4 is a positive function

of the level of volatility of the office market, and the length of the lease agreement.

Since the office market has exhibited a significant level of volatility, the discount

rate, r_4, must be considerably higher than any other discount rates used so far.

The present value of the book value, denoted B_n, is:

$$B_n = \frac{V_0(1-\sum_{t=1}^{n} D_t)}{(1+r_2)^n} \qquad \text{(68)}$$

and applying a straight-line depreciation method, Equation (68) becomes:

$$B_n = \frac{V_0(1-n/T)}{(1+r_2)^n} \qquad \text{(69)}$$

Combining Equations (67) and (69), the after-tax present value of the depreciation

allowances and the recapture of excess depreciation, denoted ΔV_0, where Δ is:

$$\Delta = u\left[\frac{1-(1+r_2)^{-n}}{T(r_2)}\right] - u_c\left[\frac{(1-\tau)(1+\pi-\delta)^n}{(1+r_4)^n} - \frac{1-n/T}{(1+r_2)^n}\right] \qquad (70)$$

The ratio between the present value of the mortgage balance and the initial loan amount is:

$$a_n = \frac{\left[\dfrac{1-(1+i)^{n-M}}{1-(1+i)^{-M}}\right]}{(1+r_3)^n} \qquad (71)$$

Assuming that the lease term were shorter than or equal to the useful life of the asset, the term of the mortgage, and the depreciation period, the equilibrium rent is:

$$L_0 = \frac{V_0[1-\Delta-v_n-\theta(\lambda_n-a_n)]}{(1-u)k_n} \qquad (72)$$

where $\lambda_n = 1 - \lambda_n'$, and

$$\lambda_n' = \frac{i}{1-(1+i)^{-M}}\sum_{t=1}^{n}\frac{1-u[1-(1+i)^{t-M-1}]}{(1+r_3)^t} \qquad (73)$$

If the competitive market conditions as well as the same holding period between the lessee and the lessor are assumed, then the present value of the expected

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salvage value between the lessor and the lessee are identical, thus no measurable benefit exists for either leasing or purchasing. In contrast, firms that incur lower transactions costs or expect to use the property for a longer period should choose owning over leasing since their cost of ownership would be lower than the equilibrium rent.

Flath [1980] analyzed short-term leases (i.e., operating leases rather than capital leases) and he reasoned that leasing "economizes upon the costs of detecting, assuring, and maintaining quality, costs of search and costs of risk-bearing." His argument applies directly to certain markets, such as rental cars and hotels, in which the users/lessees have reasonably accurate expected use period which is substantially shorter than the lessors' holding period. However, for the office market, the transactions costs savings can only be analyzed with respect to the value of flexibility (i.e., the value in risk reduction). It is well known that a significant value of flexibility is derived from an ability to modify business' spatial usage in the face of uncertainty. Flexibility is necessary since, from the user's point of view, an office building may become either too small, too large, sub-optimal in terms of location, technologically obsolete, or economically undesirable to hold on to as its spatial needs change over time. Leases are considered to confer the users/lessees with the strategic value of flexibility by matching the expected use period of the property to the length of the lease. However, the strategic value of flexibility expected to be gained from leasing over buying, under some conditions, can be negative. In the office market, where a series of back-to-back mid- to long-term leases or repeatability (the notion that the capital services generated by an

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asset are required over an infinite horizon, and that a similar, if not identical, asset replaces the old asset at the end of the lease term) occur frequently, transactions costs savings may not materialize if a lessee's mobility rate is low. More specifically, the transactions costs savings exist insofar as the lessor's holding period is substantially longer than the lessee's use of the building. As discussed in Chapter 5, under the prevailing U.S. tax laws and at reasonable economic conditions, the optimal holding period equals the depreciation period, M. In practice, however, the average holding period appears to be shorter than the optimal holding period. Given that leasing transactions costs are also non-trivial, the overall transactions costs (including the lessor's transactions costs) born implicitly by the lessee after a single renewal of a 10-year office lease agreement may even be equivalent to or greater than the transactions costs resulting from a straight purchase. Therefore, a user firm whose expected use period is relatively long would prefer to own rather than to lease.

Additionally, lessors are believed to incur lower transactions costs because they are assumed to achieve economies of scale as a consequence of specialization (e.g., Benston and Smith [1976]). However, this argument appears to be questionable considering the fact that the office market is so fragmented with many minor investors. Also, the prevalent uses of and reliance on specialists, such as appraisers, brokers, and property management firms by both owner-occupants and lessors suggest that the former firms are probably not comparatively disadvantaged, and if so, only marginally.

8.3   The Non-Financial Determinants of LVB Decisions

In the previous section, the equilibrium rent has been analyzed under the assumption of long-run equilibrium market conditions. However, local office market conditions, national office market conditions over time, and user characteristics can greatly influence the LVB decision. The first three sets of factors, 1) size of office space sought, 2) size of local office market, and 3) average office price at the metropolitan level, are based on local market conditions. The fourth set of factors, 4) the national vacancy rates and market prices, represent the changing office market conditions over time. And user characteristics include: 5) ownership structure, 6) level of utilization, 7) level of corporate hierarchy in use, and 8) the industry to which the user firm belongs. Some of these incentives have been discussed by Smith and Wakeman [1985].

First, and probably the singularly most paramount, in the absence of an active office condominium market, is that a local office market may not offer the desired-size office building at the desired location sought by the user firm. As land prices increase, many office buildings -- particularly the ones located in central business districts -- are so much larger than the amount of office space desired by a typical user firm that many of these firms are, in fact, forced out of the owner-occupant office market unless they are also willing to enter into the office leasing business. Of course, user firms competing against the firms whose primary business in office leasing are comparatively disadvantaged and are therefore expected to bear a greater cost of risk. Therefore, the size of the office space desired relative to the

average size of the building in the local market is expected to determine the LVB decisions -- the larger the office space and/or the smaller the average size of office buildings, the higher the probability of ownership is.

Second, the repeatability of office leases introduces another associated factor, namely agency costs, in relation to the transactions costs. Klein, Crawford, and Alchian [1978] discuss the notion of appropriable quasi rent, which is the excess of its value over its salvage value. Because of transactions and mobility costs incurred as well as tenant improvements invested, a lease agreement creates "market power" to either lessor or lessee. This "market power," created because the lessor and the lessee are "locked-in," can result in opportunistic behavior by either the lessor threatening to charge a higher rent or the lessee threatening to pay lower rent. Local market conditions can alter the magnitude of the "market power." For example, a larger (smaller) market for the asset will decrease (increase) the value of appropriable quasi rent. Considering the office market, a typical office building/tenant in a large downtown area, where the magnitude of lease turnovers is high, the quasi rent is likely to be low since alternative tenants and buildings can be identified relatively easily. In contrast, a large building/tenant in a suburban area with a low probability of finding an alternative building/tenant will face high agency costs in the form of significant contracting costs. Therefore, one would expect that a user firm locating in a larger local market, in terms of the total square footage, should prefer to lease relative to a comparable firm locating in a smaller local market. Similarly, central business districts, as opposed to suburban or rural areas, are expected to offer a lower quasi

rent due to a higher density.

Third, a number of studies (for example, Voith and Crone [1988], Pollakowski, Wachter, and Lynford [1992]) have pointed out the importance of inter-metropolitan differences in the office market. Their studies find that it is inappropriate to impose a single structure on all markets. In other words, equilibrium and market rents are likely to be significantly different among metropolitan areas. This suggests that the user firms' LVB decisions may be influenced by these inter-metropolitan differences in price and/or rent. A survey of 53 metropolitan areas show a wide range of differences in office tenure across the areas. For example, cities such as Columbus, Ohio and St. Louis, Missouri have virtually a 50/50 split between owner-occupants and lessees; in contrast, Orange County, Bakersfield, San Diego, and San Jose, California have roughly a 10/90 split. Since the factors that determine the equilibrium capitalization rate (e.g., interest rates, inflation rates, and tax laws) are not expected to be different among metropolitan areas, average rental income (i.e., an average rental rate multiplied by an average occupancy rate) and volatility of vacancy rates are expected to reflect the inter-metropolitan office price differences -- the higher the average rental income and lower the volatility of vacancy rates, the higher the price is. Of course, the user firms are expected to be averse to lease (own) in a metropolitan area with a relatively lower (higher) price.

Fourth, the volatility of the office market, as evidenced by the cyclical vacancy rates, along with slow supply and rental adjustments suggest that there may be

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certain periods when the market rent is lower than the equilibrium rental rate. This disequilibrium can arise due to two main reasons: As discussed in Chapter 6, since the market rental rates and vacancy rates are expected to move in the opposite direction with some lags during the periods of high (low) vacancy rates, the observed market rent may be significantly lower (higher) than the equilibrium rental rate. Therefore, the user firms are likely to prefer leasing (owning) when the vacancy rates are high (low). Similarly, the market prices of office space can be significantly high (low) relative to the construction costs due to changes in interest rates, inflation rates, and tax laws. Quite obviously, when the market price is high, the user firms can choose to either lease or to construct their own office buildings. Since the construction option is hampered by relatively long delays as well as size constraints, many user firms are likely to opt for leasing. In contrast, when the market price falls significantly below the construction costs, the user firms may find purchasing existing office buildings more economical.

Fifth, ownership structure of the user firms can affect the LVB decisions in at least three situations. User firms organized under partnerships such as accounting, architectural, engineering, legal, and management consulting firms have incentives to lease. While the amount of risk involved in investing in office buildings, as in any other type of capital assets, can only be allocated to partners, leasing introduces a means of achieving an efficient allocation of risk for partners by allowing lessors, an additional party, to bear a part of the risk. The efficient allocation of risk is achieved when risk is attributed to a party that can assume the risk at the lowest cost. Therefore, those partnership firms who believe that the

lessors are comparatively advantaged in buying, managing, and selling office buildings will chose to lease. In practice, the user firms would assign substantially higher discount rates, in particular r_4, in order to reflect their presumed greater level of uncertainties with respect to the future value. Accordingly, they would find that the market rent is lower than their own equilibrium rent. Also, ownership of office properties generates logistical problems for partnerships in that, as new partners are added and some partners leave, conflicts can arise in assessing the value of their office holdings. Practically, leasing can prevent these conflicts since lessees do not have the residual claim.

Non-profit organizations such as religious, social, and professional membership firms are guided by a particularly different set of incentives than that of the typical private firms. The most important difference is that the former does not pay taxes and as a result, under reasonable economic conditions and tax laws, its equilibrium rent is substantially lower than that of private firms. In most cases the equilibrium rent differential is large enough that it overwhelms other factors in the LVB decisions. Thus, non-profit organizations have incentives to own rather than to lease.

Publicly traded user firms have a conflicting set of incentives when it comes to LVB decisions. On one hand, these firms' financial and operating risk is already diversified among many shareholders and bondholders so that ownership of office buildings is not expected to expose them to significant additional risk. In addition, the publicly traded firms' cost of capital is likely to be lower than that of private

firms. On the other hand, the security market is likely to value office buildings at below the market value due to the accounting procedures discussed in the previous section. Brueggeman, Fisher and Porter [1990] also point out the possible comparative disadvantage of corporate-owned real estate for the same reasons. The anecdotal evidences are the popularity of leverage buy-outs of real-estate-rich firms in the mid-1980s following the inflationary periods of the late-1970s and the early-1980s. Presumably, this severe penalty on ownership offsets the possible incentives of owning office buildings by publicly traded firms.

Sixth, the agency costs of leasing also arise due to moral hazard (e.g., Alchian and Demsetz [1972]), that is, that the lessee will use the property carelessly, with little regard as to how careless use affects the property's durability or future value, V_n, since the lessee does not have the residual claim. The existence of moral hazard leads to adverse selection. If user firms recognize that market rent is higher than their user costs, then only those firms who will use the building more intensively will choose to be a lessee. For example, a firm whose density (i.e., a number of office workers to square feet occupied) is higher than the industry average can increase the value of δ. The lessors of multi-tenant buildings, who do not know *a priori,* which tenants are high users, and who are not capable of monitoring the individual tenants' marginal cost of operation, usually charge the average cost of operation (i.e., pro-rata share by square footage). As a result, the rent charged by the lessor will be too high for the low-use lessee, and conversely, the rent will be relatively low for the high-use lessee.

This suggests that only the high-use lessees will be attracted to the leased buildings and drive out the low-use lessees. Therefore, one can postulate that, *ceteris paribus*, leased buildings will have a shorter economic life due to a comparatively higher δ or that the V_n will be consistently lower than that of comparable owner-occupied buildings. If V_n were lower for the leased buildings, then the rental rate must be proportionally higher to compensate the lessor. Alternatively, in order to keep the quality of the leased building at the same level as a comparable owner-occupant building, then the maintenance expenses, typically passed on to the lessees, of the leased building must be higher. Thus the lessor's provision of the maintenance, which is paid by the lessees, ensures that the building will not be neglected because of failure to maintain it properly. However, this type of contract also creates agency problems in that the lessor's claim to the residual value V_n, while the operating costs are paid by the lessees during the term of their leases, provides an incentive for the lessor to over-maintain the building thereby increasing the V_n at the expense of the lessees. Of course, the lessor will over-maintain the building up to a point where its lessees are not driven out. Therefore the agency costs incurred due to moral hazard suggests that the market rent must be higher (lower) than the cost of office ownership for the low-use (high-use) user firms. Based on an office survey by Boston Redevelopment Authority [1979], Classes A and B buildings' average density were 207.9 and 203.6 square feet per person, respectively, whereas Class C buildings' average density was 238.5 square feet per person. Since older buildings represent Class C, one would find that those user firms occupying older buildings are the low-use firms, and accordingly, they are expected to prefer ownership.

Seventh, the heterogeneity in use of office buildings, even within a single user firm, implies that a certain location may be more valuable to the user firm (i.e., the use value) than the market value. The underlying reasoning is similar to the notion of appropriable quasi rent; however, not due to the repeatability of leases but due to the location fixity of certain uses. Suppose the use of office space within a firm can be desegregated by the level of hierarchy -- for example, headquarter, regional, and field offices. One can reasonably assume that the headquarter location is characterized by a lower mobility rate (i.e., a longer holding period), and a closer reflection of the firm's corporate image (i.e., a higher level of specificity in terms of office space and location) in comparison to the regional and field offices. Hence, for headquarter location, the user firms should choose to own in order to minimize the transactions costs and the appropriable quasi rent.

Eighth, given that firms in the FIRE and services sectors make up a majority of the office user firms, there may be a difference between the user firms in FIRE and services sectors in terms of their attitude toward office investment risk. Since the user firms in the FIRE sector are directly involved in asset investment and/or real estate, they may enjoy a comparative advantage in acquiring and selling office properties relative to the user firms in the services sector. The potential sources of this comparative advantage can include better access to financing acquisitions and lower information costs associated with general economic and real estate market conditions. If, in fact, this comparative advantage does exist for the user firms in the FIRE sector, then these firms have an incentive to own relative to the user firms in the services sector.

8.4 Methodology and Estimation Strategies

In the preceding section, eight sets of non-financial determinants of the LVB decisions have been presented. Since the objective of this chapter is to estimate an equation which will predict the LVB decision of individual users, a logit model is applied to measure the statistical significance of the determinants hypothesized above. The model will test individual decision with respect to the tenure choice so that the model can be applied to firms that exclusively lease or buy as well as firms that both lease and buy. The logit model is based on the cumulative logistic probability function and is specified as:

$$Prob(TENURE_i = 1 \mid X_{1i} \ldots X_{ni}) = F(Z_i) = F(\alpha_0 + \alpha_1 X_{1i} + \alpha_2 X_{2i} + \ldots + \alpha_n X_{ni})$$

and F(.) is a nondecreasing function such that:

$$P_i = F(Z_i) = \frac{1}{1 + e^{-Z_i}} \tag{74}$$

where the dependent variable, *TENURE*, is a dummy variable (i.e., 0 if a firm occupies leased office space and 1 if the firm owns office building that it occupies) as of 1990, and Z_i is a theoretical index which is determined by explanatory variables X's.

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The log likelihood function for the logit model is given by:

$$\log L(\alpha_0 ... \alpha_n) = \sum_{i=1}^{K} Tenure_i \log F(-Z_i) + (1 - Tenure_i) \log F(-Z_i) \qquad (75)$$

In total, 16 explanatory variables are tested and the definition of the variables are listed below in Table 19.

Table 19

Definition and Data Source of Variables

Variable	Definition	Data Source
1. LSF	Size of occupied space: Log (SF)	CB Commercial
2. LSZ	Avg size of buildings in metro area: Log (SF) 1990	CB Commercial
3. TS	Size of total office space in metro area: SF 1990	CB Commercial
4. CBD	Dummy variable: 1 if building is in CBD and 0 otherwise	CB Commercial
5. LRI	Avg rental income in metro area: Log (avg. rental rate) X occupancy rate 1986-1990	CB Commercial
6. VOL	Volatility of vacancy rates in metro area: Variance of vacancy rates 1986- 1990	CB Commercial
7. VAC	National vacancy rate in year occupancy began	CB Commercial and BOMA (Chapter 2)

8. LPR	Equilibrium price of office space in year occupancy began: Log (price)	Estimates from Chapter, 5
9. ABS	Absorption rate in year occupancy began:	Estimates from Chapter 4
10. PART	Dummy variable: 1 if user firm is partnership oriented (SIC codes 6211, 6282, 7311, 8111, 8712, and 8721) and 0 otherwise	CB Commercial and Ward's Business Directory
11. MEM	Dummy variable: 1 if user firm is in membership organization (SIC 86) and 0 otherwise	CB Commercial and Ward's Business Directory
12. PUB	Dummy variable: 1 if user firm is traded publicly and 0 otherwise	CB Commercial and Ward's Business Directory
13. LAGE	Age of building occupied: Log (1991-year constructed)	CB Commercial
14. HQ	Dummy variable: 1 if user firm's headquarter location and 0 otherwise	CB Commercial and Ward's Business Directory
15. SVC	Dummy variable: 1 if user firm is in services sector and 0 otherwise	CB Commercial and Ward's Business Directory
16. FIRE	Dummy variable: 1 if user firm is in FIRE sector and 0 otherwise	CB Commercial and Ward's Business Directory

Source: Author

The primary source of the data is CB Commercial's National Tenant and Building Files, and Metropolitan File. From these files, a total 2,137 observations (totalling approximately 275 million square feet of occupied space, which is estimated at about 10 percent of the entire occupied stock in the U. S.) are tested based on availability of other data and the value of LSF variable. The size of occupied space is of particular importance in limiting the data since user firms occupying very small office space are more likely to lease, which will result in the lessees,

seriously skewing the data. A lower limit of 50,000 square feet is chosen

somewhat arbitrarily to avoid this problem of sampling bias. The sampling bias

can be explained as follows: According to BOMA reports, the average size of a

tenant's office and an office building is approximately 10,000 and 200,000 square

feet, respectively. Given that the budget constraint and risk aversion exist, it is

reasonable to assume that an average-sized firm cannot invest economically in an

average-sized office building since it will have to lease out 95 percent of the space

that it does not occupy. Since office condominiums do not exist, the only

economically sensible strategy for the smaller firm is to obtain the space through a

lease. By setting the lower limit of the size of the lessees/owner-occupants to

50,000 square feet, one can reasonably assume that they have had a realistic

choice between leasing and buying office space. Even with the 50,000 square foot

limitation, the lessees make up about two-thirds of the data. Specifically, of the

2,137 observations, 1,411 are lessees and 726 are owner-occupants. However, in

terms of size of office space, the owner-occupants account for about 45 percent of

the overall sample.

Besides the tenure and size of the user firms' space, the CB Commercial's Tenant

File contains the user firms' name, primary SIC in four digits, and the year the

space was occupied. To verify the user firms' name and SIC, as well as to identify

their headquarter location and PUB (public v. private) status, Ward's Business

Directory is cross-referenced. From the building file, data on the occupied

building's metropolitan area, year of construction, and whether it is located in CBD

or not are available. The metropolitan file covers 53 metropolitan areas. The data

extracted from this file include individual metropolitan area's total SF and number of buildings as of 1990, and rental and vacancy rates between 1986 and 1990.

The three variables that measure the national office market conditions over time, namely VAC, LPR, and ABS, are the data estimated or calculated in the previous chapters.

Table 20 shows the descriptive statistics of the explanatory variables and Table 21 lists all the dummy variables and their respective percentage break-down in terms of the number of observation.

Table 20

Descriptive Statistics of Variables

Variable	Mean	Std. Dev.	Min.	Max.
Occupied space size (in 1,000 sf)	128.78	138.21	50.00	2,000
Avg bldg size in metro (in 1,000 sf)	113.42	93.81	18.33	386.23
Office market size in metro (in MM sf)	11.37	0.87	7.60	12.73
Avg rental rate in metro (in $/sf)	15.20	3.86	8.75	23.47
Avg vacancy rate in metro (in pct)	20.18	5.50	12.49	29.17
Vacancy rate variance in metro (in pct)	6.08	9.37	0.76	52.71
Building age (in year)	19.84	19.55	2	157

Source: CB Commercial

Table 21

Percentage Distribution of Dummy Variables

Dummy Variables	1	0
CBD	36 %	64 %
PART	12	88
MEM	2	92
PUB	50	50
HQ	65	35
SVC	28	72
FIRE	32	68

Source: Author

8.5   Estimation Results

Table 22 shows the empirical results of the logit equation based on 2,137

observations. The correctly predicted rate is 1,236 out of 1,411 (87.60 percent) for

lessees and 382 out of 726 (52.62 percent) for owner-occupants. The overall

percentage correctly predicted is 75.71 percent. Considering the fact that the

dependent variable is highly skewed, the relatively high prediction rate for the

lessees is not such a surprising finding. Nevertheless, all the variables except LSZ,

VOL, and PUB are statistically significant at the five percent level and have the

expected signs (although, LSZ is significant at the 10 percent level). Apparently,

the insignificance of the VOL variable implies that VOL does not reflect the inter-

metropolitan differences in the level of office investment risk. Similarly, the LVB

decision behavior between publicly-traded and private firms is not much different.

As pointed out earlier, the publicly-traded firms have both positive and negative incentives to lease, which may offset each other.

Table 22

The Logit Model Results of Equation (75)

Dependent Variable: Tenure (1 if own 0 if lease)

Office Size: 50,000 sf or More

Variable	Estimated Coefficient	Standard Error	t-stat
LSF	0.8996	0.0911	9.95
LSZ	-0.2926	0.1761	-1.66
TS	-0.4639	0.1140	-4.07
CBD	-1.1787	0.1416	-8.32
LRI	-0.0043	0.0020	-2.15
VOL	-0.0004	0.0078	-0.05
VAC	-0.0884	0.0123	-7.19
LPR	-0.4184	0.1173	-3.57
ABS	-0.0617	0.0309	-2.00
PART	-1.1669	0.3504	-3.33
MEM	2.3702	0.4096	5.79
PUB	0.0922	0.1198	0.77
LAGE	0.5874	0.0943	6.23
HQ	0.7952	0.1292	6.15
SVC	-0.3874	0.1619	-2.39
FIRE	0.4121	0.1237	3.33
CONSTANT	3.8798	1.2047	3.22

Source: Author

Since VOL and PUB variables are not significant, the estimation results without

the two variables are presented in Table 23. Interestingly, the prediction rate

improves slightly to 87.74 percent for lessees, 53.31 percent for owner-occupants,

and 76.04 percent for overall observation. All the variables are statistically

significant at the five percent level, except LSZ variable, which is significant at the

10 percent level.

Table 23

The Logit Model Results of Equation (75)

Dependent Variable: Tenure (1 if own 0 if lease)

Office Size: 50,000 sf or More

Variable	Estimated Coefficient	Standard Error	t-stat
LSF	0.9119	0.0897	9.95
LSZ	-0.2924	0.1732	-1.69
TS	-0.4649	0.1098	-4.23
CBD	-1.1788	0.1408	-8.37
LRI	-0.0043	0.0020	-2.15
VAC	-0.0880	0.0123	-7.15
LPR	-0.4152	0.1172	-3.54
ABS	-0.0610	0.0309	-1.97
PART	-1.2154	0.3443	-3.53
MEM	2.3428	0.4067	5.76
LAGE	0.5869	0.0941	6.24
HQ	0.7676	0.1241	6.19
SVC	-0.4061	0.1601	-2.54

FIRE	0.4016	0.1229	3.27
CONSTANT	3.8812	1.1677	3.32

Source: Author

Consistent with the hypotheses, the estimated coefficients suggest that size of

occupied space, membership firms, age of occupied building, headquarter location,

and FIRE sector firms are positively related to the likelihood of choosing

ownership. And the metropolitan level variables (i.e., average size of office

building, total size of office market, and average rental income), CBD variable

reflecting the building size effect, national market conditions (i.e., vacancy rate,

equilibrium price, and absorption rate), partnership-oriented firms, and services

sector firms are negatively related to the likelihood of choosing ownership. In

terms of the magnitude of estimated coefficients, the ownership structure of user

firms (i.e., PART and MEM variables) most strongly affects the LVB decision,

followed by the size of occupied space relative to the size of available buildings (i.e.,

LSF, LSZ, and CBD variables).

Since the dependent variable is seriously skewed, the estimation is performed for

those observations with a minimum of 100,000 square feet occupied space. This

reduces the total number of observations to 885, of which 502 are lessees and 383

are owner-occupants. The estimation results are shown in Table 24. The correctly

predicted rate is 78.88 percent for lessees, 64.49 percent for owner-occupants, and

the overall rate is 72.66 percent. Since the dependent variable is reasonably

balanced between lessees and owner-occupants, the overall correctly predicted rate

is quite good.

In addition to VOL and PUB variables, the LRI variable is found to be statistically insignificant, and therefore, it is dropped in this estimation. The fact that both VOL and LRI variables are statistically insignificant suggests that the inter-metropolitan differences in price do not affect the larger (in terms of square footage demanded) user firms' LVB decisions. All other variables are statistically significant at the five percent level, except ABS variable, which is significant at the 10 percent level. The magnitude of the estimated coefficients for only LSF and LSZ (both of which are related to the size of occupied space) is significantly different from the earlier results. Consistent with the theory, the positive effect of the LSF variable and the negative effect of LSZ variable on the likelihood of choosing ownership are more pronounced for the larger user firms. This consistent finding appears to validate the reliability of the estimations.

Table 24

The Logit Model Results of Equation (75)

Dependent Variable: Tenure (1 if own 0 if lease)

Office Size: 100,000 sf or More

Variable	Estimated Coefficient	Standard Error	t-stat
LSF	1.2591	0.1635	9.95
LSZ	-0.5261	0.2467	-2.13
TS	-0.4805	0.1633	-2.94
CBD	-1.1743	0.1978	-5.94
VAC	-0.0573	0.0184	-3.11
LPR	-0.5323	0.1740	-3.06
ABS	-0.0863	0.0453	-1.91

PART	-1.4182	0.6424	-2.21
MEM	2.6338	0.7959	3.31
LAGE	0.5223	0.1388	3.76
HQ	0.5556	0.1871	2.97
SVC	-0.4755	0.2581	-1.84
FIRE	0.5991	0.1822	3.29
CONSTANT	2.8251	1.7371	1.63

Source: Author

8.6 Concluding Remarks

In this chapter, the equilibrium rental rate equation is developed based on the neo-classical approach in calculating the user-cost-of-capital. And various theories on the non-financial determinants of the lease versus buy decision have been presented and tested empirically. Generally speaking, the determinants of LVB decision can be grouped into financial and non-financial incentives. The traditional LVB analyses concentrate on the financial incentives by calculating the equilibrium rental rate. According to these models, user firms with higher (lower) tax rates and lower (higher) cost of capital are likely to prefer owning (leasing) because their equilibrium rental rates are likely to be lower (higher) than the market rental rates. However, a direct application of these models to the office market can lead to erroneous conclusions because of two basic reasons: First, the LVB analysis of office building is far more complicated by the need to assess the resale value, which is probably the most important and most uncertain factor in the analysis. Unfortunately, traditional LVB analyses treat the resale value as a negligible factor or assume it away completely (for example, Levy and Sarnat

[1979]). Second, while traditional LVB analyses assume that the market is in a long-run equilibrium, as discussed in the previous chapters, the office market suffers from a constant state of disequilibrium since the speed of rental and supply adjustments are very slow. This suggests that the equilibrium rental rate and the market rental rate may differ not from the financial asymmetries but rather from the market (i.e., non-financial) factors over time as well as cross-section. Another set of non-financial factors arise from the differences in the user characteristics such as ownership structure, the level of utilization, the level of corporate hierarchy, and the industry in which they belong.

Specifically, sixteen non-financial variables are identified as possible sources of asymmetries in LVB decisions and they are tested empirically. Based on the analysis, the hypotheses are that leasing is more likely: 1) if the size of office space demanded is smaller, 2) if the average size of office buildings in the metropolitan area is larger, 3) if the total size of the office market in the metropolitan area is larger, 4) if the location demanded is in a central business district, 5) if the average rental income is higher, 6) if the volatility of vacancy rates is higher, 7) if the national vacancy rate is higher, 8) if the national equilibrium office price is higher, 9) if the national absorption rate is higher, 10) if the ownership structure of the user firm is a partnership, 11) if the user firm is a membership organization, 12) if the user firm is a publicly- traded corporation, 13) if the level of utilization is high (as proxied by the age of office building), 14) if the location is not the user firm's headquarter location, 15) if the user firm belongs to a services sector, and 16) if the user firm does not belong to the FIRE sector. The 12th factor, the public

versus private firm, poses a problem in the analysis because the public firms

appear to have conflicting sets of incentives which may offset each other.

The primary source of the data to test the hypotheses is CB Commercial, a

national real estate firm. Even though the data contain much more observations, a

lower limit was set at 50,000 square feet in terms of office space occupied. This

lower limit is necessary so that the dependent variable (i.e., tenure) is not

excessively skewed toward lessees. The data extracted include 2,137 observations

totalling 275 million square feet. Of the 2,137 observations, 1,411 are lessees and

726 are owner-occupants. However, because owner-occupants' average office size is

larger, owner-occupants account for approximately 45 percent of the data's total

square footage.

Empirical results, using the logit model, show that all the variables, except the

volatility of vacancy rates and public versus private firm variables, are statistically

significant in determining the LVB decisions. More importantly, all the significant

estimated coefficients have the expected signs. The correctly predicted rate is

about 88 percent for lessees, 53 percent for owner-occupants, and 76 percent for

overall observations. The high prediction rate for the lessees is expected since the

dependent variable is skewed significantly. The magnitude of estimated

coefficients suggests that the ownership structure of user firms and the size of

occupied space relative to the size of available space are the two strongest

determinants in the LVB decisions.

Since the dependent variable is severely skewed, the estimation is made for those observations with 100,000 square feet or larger occupied space. This is meant to balance the dependent variable between lessees and owner-occupants. The resulting data contain 885 observations, of which 502 are lessees and 383 are owner-occupants. The correctly predicted rate is quite good at about 79 percent for lessees, 64 percent for owner-occupants, and 73 percent for overall observations. In this estimation, one additional variable, namely the average rental income in a metropolitan area as a proxy for the inter-metropolitan office price differential, is found to be statistically insignificant. Furthermore, the magnitude of all the estimated coefficients, except two variables related to the size of occupied space, is very close to the earlier results.

Based on the empirical findings in this chapter, several practical implications emerge. First and foremost, as the size of office buildings increases over time, the likelihood of ownership of office buildings by user firms declines since the size of office space demanded by the user firms is not likely to increase. This size issue, by itself, appears to foreshadow the increasing reliance on leases rather than ownership by the user firms. The only reasonable means for the ownership rate to increase in the future seems to be a growing popularity of office condominiums, which has never been popular in the U. S. Office condominiums can be an economical alternative to leases for those user firms that are stable (in terms of office space demanded). If the office condominium market were to become active, assessing the market value as well as matching buyers and sellers would become far more effective and efficient. In fact, it is quite conceivable that dealers and

centralized auction markets would emerge to make the office market more efficient. With frequent trading of office condominiums, more accurate market information will become available, which will reduce the uncertainties, and therefore, reduce the severe discount imposed by the securities market to user firms with large real estate holdings.

Second, the increasing dominance of the rental market over the last two decades may be partly attributed to the increasing demand for office space by user firms in the services sector. The employment growth by firms in the services sector over the last two decades has be simply tremendous. The average annual employment growth rate between 1970 and 1990 for FIRE and services sectors are 3.2 percent and 4.5 percent, respectively. In comparison to the overall private employment growth rate at 2.2 percent, the services sector employment grew twice as fast as the overall sectors. Also, the services sector firms, on average, demand a smaller size office space relative to non-services sector firms. Based on the data used, the average size of office space for services sector firms and non-services sector firms are 96,500 square feet and 141,360 square feet, respectively. The difference in the size of office space may be even greater had the office size limitation at 50,000 square feet been removed. In addition, the services sector firms tend to be located in CBD with higher frequency than the non-services sector firms. About 46.3 percent (in terms of number of observations) of services sector firms is located in CBD, whereas only 32.6 percent is located in CBD for the non-services sector firms. Finally, holding all else constant, the negative estimated coefficient for the SVC dummy variable implies that the services sector firms prefer leasing over owning,

presumably due to a higher degree of risk aversion in investing in highly durable assets. If the services sector firms continue to grow faster, then the share of lessees will also continue to rise.

Third, the empirical findings suggest that suburban office space tends to be owner-occupied with a greater frequency than comparable downtown office space. Recently, the market share of suburban office buildings relative to downtown office buildings has been growing rapidly (according to SIOR's 1990 survey, the suburban office space market share is at 54.7 percent), and if this trend continues, the share of owner-occupants may increase. Of course, the impact of the incentive to lease due to the rising size of office buildings probably offsets, or even overwhelms, this suburban incentive to own. Therefore, it may be correct to state that the share of owner-occupants may not be as low as it has been.

Fourth, the national office market conditions (e.g., price and vacancy rates) contributed to the rise in the share of lessees in the 1980s. As pointed out in Chapter 7, the unprecedented level of construction of speculative rental office space in the 1980s is attributed to the favorable tax laws and high absorption rates in the early-1980s, which led to a steep rise in office price. Naturally, the high office price forces the user firms to seek leases rather than purchases, thereby raising the share of lessees. Not only that, many owner-occupied firms found sale-leaseback transactions a very attractive means of cashing out appreciation in their equity. This further raised the share of lessees. By the mid- and late-1980s, the vacancy rates climbed to an unprecedented level, which forced many lessors to offer

very low rental rates. These low rental rates continue to make leasing a more attractive alternative for acquiring office space. However, in the 1990s, if as expected, the office price drops drastically due to unfavorable tax rules and declining absorption rates, and the vacancy rates decline, office ownership may become a more attractive alternative in comparison to leases.

Chapter 9

Conclusions

9.1   Introduction

Business expenditures on plant and equipment investment have always been considered the most important component of the GNP because they are believed to: 1) increase productivity, which in turn increases wage rates and improve standards of living; 2) raise the aggregate employment level; and 3) intensify the volatility of the GNP. In light of this belief, many macroeconomists have attempted to understand the fundamental determinants of variations in the aggregate investment. However, none of the existing formulations, while being theoretically sound, have been able to explain and forecast the variations to an acceptable level when they are tested empirically. These unsuccessful empirical findings are a result of unrealistic assumptions made in order to simplify the complexity of capital investment decision-making. The complexity arises from unique properties possessed by individual assets as well as users of those assets who also respond differently to the prevailing market conditions.

In the absence of a coherent understanding of the determinants of aggregate investment, the government's fiscal and monetary policy has always been controversial as reflected by a potpourri of investment stimuli such as, investment

tax credits, lower tax rates, accelerated depreciation, increased government

spending, and, of course, liberal lending regulations. Moreover, these investment

stimuli's adverse side effects, namely higher government deficits and/or higher

inflation rates, have further confused their ultimate consequences. In addition,

unequal treatment of the investment stimuli among assets abruptly shift the

limited resources from one type of asset to another. In this process, certain assets

may become over-invested, which leads to under-utilization followed by a serious

decline in price, while others become under-invested, which can lead to a severe

shortage. Finally, the speed at which actual investments respond to the stimuli

vary not only by the type of assets, but also by the prevailing market conditions of

the assets. Frequently, market responses to the stimuli occur with relatively long

lags so that by the time the actual investments occur, the general economic and

the asset-specific market conditions are likely to be significantly different from

those at the time the stimuli are provided.

A set of equations, formulating demand for and supply of office buildings as well as

rent-adjustment, presented in Chapters 4, 5 and 6, are an attempt to improve our

understanding of the ways in which firms invest in and utilize a single category of

assets. By analyzing only office buildings, which have been one of the fastest

growing and the most volatile components of all the major assets (within plant and

equipment investment) over the last 40 years, idiosyncrasies of the office market

can be specified to reflect the firms' realistic investment and utilization behavior.

The important distinctions of the office market are: 1) investments are made by

both owner-occupant and rental firms; 2) buildings are purchased with a high

leverage ratio; and 3) buildings are frequently traded with a considerable amount of capital gains.

The model presented in this thesis also differs from past office models that have been advanced by real estate economists to explain the construction rates in the office market. Real estate economists' models assume that the marginal rental rates, usually proxied by lagged vacancy rates, is the fundamental determinant of the office investment. An absence of full recognition of the variability of the capitalization rates has led to generally poor empirical results. The model developed in this thesis overcomes this problem by carefully estimating the equilibrium price as a function of observed net operating income and capitalization rate and uses the absorption rate as a proxy for the degree of disequilibrium in the market.

In essence, the primary weakness of the previous studies is that the aggregate investment models focused on the capital market while the office models focused on the property market, when, in fact, the market behavior is determined by both the capital and property markets. Specifically, the aggregate investment models assume that the market is in equilibrium so that the capitalization rate can be calculated with an assumption that the future stream of net operating income increases by a constant inflation rate and decreases by a constant depreciation rate. Hence, variations in the capitalization rates are assumed to determine the investment rates. In contrast, the office models assume that the capitalization rate is constant and that marginal rental rates respond to the market fluctuations so

that the investment rates are determined by the level of marginal rental rates.

Another improvement of the model in this thesis is an explicit recognition of the mid- to long-term nature of office lease agreements. Past rental adjustment models specify the rental adjustment for the spot market, such as multi-family residential markets, where a typical term of rental agreements is a single year. By considering the term structure, the rental adjustment must reflect not only the current state of supply and demand (i.e., vacancy), but also expected vacancy in the near future. Since the current expected investment rate (proxied by a lagged investment rate) will affect the near-term vacancy rate, change in the office market rental rate is assumed to be a decreasing function of the lagged investment rate.

Having estimated the three equations (the level of absorption and investment, and rental adjustment), simulations are presented to analyze the impact of changing inflation and interest rates, and tax laws. Contrary to the macroeconomists' view, higher inflation and tax rates act as incentives to invest in the office market primarily due to the high leverage ratio and the incentive to trade. Also, simulation results suggest that poor timing and frequency of changes in the tax rules in the 1980s have exacerbated the cyclical nature of the rental office market. Specifically, in the absence of the tax rules changes in the 1980s, the extraordinarily high office investment levels in the mid-1980s would not have occurred and, as a result, the vacancy rate would have peaked at around 15 percent in 1984.

Finally, to understand the increasing dominance of rental office space over the last two decades as well as to understand the corporate leasing policy, various theories on the determinants of lease versus buy (LVB) decisions are developed and tested empirically. This thesis is believed to be the first study that analyzes the LVB decisions for office space. While the traditional LVB analyses focus on the difference in the effective marginal tax rates between a lessee and a lessor, the empirical evidence that a majority of firms both lease and own office buildings appears to contradict the theory. Rather, this thesis hypothesizes three sets of non-financial incentives that are believed to determine the LVB decisions, namely: 1) local office market conditions; 2) national office market conditions over time; and 3) user firms' characteristics.

9.2   Summary of the Office Model and Empirical Findings

The emergence of an active rental market within the last 20 years with highly cyclical vacancy rates necessitates developing demand and supply models for owner-occupant firms and a combination of owner-occupant and rental firms. Overall, four sets of equations along with variations of those equations are presented and tested empirically in Chapters 4 and 5. The data cover a period between 1951 and 1990, which was split into two subperiods of 1951 to 1970 and 1971 to 1990. The first subperiod represents a period in which owner-occupant space dominated the overall office market whereas the second subperiod reflects an increasingly active rental market in addition to the owner-occupant space. The rental adjustment model, on the other hand, is developed and tested for the second

subperiod only.

9.2.1 The Demand Model

The demand for office space is assumed to be determined fundamentally by the level of office employment. The underlying assumption is that office space, just like any other capital resources, cannot be utilized by itself, but rather in combination with other equipment (in particular, office, computing, and accounting machinery) and, most importantly, human labor. The assumption of complementarity between office space and office employees, in this case a high degree of complementarity, is the essence of the demand model. User firms, being either owner-occupants or lessees, strive to achieve the optimal ratio between the amount of office space and the number of office employees in search of profit-maximization -- over-investment in office space is likely to generate lower rate of return on the office investment due to a lower utilization rate whereas under-investment will lower workers' productivity caused by cramped and/or lower-quality space. Ever-changing economic circumstances force the firms to constantly adjust the demand for office space to find the new optimal combination. However, the process of adjustment is neither simple nor quick for the following reasons: First of all, the process of identifying the optimal combination requires a substantial amount of time and effort. Second, even if the optimal combination is identified, the transactions costs involved in the adjustment process are considerably expensive so that past investment decisions are rarely reversed. In other words, past commitments may force the firms to maintain a suboptimal

combination. Third, the process of constructing office buildings is time-consuming so that actual delivery of office space occurs after long lags.

Based on the fundamental assumption that the occupied stock of office space is highly complementary to the number of office employees, the desired occupied stock is assumed to bear a constant proportionality to the current year's number of office employees and change in the number of office employees. The main motive of including the change in the number of office employees is that the user firms are likely to anticipate near future demand since the adjustment costs are so prohibitively expensive. As discussed above, instantaneous adjustment occurs rarely so that the actual absorption is assumed to be proportional to the difference between the previous year's actual occupied stock and the current year's desired occupied stock.

For rental and owner-occupant space, the desired occupied stock is assumed to be a function of expected rental costs in addition to the number of office employees and change in the number of office employees. The expected rental costs need to be explicitly included in this equation to recognize that lessees' absorption is a decreasing function with respect to the rental costs. Furthermore, a main feature of the advent of the active rental market is that the risk of under-utilization of office space is shifted from the user firms to the lessors. Thereby, the user firms can maintain their optimal utilization level relatively easily. Since the optimal utilization level is assumed to be maintained closely, the difference between the current year's desired and actual occupied stock variables is no longer so

important. The resulting absorption function increases with respect to additional

office employment and decreases with respect to additional rental costs. Additional

rental costs are simply the expected rental rate multiplied by the number of new

office employees.

In the empirical testing, both sets of equations were tested for the full period as

well as for the two subperiods to determine the stability of the estimated

coefficients. Not surprisingly, the estimated coefficients for both equations were

not stable over the full sample period. The empirical results showed that the

owner-occupant space equation explained the absorption rates in the first

subperiod very well and that all parameters were statistically significant and of the

expected signs. The estimated occupied stock per current employee is about

$26,800, occupied stock per current change in employee is around $85,400, and

adjustment rate is 12.3 percent. Expectedly, in the owner-occupant office market,

the user firms appear to absorb considerably more space than necessary in

anticipation of future expansions. The statistical fit of the equation (a corrected R^2

at 87 percent) is very good. As hypothesized, the absorption level in the second

subperiod was better explained by including the expected rental costs variable.

While the expected rental costs and change in the number of employees variables

are statistically significant at the five percent level, the lagged occupied stock and

current number of employees are significant at the ten percent level. Based on

unrestricted distributed lag formulation, and using two-year employment growth

along with the expected rental costs change, the equation's statistical fit improved

substantially (a corrected R^2 at 87 percent). These findings imply that the first

subperiod is better estimated by the traditional stock-flow model, whereas the second subperiod, due to the rental market, is better estimated by the flow model.

9.2.2 The Supply Model

As with the demand equations, investment equations are formulated for owner-occupant firms and for rental firms. While the fundamental investment motivation for both types of firms is profit maximization, their investment process -- and therefore their investment behavior -- differ between the owner-occupant and the rental firms. The owner-occupant firms' investment objective is to achieve the optimal combination between office workers and office stock in consideration of the user-cost-of-capital. Accordingly, the supply equation for the owner-occupant firms is very similar to the demand equation, except that the occupied stock variable is replaced by the total stock.

In contrast, the rental firms' investment is driven primarily by the difference between market (or demand) and supply prices for office buildings. In equilibrium, the market and supply prices must be equal, therefore, no incentive exists for further investment. However, as long as the market price is higher (lower) than the supply price, even if the vacancy rate is high (low), investment activities will (not) materialize. Since the market price time-series is not available, it is assumed to be a function of absorption and vacancy rates, and equilibrium price. During a period of rising (falling) absorption rate, the market price is assumed to increase (decrease) as the market rental rate is expected to increase (decrease).

Similarly, if the vacancy rate is low (high), both the market rental rate and price are expected increase (decrease). The equilibrium price is estimated based on net operating income and equilibrium capitalization rate. Applying the traditional user-cost-of-capital formulation along with peculiarities of high leverage and trading incentives, the equilibrium capitalization rate time-series is calculated.

As with the demand equations, the estimated parameters are not stable between the two subperiods to justify using a single equation to estimate the office investment over the 40-year period. Rather, confirming a hypothesis that the first subperiod's investment is attributed primarily to the owner-occupant firms, variations in the investment level are almost completely explained by the number of office employment and lagged stock. The estimated investment per employee is about $32,800, which is somewhat higher than the expected value (but offset by a negative constant), and the adjustment rate is 11.6 percent. Moreover, the equilibrium capitalization rate is not found to be statistically significant in determining the level of office investments, which confirms the appropriateness of the accelerator model.

The estimation results for the second subperiod show that the price variables that determine the rental investment (i.e., the absorption, vacancy, equilibrium price, and lagged investment variables) are statistically significant and of the expected signs. The most appropriate lag for the absorption, vacancy, and equilibrium price variables is found to be three years, and the estimated coefficients for investment adjustment is 42 percent. The statistical fit of this equation is extremely good with

a corrected R^2 at 93 percent. In decomposing the equilibrium price series into a reciprocal of the capitalization rate and the net operating income series, both variables are found to be statistically significant. As another variation, the net operating income variable is replaced with the rental income variable and this equation results in essentially the same findings. The only difference is that the lagged absorption variable become statistically insignificant. These empirical findings appear to provide substantive support for the hypothesis that the equilibrium capitalization rate is an important determinant of rental office investment.

9.2.3 The Rental Adjustment Model

The search-theory based rental adjustment model developed by Wheaton and Torto is extended to include expected current and near-term supply adjustments in specifying equilibrium rental rates. Specifically, the optimal vacancy rate is assumed to be a function of a linearly rising long-run structural vacancy rate and the short-run expected growth vacancy rate. The long-run structural vacancy rate is expected rise over time because of the increasing reliance on the rental office market. On the other hand, the amount of the short-run expected growth vacancy is assumed to be: 1) an increasing function of the expected demand shocks, which is proxied by a lagged absorption to stock ratio; and 2) a decreasing function of expected new construction completions, which is proxied by a lagged investment rate. Assuming a constant partial adjustment rate, the actual rental rate change is assumed to bear a constant proportionality to the difference between a lagged

rent and the equilibrium rent.

Utilizing an average real rental rate series from BOMA, the empirical results show that the estimated adjustment rate is insignificantly different from zero. This suggests that the traditional rental adjustment model, in which the rental rate adjustment is based on the gap between optimal and actual vacancy rates, may be more appropriate. Presumably, the usage of average real rental rate series, as opposed to marginal real rental rate, contributed to this finding as well as long lags, which range from two to four years. Based on the traditional rental adjustment model, the estimated adjustment rate is about 70 percent, and the structural vacancy rate rose by 0.8 percent per year. Also, a single percentage difference between lagged absorption and investment rates induces about 2.4 percent change in the optimal vacancy rate.

9.2.4 Simulation Results

The volatile nature of inflation and interest rates coupled with frequent tax law changes have made office investment quite risky particularly in the last two decades. From the equilibrium capitalization rate formula, the effect of debt financing and depreciation allowances can be extracted to determine their trend over the 40-year period. First, the effect of debt financing has been relatively stable between the late-1940s and the early-1970s. In the mid- and late-1970s, the unexpected surge in the inflation rates made the net benefit of debt financing very high and therefore the equilibrium capitalization rate became quite low. In

contrast, in the mid- and late-1980s, the success of anti-inflationary policy without a concomitant drop in long-term interest rates made debt financing quite unattractive. Of course, this implies that the equilibrium capitalization rate rose sharply during this period. Second, the present value of depreciation allowances, after a significant jump in 1954, showed steady decline until 1980. However, with the enactment of the ERTA in 1981, the first half of 1980s saw a dramatic increase in the present value of depreciation allowances followed by a similarly dramatic decline due to the TRA of 1986. The combined effects of debt financing and depreciation allowances have been that of general decline until 1980, followed by a three-year jump, and a dramatic drop in the late-1980s. Based on this analysis, the unparalleled high equilibrium capitalization rates in the late-1980s foreshadow a large drop in office prices and investment levels in the early- and mid-1990s.

Simulations based on the equilibrium capitalization rate equation show that, contrary to the general belief, higher inflation and ordinary tax rates actually lower the cost of capital. Considering the impact of tax law changes in the 1980s on the office market, the ERTA provided an unprecedented tax break, a part of which was offset by the drop in the inflation rates. In contrast, the TRA of 1986 was simply devastating. Using the parameters estimated in Chapters 4, 5, and 6, the simulation results show that much of the rise in the office investment rates in the early-1980s would have occurred even without the ERTA. And in the absence of the ERTA and TRA of 1986, the excess investment in the mid-1980s would not have occurred. Therefore, the estimated vacancy rates would have been significantly lower throughout the 1980s. However, the lower vacancy rate,

particularly in the mid-1980s would contribute to higher investment levels in the late-1980s. Just as importantly, the full negative effect by TRA of 1986 is not expected to be felt until the early- and mid-1990s due to long lags in the supply response and rental adjustment process.

9.3   The Determinants of Lease-Versus-Buy Decisions

The lease versus buy (LVB) decision is quite complex as evidenced by a substantial number of articles written on the subject. The problems in understanding the incentives that determine LVB decisions have been exacerbated by some unreasonable and conflicting assumptions made in the traditional LVB analyses to simplify calculation of the equilibrium rental rate. Even though the effective marginal tax rate is important in the LVB analysis, it cannot be the key determinant since many firms both lease and buy office buildings. Rather, in this thesis, eight non-financial determinants, measured by 16 variables, are hypothesized as possible sources of asymmetries and are tested empirically using a logit model. Considering office space larger than 50,000 square feet (2,137 observations covering approximately 10 percent of all U. S. office space occupied in 1990), the empirical results indicate that all but two variables (i.e., volatility of local vacancy rates and public vs. private firm dummy variable) are statistically significant. The correctly predicted rate is about 88 percent for lessees, 53 percent for owner-occupants, and 76 percent for overall observations. The determinants can be grouped into three categories.

First, the local office market conditions are believed to be important. The likelihood of leasing increases 1) if the size of office space demanded is smaller, 2) if the average size of office buildings in the metropolitan area is larger, 3) if the total size of the office market in the metropolitan area is larger, 4) if the location demanded is in a central business district, and 5) if the average rental income in the metropolitan area is higher.

Second, national office market conditions over time affect the LVB decision. Specifically, 6) higher national vacancy rates, 7) higher equilibrium office price, and 8) higher national absorption rates are positively related to the likelihood of leasing.

Third, user characteristics also influence the LVB decision. The probability that the user firm will lease is increased if 9) its ownership structure is partnership-oriented, 10) it is not a membership organization, 11) its office utilization level is high (proxied by age of buildings), 12) the office is situated in its headquarter location, 13) it belongs to the services sector, and 14) it is not in the FIRE sector.

To balance the highly skewed dependent variable in the above analysis, only those observations with 100,000 square feet or higher office space are considered to verify the reliability of the estimations. Based on 885 observations, the relatively high correctly predicted rate is maintained. The prediction rate is about 79 percent for lessees, 64 percent for owner-occupants, and 73 percent for overall observations. Only one other variable, namely the average rental income, is found to be

statistically insignificant.

9.4 Limitations of the Model and Possible Extensions

The model presented in this thesis contains a few weaknesses which future research may overcome. These weaknesses are in both theoretical development or/and in empirical implementation of the model.

First, the capitalization rates are calculated based on myopic expectations (i.e., no change in the underlying economic conditions is anticipated). A problem imposed by this assumption is that the model ignores the short-run impact on investment caused by anticipated tax changes. With such frequent tax legislation changes, investors are likely to anticipate future tax changes to a certain degree and consider the ephemeral nature of tax rules in their decision-making. The importance of anticipated tax legislation changes in the office market is that they alter not only the timing of investment but also the timing of trading or disposition. The latter impacts greatly on the present value of expected after-tax capital gains. Auerbach and Hines [1988] show a method of specifying the nature of anticipated tax changes that one may apply in a future study.

Second, the rental adjustment model is tested on the average rental rate rather than the marginal rental rate. A natural extension of the study is to develop a relatively long and reliable time-series on the marginal rental rates similar to what Wheaton and Torto [1992] have done in their hedonic-based index. Obviously a

severe lack of information on rental rates makes this process difficult to achieve.

Third, in calculating the equilibrium capitalization rate, the model assumes that the availability of debt financing is inexhaustible and that only the level of interest rates is affected by scarcity of money. However, there is a sufficient amount of evidence in the credit market of "credit crunch," especially in recessionary periods, to extend this model to incorporate possible lack of debt funds. For example, based on ACLI data, the major insurance companies' annual loan commitment for office mortgages averaged $10.4 billion in the second half of 1980s. By 1991, the amount dropped by over 80 percent to $1.8 billion. On the other hand, Hendershott and Kane [1992] argue that the office boom in the 1980s is partly attributed to "lending frenzy" by commercial banks, S&L's, and insurance companies. There is also a sufficient amount of anecdotal evidence that some developers were able to get 100 percent financing in the mid- and late-1980s. By determining the magnitude and specification of this "credit crunch and lending frenzy," which is by no means an easy task, one may be able to better explain the persistence of booms and busts in the office market.

Fourth, the empirical analysis of the model relies on national data. Since the national office market consists of distinctive metropolitan office submarkets (according to EIA data, in excess of 90 percent of all office buildings are located in metropolitan areas), the regional variations are not taken into account. By focusing at the metropolitan level, variations in local office market conditions may be explained by local office employment growth, rental, and vacancy rates, along

with the national capitalization rates. Also, differences in the adjustment rates may be identified. Empirical findings from this type of analysis will directly benefit regional policy makers as well as office investors and users.

Fifth, the model explicitly differentiates rental and owner-occupant firms' investment behavior, and based on an assumption that the rental market has become significant and active since 1971, empirical evidences confirm the need for their differentiation. The investment motives for the rental firms are probably similar whether they belong in the real estate industry or other industries so that they can be considered homogeneously. However, the owner-occupant firms data aggregate seventy different industries, which implies that firms in different industries may exhibit different investment behaviors. In particular, a detailed analysis of investment behavior by nineteen different industries in the FIRE and services sectors will be able to determine whether or not owner-occupant firms can be treated homogeneously in their office investment behaviors. The distinctive nature of the industries may uncover factors other than those examined in this model that may not have been reflected in the process of aggregation.

9.5   Policy Implications

Uncertainties surrounding U. S. corporate investment decisions -- in particular for long-lived capital such as office properties -- are simply too monumental for any investors to deal with due to constantly changing investment incentives. The U. S. Government has changed tax legislation in five different years within the 1980s

and 17 times since 1953. Even in those years without changes in tax legislation,

movements in expected inflation and real interest rates alter investment

incentives. Besides the fiscal and monetary policy changes, office-properties

investors, whether they are rental or owner-occupant firms, have had to cope with

the volatile and growing rental office market which experienced exploding vacancy

cycles over the last 30 years. The growing rental office market also meant that a

growing number of lessees and rental firms have had to respond to widely

fluctuating rental rates.   In light of the complexity involved in the office

investment decisions, a few policy implications arise.

First and foremost, contrary to the conventional wisdom that a high (low) inflation

rate and a high (low) tax rate induces lower (higher) capital investment, high

leveraging and trading characteristics of office investment result in quite the

opposite responses. Simulations that varied inflation rates and tax rates suggest

that higher inflation and tax rates actually lower the cost of capital, thereby

increasing the rate of office investment. In analyzing the impact of the

government's monetary and fiscal policy, more careful analyses with respect to

commercial real estate is warranted.

Second, the cost of adjustment appears to be high as reflected by very low rates of

adjustment in both absorption and investment equations. More importantly, the

rental office investment occurs with very long lags (three years based on this

empirical study). The fact that market responses are so slow suggests that

frequent changes in the government's monetary and fiscal policy severely

destabilize the office market since the supply is never sufficiently adjusted and incomplete adjustments persist. In addition, the supply and rental adjustments appear to occur concurrently (at least, in the 1970s and 1980s), which only amplify the market disequilibrium.

Third, in terms of demand for office space, approximately $21,000 per office employee (in 1982 dollars) appears to the desired amount of absorption and the actual absorption is spread out roughly over a two-year period. The fact that the amount of office absorption and the number of office employees exhibit a high degree of complementarity implies that the fundamental force behind office investment is office employment growth. Naturally, office employment growth is influenced by business fluctuations, which implies that as long as business fluctuations persist, the disequilibrium in the office market is inevitable.

Fourth, another factor that exacerbates the cyclical nature of the rental office market is the speculative behavior by user firms. The observed absorption rates over the last 20 years shows that they have become significantly more volatile as the user firms absorb more (less) than necessary amount of space during a period of high (low) expected demand and low (high) rental rates. The repercussion of this increasingly more volatile absorption rate is that office investment rate, which is a function of a past absorption rate in this model, will continue to be volatile.

Fifth, the advent of an active rental market, by bearing the risk of disequilibrium, allows the user firms to reach and maintain their optimal utilization level. This

poses a question as to who can bear the cost of this risk more efficiently. User firms seeking greater flexibility in light of rapidly changing global competition, will ultimately have to pay for the cost of flexibility whether they use it or not. Even though office condominiums have never been popular in the office market, it is conceivable, although unclear at this point, that active office condominium markets can emerge in the future as another means of acquiring or providing office space in search of cost efficiency and flexibility.

The theory and empirical evidence presented in this thesis provide some insights into the ways in which the office market behaves. Hopefully, this can assist in achieving the monetary and fiscal policy's objective of moderating the cycles and providing a steady stimulus to the office market. Furthermore, both investors and users of office space can use this information to better anticipate the near-term changes in the supply of and demand for office space as well as in the rental rates. Given better information, the investors and users are expected to formulate more effective strategies to cope with the inevitable market volatility.

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Appendix A:

Data for Calculating the Equilibrium Capitalization Rate

Year	Expected Inflation Rate	Ordinary Income Tax Rate	Capital Gains Tax Rate	Depre- ciation Period	L. T. Interest Rate	Riskfree Interest Rate
1947	1.51%	38%	26%	40	2.52%	2.03%
1948	1.62%	38%	26%	40	2.70%	2.34%
1949	1.52%	38%	26%	40	2.52%	2.63%
1950	1.49%	42%	26%	40	2.48%	2.39%
1951	1.63%	51%	26%	40	2.72%	2.60%
1952	2.48%	52%	26%	40	2.87%	2.68%
1953	2.98%	52%	26%	40	3.08%	2.92%
1954	2.83%	52%	26%	40	2.74%	2.57%
1955	0.75%	52%	26%	40	2.97%	2.83%
1956	0.65%	52%	26%	40	3.34%	3.07%
1957	1.28%	52%	25%	40	3.80%	3.45%
1958	1.80%	52%	25%	40	3.65%	3.45%
1959	2.08%	52%	25%	40	4.25%	4.12%
1960	2.13%	52%	25%	40	4.26%	4.13%
1961	1.55%	52%	25%	40	4.20%	3.90%
1962	1.10%	52%	25%	45	4.18%	4.02%
1963	1.25%	50%	25%	45	4.13%	4.04%
1964	1.15%	46%	25%	45	4.26%	4.18%
1965	1.30%	48%	25%	45	4.39%	4.23%
1966	1.78%	48%	25%	45	5.09%	4.72%
1967	2.23%	48%	25%	45	5.47%	4.93%
1968	2.95%	53%	25%	45	6.12%	5.40%
1969	3.93%	53%	25%	45	6.92%	6.25%

1970	4.63%	49%	28%	45	7.76%	6.79%
1971	4.95%	48%	30%	45	7.16%	6.01%
1972	4.70%	48%	30%	45	7.09%	5.82%
1973	4.88%	48%	30%	45	7.37%	6.97%
1974	6.20%	48%	30%	45	8.04%	7.93%
1975	7.38%	48%	30%	45	8.43%	8.04%
1976	8.03%	48%	30%	45	8.21%	7.86%
1977	8.10%	48%	30%	45	8.10%	7.62%
1978	7.25%	48%	30%	45	8.65%	8.42%
1979	7.80%	46%	30%	45	9.43%	9.24%
1980	9.73%	46%	28%	45	11.56%	11.29%
1981	10.68%	46%	28%	15	13.72%	13.69%
1982	10.33%	46%	28%	15	13.03%	13.07%
1983	8.30%	46%	28%	15	11.45%	11.27%
1984	6.00%	46%	28%	18	12.43%	12.49%
1985	4.33%	46%	28%	19	10.94%	11.04%
1986	3.25%	46%	39%	31.5	9.02%	8.14%
1987	3.35%	40%	37%	31.5	9.32%	8.65%
1988	3.30%	34%	34%	31.5	9.55%	9.00%
1989	3.60%	34%	34%	31.5	9.16%	8.58%
1990	4.48%	34%	34%	31.5	9.40%	8.67%

Source: U. S. BEA, U. S. Federal Tax Code, Moody's, and Author