Industry location patterns in metropolitan area office markets – Central Business Districts versus suburbs

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I. Abstract

This paper is an initial study of the location patterns among Information, Finance Insurance & Real Estate companies locating in Central Business Districts (CBD) versus suburbs, using SIC/NAICS codes at the zip code level. These patterns are initially studied through statistical analysis and then their effect on the probability of a company locating at a CBD versus the suburbs is determined through econometric modeling of real estate office market and economic parameters. In addition, the effect of all these factors on both areas' vacancy rate is also studied. The studied cities include Atlanta, Boston, Chicago, Washington and Los Angeles with the study period being from 1998 through 2001, with quarterly data.

II. Introduction

In the majority of office market literature the metropolitan area is used as the smallest geographic scale to formulate an econometric model (Pollakowski, Wachter and Lynford, 1992; Tsolacos, Keogh and McGough, 1988; King and McCue, 1987; Wheaton, 1987). Data lags lead to the agglomeration of rent, vacancy rates and other office market characteristics at the metropolitan area level without a breakdown by office classes (A, B or C) (Torton Wheaton Research 2001). In their study of the London office market between 1977-96, Hendershott, Lizieri and Matysiak (1999) developed a model that includes a demand, a supply and a rent adjustment equation. This rent adjustment is more complex than both Rosen's and an earlier version by Pollakowski, Wachter and Lynford's (1992) works. The rent in the Hendershott et al.'s case adjusts to deviations of the vacancy rate and rent from their respective long-run equilibriums.

Other studies focus on certain number of office buildings and track certain office market characteristics, such as rent levels over a period of time (Webb and Fisher, 1996) or certain cities (Rosen, 1984). Rosen (1984) focused in the city of San Francisco and estimated office supply, demand and rent equations with annual data from 1961 to 1983. In his paper Rosen highlights

that the change in rent in the rent-adjusted equation is a function of the difference between the actual vacancy rate and the average vacancy, in addition to the change in an overall price index. Hanink (1996) focused on the spatial extent of office vacancies on national and regional U.S. data from the 1980s. Hanink uses a mixed temporal autoregressive model and a mixed spatial autoregressive model to identify trends in both scales. Clapp, Pollakowski and Lynford's (1996) study of the Boston CBD and suburb market at the city level, from 1980 to 1988, indicated that demand for office space in sub-markets is responsive to agglomerations by type of industry as well as growth in Finance Insurance and Real Estate (FIRE) employment. Another study of fourteen cities from 1979 to 1983 linked the rent levels with the vacancy rate, U.S. gross national product and total metropolitan employment (Hekman, 1985). In addition, the supply of new office space depended on rent and growth in office employment. The Wheaton, Torto and Evans' (1997) study identifies that vacancy rate depends on rent and the amount of mobility in the market. Lately, McDonald (2000) argues that mobility and search of office space indicate demand for vacant space.

Focusing on the spatial patterns of office markets, Archer has written various papers on this topic. Archer's 1981 study of two cities in the U.S. indicated that market oriented firms are primarily sensitive to market location, while non-market oriented firms are more sensitive to linkages and personnel commuting costs. Arher and Smith (1993) suggest that suburban office markets are completely segregated from their central city's office markets. In their latest study Arher and Smith (2003) try to explain suburban office clustering of class "A" offices, based on the nature of office functions and related industry economies of scale. Their findings suggest a sequence of clusters, increasing in size and distance from the Central Business District (CBD). Finally, a study by Chakravorty et al. (2003) examines eight industrial sectors for evidence of global and local clustering, through the Global and Local Moran. Although this study is not real estate related the spatial autocorrelation methodology is used in the analysis of this paper's data set.

This study breaks-down the CBDs and suburbs of Atlanta, Boston, Chicago, Washington and Los Angeles by zip code in an effort to evaluate the effect of economic data on local office markets, at the smallest possible geographic area that data can be obtained. Industry clusters are identified within the CBDs and suburbs based on the number of employees and number of establishments of the Information, Finance Insurance & Real Estate (FIRE), and SIC/NAICS codes. These clusters also help in the identification of the probability of a company to locate at the CBD versus a suburb. In addition, the impacts of both economic and real estate factors on vacancy levels are studied. This study utilizes assumptions, econometric and spatial modeling

introduced by other studies referred in the literature review but in a way that captures trends at the smallest possible geographical level.

III. Data

The study area includes 5 major U.S. metropolitan areas - Atlanta, Boston, Chicago, Washington D.C. and Los Angeles - for which both economic and office market data were gathered. The office market data were provided by Grubb & Ellis and include asking rents, total office space and vacant office space of both the CBD's and suburbs at a quarterly basis from 1998 to 2001 (Figures 1, 2 and Fig. 3, which was estimated based on Rosen (1984)). The economic data were gathered from the U.S. Census and include employment and number of establishments by zip code for the same time period with the real estate data. However, these data are annual in contrast to the quarterly real estate data (Figure 4).

III. Methodology

This study focuses on the interaction between real estate and economic data at the zip code geographic level and is conducted in three phases. The first is to identify spatial agglomerations of employment and establishments within a CBD and a suburb using the economic data at the zip code level. The second is to identify the effect of selected real estate and economic factors on the probability of a company to locate in a CBD versus a suburb. The third goal is to implement Hanink's mixed spatial autoregressive model on office vacancy to our data with the addition of the probability of a company locating in the CBD versus the suburbs, and determine the effect a company's location decision has on the vacancy rate.

In the first phase, the areas of study within each city were determined based on the CBD and suburb boundaries of the real estate data provided by Grubb & Ellis. The real estate data boundaries were overlaid on road and zip code maps of the studied cities and the appropriate zip codes were selected, to accomplish geographic compatibility for both the real estate and economic data (Map 1 through 5).

This paper will use the Global Moran I and its statistical significance test (Eqs. 1 and 2), to describe the overall spatial relationship across all zip codes within a CBD or suburb and the Local Moran I and its statistical significance test (Eqs. 3 to 5) to describe the heterogeneity of spatial association across the different zip codes within the CBD or suburbs. These spatial relationships will be determined for both the number of employees and the number of establishments. The Global Moran I is defined as:

$$I = \frac{n\sum\sum w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{W\sum(x_i - \bar{x})^2} \quad \text{(Eq. 1)}$$

$$E(I) = \frac{-1}{(n-1)} \text{ (Comparison of Global Moran with its expected value based on this formula)} \quad \text{(Eq. 2)}$$

where: x_i the number of employees (or number of establishments) in area unit i, w_{ij} is a weight derived from a spatial weight matrix and W is the sum of all cell values of the weight matrix. A stochastic weight matrix is used to take into account the number of immediate neighbors, using 1/total number of neighbors as a weight.

The Local Moran I is defined as:

$$I = z_i \sum_i w_{ij} z_i \quad \text{(Eq. 3)}$$

$$z = \frac{(x_i - \bar{x})}{\delta} \quad \text{(Eq. 4)}$$

$$E(I_i) = \frac{-w_i}{(n-1)} \text{ (Comparison of the Local Moran with its expected value based on this formula)} \quad \text{(Eq. 5)}$$

where: z_i is the deviation from the mean and δ is the standard deviation of x_i

The results from both Morans' allow the formulation of clusters within the CBDs and suburbs for each of the selected cities on an annual basis from 1998 to 2001. Because of the census data set structure, the clusters are formulated at an annual basis. In the next stage, however, the quarterly real estate data set is fully utilized and therefore it is assumed that the annual clusters generated before are maintained through the four quarters of a year. This assumption allows the development of a binary choice model (Eq. 6) using quarterly data from 1998 to 2001. This model provides insight in the probability of a company to locate in the CBD versus the suburbs.

$$P(Y=1/X)=\Phi(\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6W_6+\beta_7X_7+..+\beta_nX_n+\varepsilon) \text{ (stage one)} \quad \text{(Eq. 6)}$$

where:

- Y = the probability of a company to locate in the CBD versus the suburbs, which takes the value 1 if the company is located in the CBD and 0 if it is located in the suburbs,
- X_1 is the difference in asking rent levels between the CBD and the suburbs [$\Delta(rents_{CBD\text{-}suburbs})$]

- X_2 is the occupied office space growth and is determined in two steps as follows (Eq. 6.1 & 6.2):

$$Occupied\ Office\ Space\ Growth\ (OSG)_{ij} = \frac{OS_{j+1} - OS_j}{OS_j} \quad \text{(Eq 6.1)}$$

$$Occupied\ office\ space\ (OS)_{ij} = Total\ supply\ of\ office\ space - vacant\ space \quad \text{(Eq. 6.2)}$$

OSG_{ij} (or OS) is the local occupied office space growth in the i^{th} city during the j^{th} quarter, from 1998-2001.

- X_3 is the Actual Vacancy Rate Growth, which is determined in two steps. The first step is based on Rosen (1984) (Eq. 6.3):

$$Actual\ Vacancy\ Rate\ Growth\ (VG)_{ij} = \frac{V_{j+1} - V_j}{V_j} \quad \text{(Eq. 6.3)}$$

$$Actual\ Vacancy\ Rate\ (V)_{ij} = \frac{Total\ supply\ of\ office\ space - occupied\ office\ space}{Total\ supply\ of\ office\ space} \quad \text{(Eq. 6.4)}$$

VG_{ij} (or V) is the Actual Vacancy Rate Growth in the i^{th} city during the j^{th} quarter, from 1998-2001.

- X_4,X_5 is the Employment growth (or number of establishments growth) is calculated as (Eq. 6.5):

$$\text{Employment Growth (EG)}_{in} = \frac{Employment_{n+1} - Employment_n}{Employment_n} \quad \text{(Eq. 6.5)}$$

EG_{in} is the Employment growth in the i^{th} city during the n^{th} year, from 1998-2001. For EG we assume that employment growth is maintained within the 4 quarters of a year.

- W_6 Are weights reflecting the differences among the markets studied (Eq. 6.6):

$$Weight\ of\ occupied\ office\ space\ (WOS)_{ij} = \frac{OS_{ij}}{weighted\ average\ OS_{all\ cities,\ all\ quarters}} \quad \text{(Eq.6.6)}$$

$$Weighted\ average\ OS_{all\ cities,\ all\ quarters} = \frac{\sum_{n=1}^{5} (\overline{OS}_{i,\ all\ quarters} * st.dev.\ OS_{i,\ all\ quarters})}{\sum_{n=1}^{5} (standard\ deviation\ OS_{i,all\ quarters})} \quad \text{(Eq. 6.7)}$$

WOS_{ij} is the weight of occupied office space in the i^{th} city during the j^{th} quarter, from 1998-2001

- $X_{7..n}$ Are growth dummies reflecting the Moran's clusters results for both employees and number of establishments.

In the third phase of this study we evaluate the effect of all the previous analysis of the CBD and suburbs on their office vacancy rates. Therefore, we use Hanink's model (Eq. 7) with a maximum likelihood procedure, but we make it the second stage of a 2SLS model with the probability of a company to locate in the CBD versus the suburbs being the first stage (Eq. 6).

$$LV_{ij} = a + b_1 WLV_i + b_2 NV + \sum_{q=1}^{j} b_4 T + P(Y = 1/X) + \varepsilon \quad \text{(stage two)} \qquad \text{(Eq. 7)}$$

where:

- LV is the local office (CBD or suburbs) vacancy rate in the i^{th} city during the j^{th} quarter.
- WLV_i is the distance weighted average of vacancy rates at other places. The values of W are inversely proportional in their weighting so that the vacancy rate of a more distant place contributes less to WLV than does the vacancy rate at a more proximal place. The weights have a sum of 1.
- NV is the national vacancy rate (CBD or suburb).
- T is a set of dummy variables (q=1, q=n) that account for variations in LV simply attributed to the quarter of observation.

IV. Results & Discussion

Not yet - in progress

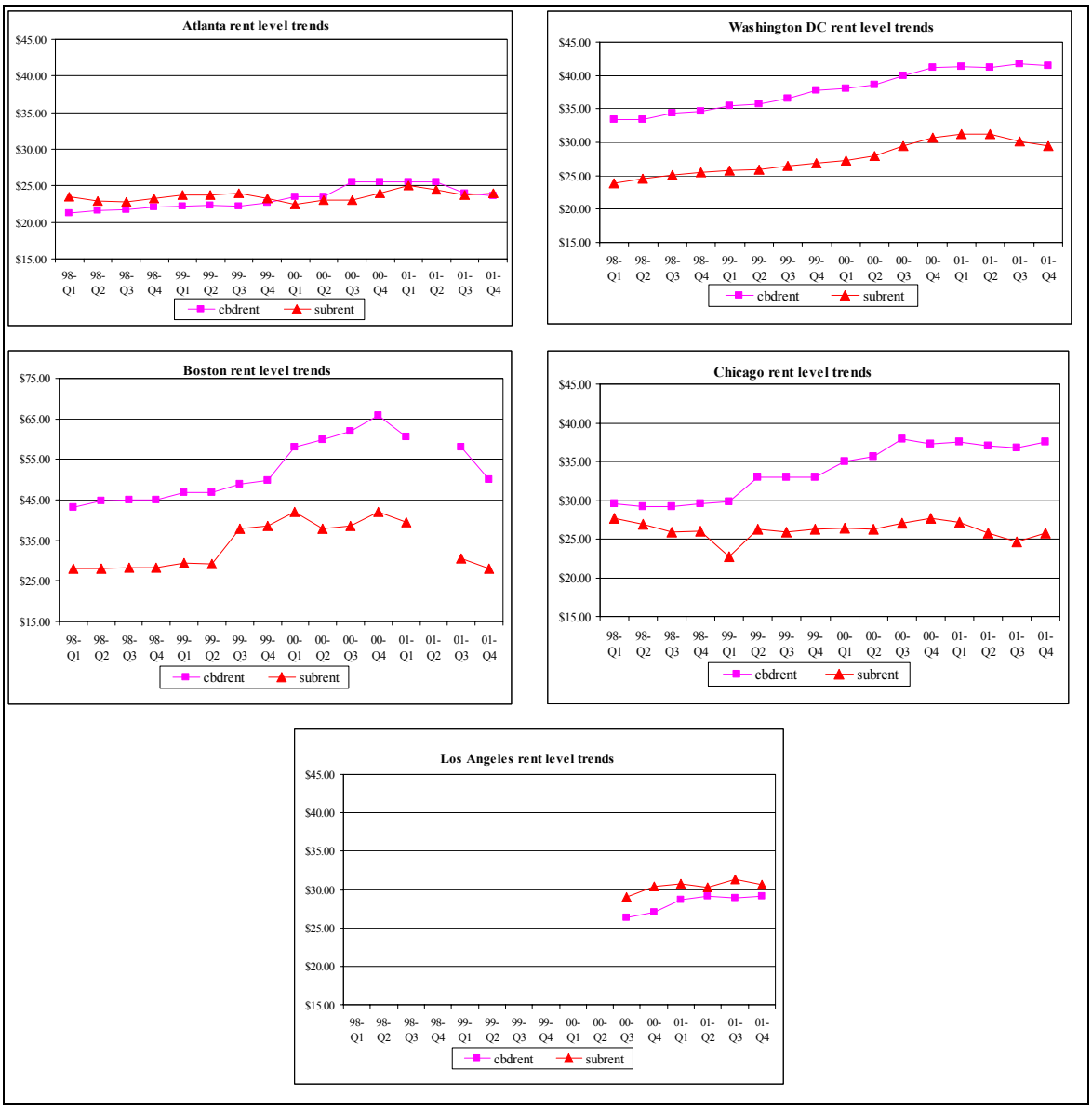


Figure 1. Rent level trends in the cities studied (Source: Grubb & Ellis)

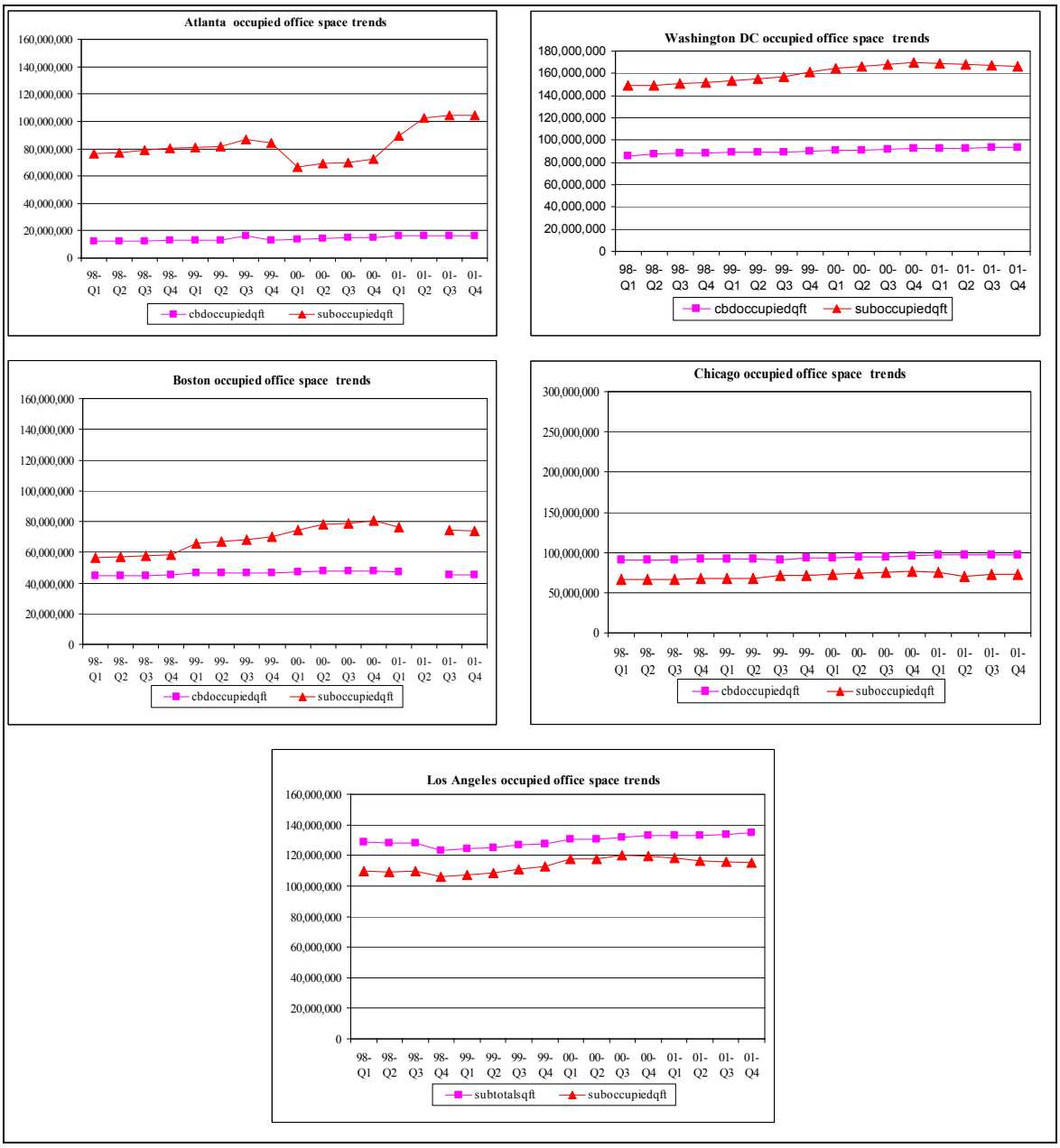


Figure 2. Occupied office space trends in the cities studied (Source: Grubb & Ellis)

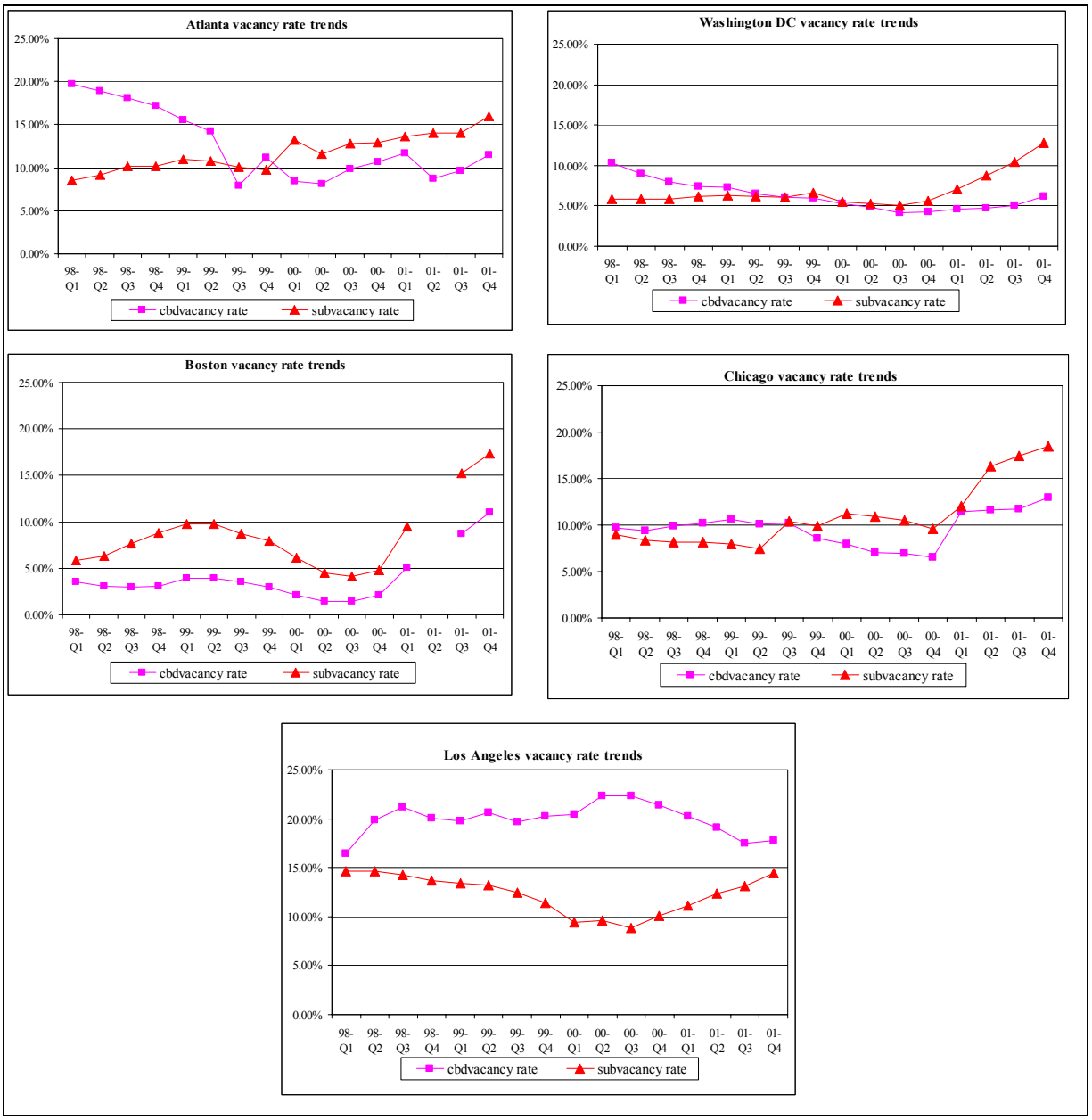
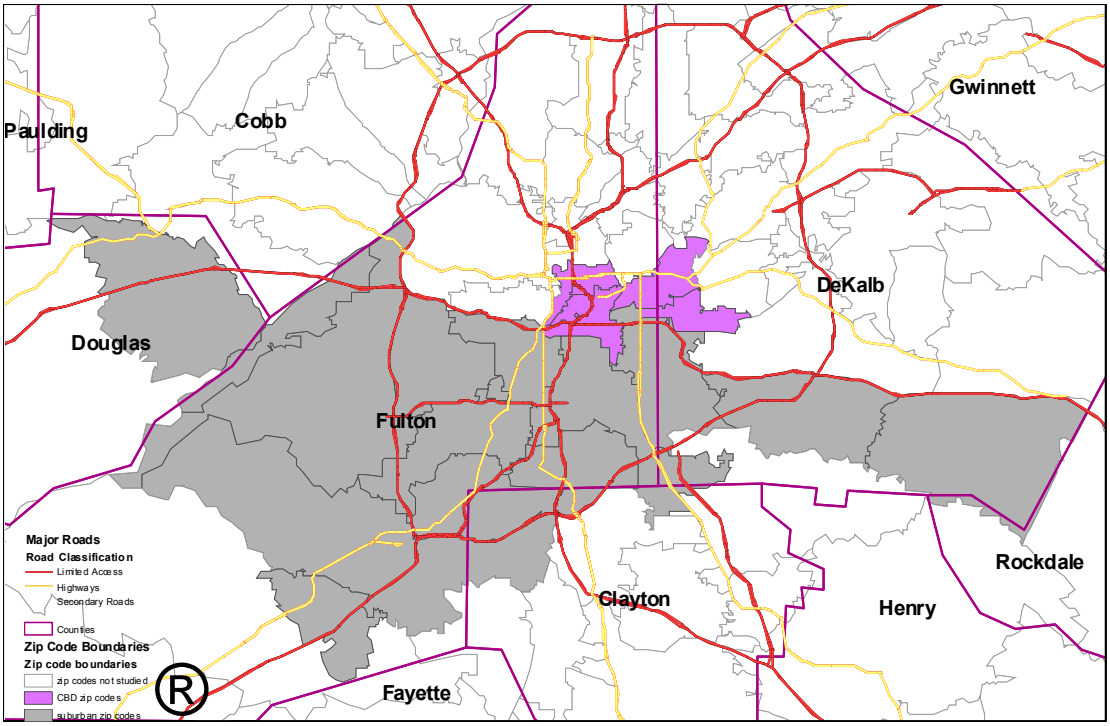
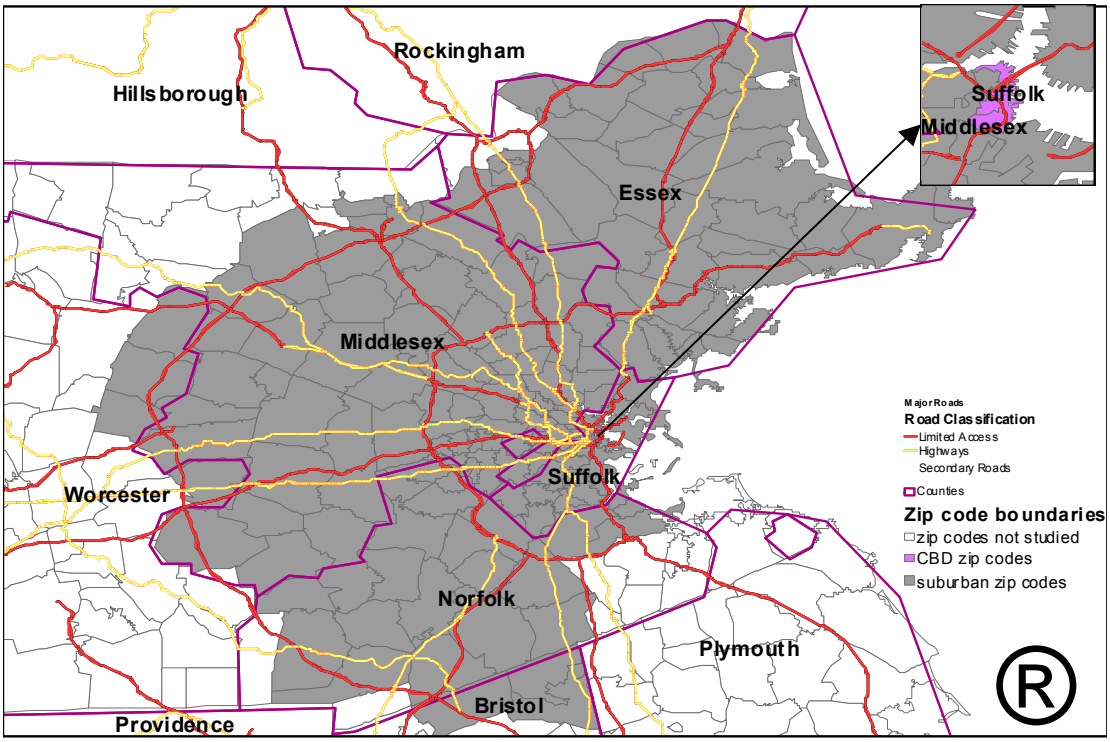


Figure 3. Vacancy rate trends in the cities studied (Estimated based on Grubb & Ellis data)

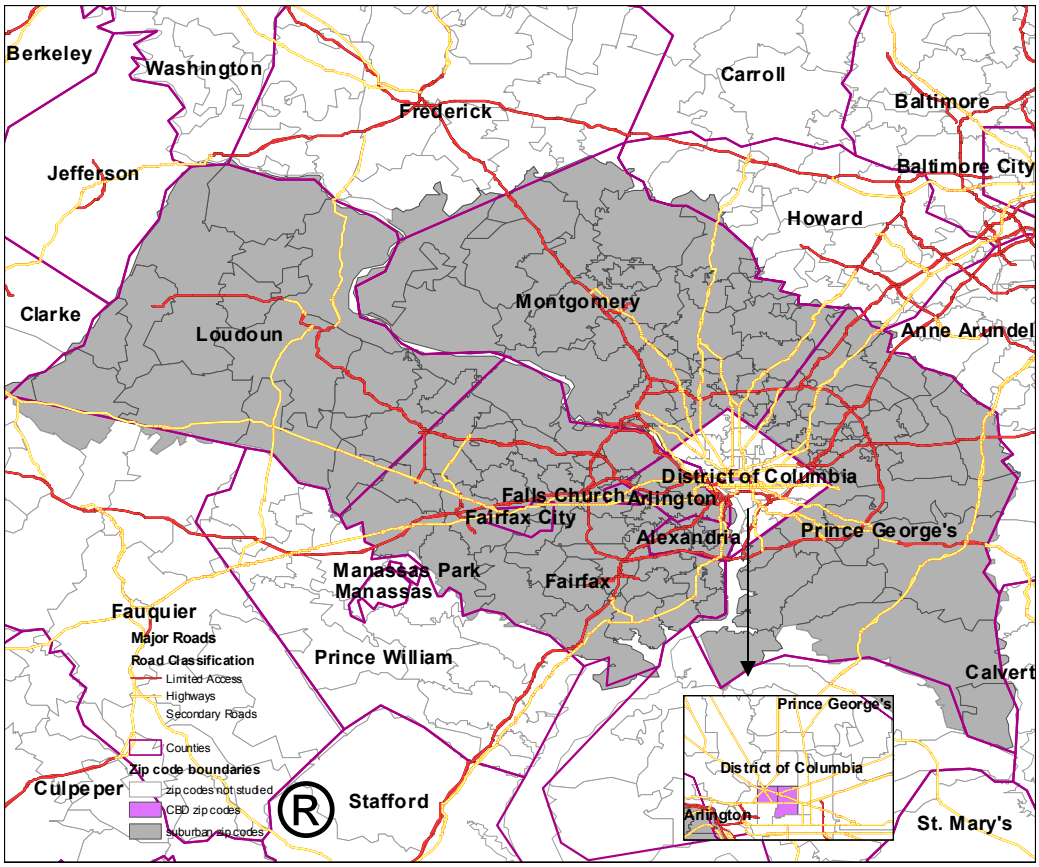
Figure 4. Employment & Establishment trends in the cities studied (Source: U.S. Census)



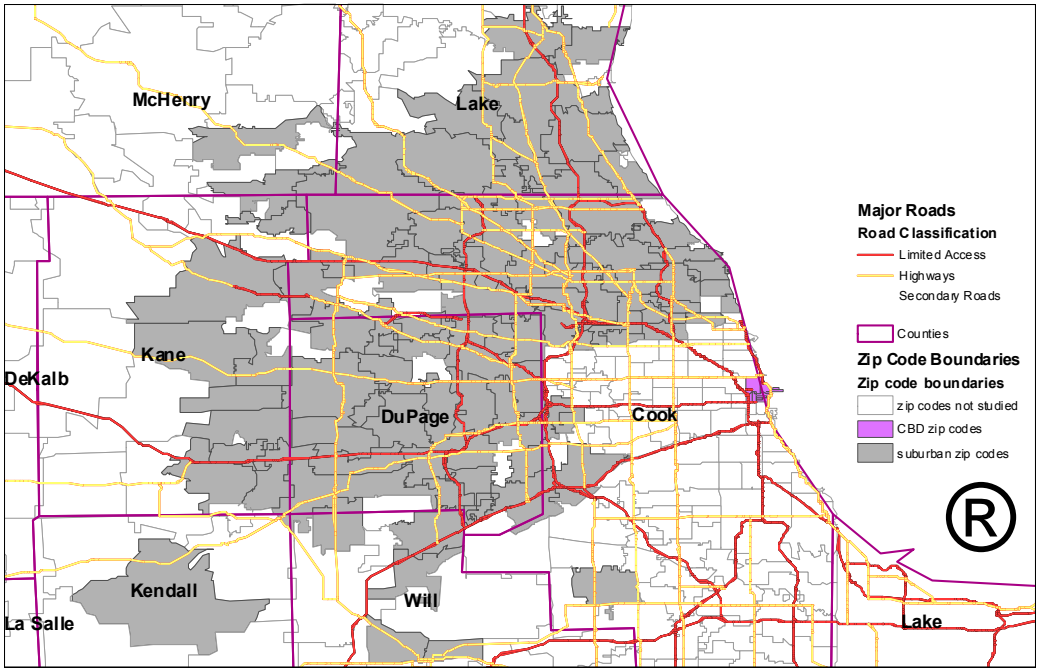
Map 1. Atlanta area of study at the zip code geographic level



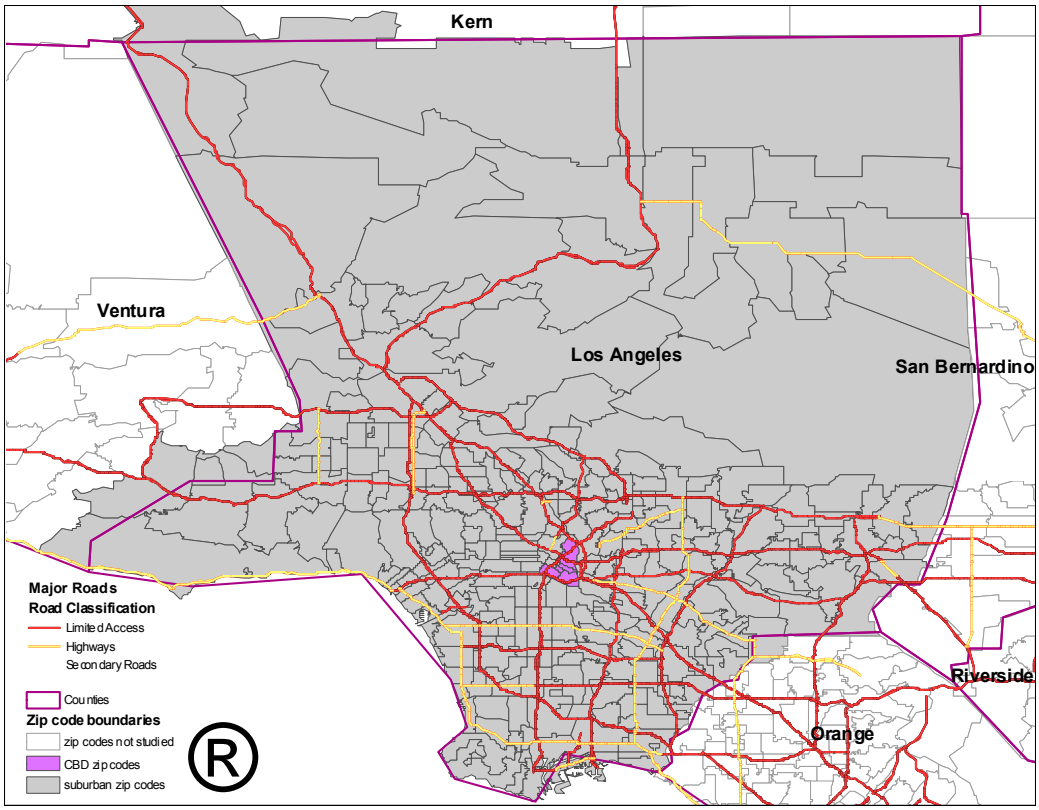
Map 2. Boston area of study at the zip code geographic level



Map 3. Washington D.C. area of study at the zip code geographic level



Map 4. Chicago area of study at the zip code geographic level



Map 5. Los Angeles area of study at the zip code geographic level

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