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Spatial patterns of office employment in the New York region

In the wake of the September 11 attacks on New York City, nearly 100,000 office workers were dispersed to over 1000 different destinations, many of them within Manhattan and a few of them as far away as London and Tokyo. While the immediate impact of the attacks on New York's regional economy has been thoroughly document in the literature, the secondary consequences and potential economic ripple effects are more difficult to grasp. While this study does not attempt to disentangle the effects of the 9/11 from concomitant dynamic processes, it focuses on three broader questions in the context of the 9/11 attacks using empirical data from 1998 through 2004: First, little is known about geographic concentration outside of the manufacturing sector and hardly any consistent empirical work has been done on the spatial dynamics of office-using industries. Taking similar studies of the manufacturing sector as a point of departure, this paper simply takes a step back to answer the basic question: do establishments in the office-using sectors tend to be spatially concentrated in the New York region? If so, have recent changes in office employment been more dynamic in the Manhattan core or in the more peripheral counties of the agglomeration? Secondly, the regional employment analysis is extended by introducing some simple measures of labor productivity for office-using industries and by comparing productivity growth in the core to that of the outer region. Thirdly, the regional county-level analysis is complemented with a more disaggregated analysis of co-agglomeration in office using industries at the zip code level. To this aim, measures of co-agglomeration are calculated for all possible combinations of industries and the distribution of these measures is examined.

For the purpose of the empirical analysis, these three questions can be rephrased in the following way: 1) How concentrated is office employment in Manhattan, the center of the New York region and what changes have occurred in the ratio between the urban core and the suburban periphery in recent years? 2) Is labor productivity in office-using industries similar in the core and periphery? 3) What conclusions can be reached from zip code level analysis of co-agglomeration of office industries regarding the existence of small-scale spillover effects?

Research problem

Employment dynamics of office-based service industries are a main determinant of the demand for office space and an integral part of contemporary metropolitan economies. This is particularly true for Manhattan where FIRE (finance, insurance and real estate) and other office-using industries account for over 40 percent of total employment. In Lower Manhattan, office jobs make up approximately 75 percent of all jobs (Bureau of Labor Statistics 2007). At the regional level, suburban areas have experienced strong growth in office space and employment growth virtually throughout all metropolitan areas. In contrast, growth in inner cities has been more modest and in some cases even negative. Lang (2000) reports that in the aggregate US market office space almost tripled within one decade (1979-1989) whereas central city office space grew only by 90 percent. During the 1990s, growth of suburban office inventories slowed down remarkably, allowing inner cities to partially regain their competitiveness. Construction of new office space was 280 million square feet in inner cities and 234 million square feet in the suburban areas at the national level. This long-term trend towards more decentralized office is partially counteracted by the requirement of frequent face-to-face contacts in knowledge intensive industries. Glaeser and Kahn (2001) report that financial and business services, research and development activities, and technology development are among the industries that are strongly dependent on face-to-face communication. In addition, Rauch (1993) found knowledge spillovers in dense urban environments with a high employment density to be a source of significant productivity gains. Schwartz (1992) contends, however, that suburban proximity as found, for instance, in campus-style suburban office parks may be sufficient to replicate the proximity and communication patterns found in Central Business Districts. In a similar vein, Chang and Coulson (2001) reported that employment growth in central cities is associated with complementary suburban growth but also found cases in their empirical study where suburban growth occurred as substitutive growth at the expense of the urban core. In the face of conflicting empirical evidence, it is pertinent to briefly review the theoretical foundations of agglomeration economies before commencing the empirical analysis.

Categorization of agglomeration economies

Cities have a number of distinct features that enhance their competitiveness over more peripheral areas. First, the diffusion of information among firms regarding

research and development, labor, financing, and marketing strategies is particularly high in cities (Blair, Premus 1993). Transfer costs and unit costs are lower, labor productivity and management efficiency are higher (Hoover and Giarratani 1985). These locational advantages are transmitted via agglomeration economies. The term 'agglomeration economies' denotes a variety of distinct processes that result in spatial concentration of economic activities at various geographic levels. Three microfoundations of agglomerative forces have been defined in the literature: (1) knowledge spillovers, (2) labor market pooling, and (3) input sharing (Rosenthal, Strange 2001). When analyzing agglomeration effects in this context, it is helpful to break down agglomeration economies into two types of effects: localization economies or Marshall-Arrow-Romer (MAR) externalities which are dependent on the size of a particular industry within a city and urbanization economies (also termed Jacobs externalities) which are dependent on the overall size of a city's economy (Henderson 1997). Following this definition, localization economies refer to savings in production costs that a firm achieves by sharing industry-specific input factors with companies of the same industry or by gaining joint access to a large pool of workers with specialized skills relevant to the particular industry or trade. Urbanization economies, which are more broadly defined, apply to all urban location factors such as transportation infrastructure, public utilities, information services and other factors that are simultaneously relevant for a number of industries and exhibit decreasing average costs with large-scale production (McDonald 1997, 37).

1.1 Methodology and data

Four types of concentration measures that have become standard in regional science and regional economic studies are used in this analysis: the location quotient, the Hirschman Index and the locational Gini coefficient and the Ellison-Glaeser-Index.

Concentration indices

The most basic measure among these is the location quotient which is formally defined as:

$$LQ = \frac{e_{ij}^t}{e_j^t} \div \frac{E_i^t}{E^t} \qquad (1)$$

where e_{ij}^t is employment in a given industry *i* in region *j* in year *t*. E_i^t is national employment in industry *i*. The location quotient approach compares the concentration of employment in a given industry and spatial unit to that industry's share at the aggregated national level. LQ values below 1.0 indicate that an industry has relatively fewer employees in a given spatial unit compared to the national level whereas a value above 1.0 indicates that an industry's share in the economy of a spatial unit is higher than it is in the national reference system. In the location analysis literature, LQ values above 1.0 are also interpreted as indicative of comparative regional economic specialization. LQ values above 1.0 are also routinely used to identify export industries in an export-base framework (Klosterman 1990).

The Hirschman-Herfindahl Index (HHI) takes into account the relative size and distribution of the competitors in a market and varies from 0 to 10000, where zero represents no concentration at all and 10,000 represents a perfect spatial monopoly. It is calculated by squaring the market share of each unit competing in the market (counties, in our case) and then summing the resulting numbers.

$$HHI = \sum_{i=1}^{N} \left(\frac{x_i}{X} \right)^2 \qquad (2)$$

where x_i is the number of office workers in location *i* and *X* is the total number of office workers in all regions. Markets in which the HHI is between 1000 and 1800 points are considered to be moderately concentrated and those in which the HHI is in excess of 1800 points are considered to be markedly concentrated.

The spatial Gini coefficients are based on industry employment normalized by the overall industry-mix and distribution of the CMSA in the following form:

$$G = \sum_{i=1}^{N} \left(\frac{z_i}{Z} - \frac{x_i}{X} \right)^2 \qquad (3)$$

where z_i is the number of workers of a particular office-using industry in location, *Z* represents the total number of workers of that industry in all regions, x_i is the number of all office workers in location *i* and *X* is the total number of office workers in all regions.

An industry which is not geographically concentrated more than the overall aggregate job distribution has a coefficient of 0. The coefficient approaches 1 with increasing spatial concentration of an industry. Spatial Ginis were applied, among others, by

Krugman (1991, 1993) and Audretsch and Feldman (1996) to measure spatial concentration and to assess economic innovation. One of the advantages of the Gini coefficient is that it eliminates the size effect resulting from the fact that large employment and population centers are more likely to have larger numbers of workers in any given industry regardless of their industry-specific specialization. As Ellison and Glaeser (1997) point out, however, the Gini coefficient may overestimate concentration for some industries with relatively few plants. A positive value of the spatial Gini may also arise in a situation where an industry is merely made up of a small number of large plants (possibly due to industry size or internal economies of scale) with no agglomerative force present that causes the concentration. The authors propose an index which eliminates the distorting influence of industrial structure, which takes the following form:

$$E(\gamma) \equiv \frac{G - \left(1 - \sum_i x_i^2\right) HHI}{\left(1 - \sum_i x_i^2\right)(1 - HHI)} \equiv \frac{\sum_{i=1}^{M} (s_i - x_i)^2 - \left(1 - \sum_{i=1}^{M} x_i^2\right)^2 \sum_{j=1}^{N} z_j^2}{\left(1 - \sum_{i=1}^{M} x_i^2\right)\left(1 - \sum_{j=1}^{N} z_j^2\right)} \qquad (4)$$

where *G* is the spatial Gini, *HHI* is the Hirschman-Hefindahl Index, s_i is the share of industry employment in region *i*, x_i is the share of total employment in region *i*, and z_i is the share of establishment employment of the industry. In the Ellison-Glaeser Index, the inclusion of the term $(1 - \sum_i x_i^2)$ ascertains that E(γ)=0 when neither agglomerative spillover forces nor natural advantage are present. A zero value of γ indicates a perfectly random location process whereas positive γ values can be interpreted as excess concentration. It is not possible, however, to undertake any causal analysis of agglomeration effects with these measures. As Ellison and Glaeser (1997) point out, excess agglomeration as measured by E(γ) may result from either the presence of natural advantages or spillover effects. It is not possible to disentangle the impacts of both factors with the Ellison-Glaeser index since the cause of agglomeration of a particular industry may be pure natural advantage, pure agglomeration spillovers or a combination of both factors.

Datasets

The empirical analysis of this study is based on two main datasets, the County Business Patterns and the more disaggregated ES-202 data.

County Business Patterns (CBP) is an annual federal data series that provides standardized data on employment and wages by industry and county. This series which is maintained by the United States Bureau of Labor Statistics (2001-2007) is widely used in employment research to study the economic activity of detailed geographic areas over time and to benchmark time series data between economic censuses. CBP data excludes self-employed individuals, private household workers, railroad employees, agricultural employees, and most government employees. Since 1998, it has classified industry using the new North American Industry Classification System (NAICS). Before 1998, it used the previous Standard Industry Classification (SIC) system. Economy.com, a private data supplier has made an effort to reconcile SIC and NAICS data at the county level. This reconciled continuous time series of employment is used to conduct the analysis described above.

ES202 Employment Data is the second major data series applied in this analysis. It comprises the New York State Department of Labor (DOL, 2004) Covered Employment and Wages data which is a quarterly time series of the number of workers and companies as well as the dollar amounts of aggregate wages by detailed industry and zip code of firm location. DOL collects this information from employers covered by New York State's Unemployment Insurance Law. ES202 data cover approximately 97 percent of New York's nonfarm employment, providing a virtual census of employees and their wages as well as the most complete universe of employment and wage data, by industry, at the state, regional, county, and zip code levels. The data used for this study defines industry according to the older Standard Industrial Classification system (SIC) for 1992 through 2001 and the newer North American Industry Classification System (NAICS) for 2000 through 2003. Because the SIC and NAICS have not been made compatible at the zip code level, the small-scale analysis focuses only on the years organized according to the SIC system.

A known problem with using ES202 data for this type of analysis is that firms do not always report jobs where they are actually located, as the reporting form asks, but instead at the address of the company's headquarters or accounting service. While this may somewhat distort the picture of how jobs are distributed across zip codes, the

main trends will nonetheless be visible. Another problem with ES202 data is that it suppresses data for zip codes with fewer than three employers in the SIC for confidentiality reasons. To remedy this problem, I apply a suppression correction algorithm. If observations were available for other years in the series (i.e. years when the number of reporting companies in an SIC rose above two) I calculated employment for the suppressed cases by applying the per-firm average taken from those other years. Where employment information was missing for whole series (because number of firms in zip code was continuously below three), no adjustments were made. The upward adjustment of employment numbers due to suppression correction ranged from 0.04 percent of total employment in 2001 to 0.27 percent in 1992. Further correction of cases with no valid observations would probably increase employment totals at the same order of magnitude.[1]

1.2 Results

The development of regional office employment in the New York area largely echoes the broader national and international trends. The most important among these long-term trends is the growing importance of suburban office locations compared to central city locations. Figure 1 demonstrates that Manhattan had more office jobs at the beginning of the 1980's than all other thirty counties of the CMSA combined.[2] Over the course of the following two decades, the CMSA counties outside of Manhattan added more than half a million office workers while Manhattan office employment stagnated. It is also evident from the graph that the impact of the two business cycles in the observed period is reflected in both Manhattan and outer CMSA employment. While Manhattan office employment oscillates cyclically by an order of magnitude of 100,000 office workers, the other CMSA counties exhibit a clear secular growth pattern in office employment. Although employment growth in the outer CMSA appears dynamic compared to Manhattan, it is rather sluggish in the larger comparison of US national growth. In fact, the national employment growth rate in the last three

[1] For the purpose of this research, office employment is defined as including the NAICS categories 51 Information, 52 Finance and insurance, 53 Real estate, 54 Professional, scientific, & technical services, 55 Management of companies and enterprises and 56 Administrative & support services. Excluded from the latter category are 5621 Waste Collection, 5622 Waste Treatment and Disposal and 5629 Remediation and Other Waste Management Services. This definition is widely used for public and private research, among others by the New York City Office of Management and Budget (2007).

[2] The Consolidated Metropolitan Statistical Area (CMSA) consists of 31 counties in four states (New York, New Jersey, Connecticut, and Pennsylvania) which form an agglomeration of roughly 20 million inhabitants and 13,000 square miles. See Census.gov for geographic and other details regarding the CMSA counties.

decades of the Twentieth Century is more than double that of the New York-New Jersey-Connecticut CMSA (Hughes, Nelson 2002). It would be premature, however, to conclude that the figures signal a massive decentralization of office jobs. Until the 1980's, the New York region was one of the most highly concentrated in the country with more than 50 percent of office jobs being clustered in only one out of 31 counties on a land area that accounts for a mere 0.2 percent of the entire metropolitan area. In fact, Manhattan is unique in that it is the only county in the US in which the number of workers (2.2 million in 2003) permanently exceeds the number of local residents (estimated 1.6 million in 2003) despite the ongoing decentralization trend.[3]

Another caveat regarding these comparisons is that large percentage gains are more easily achieved in regions with no or little previous office employment while growth in the Manhattan and other mature markets requires large growth in absolute numbers.

[FIGURE 1 SEE BELOW]

Turning to a more detailed analysis of the regional distribution of office employment, Table 1 and Table 2 present the empirical values of two standard measures of concentration as described in the previous section using County Business Pattern data. Table 1 shows the results of this calculation for county-level HHI values in the NAICS categories that are considered primarily office-using industries. Following the common definition of the threshold value where industries with an HHI value above 1800 are considered highly concentrated, three sectors qualify as such: information, finance and insurance and professional and technical services. Administrative and support services are the least concentrated activities. All industries have become less concentrated in the observed period from 1998 through 2003 with the exception of NAICS category 51 (Information).

[TABLE 1 SEE BELOW]

The values for the spatial Gini (Table 2) largely confirm the developments identified in the HHI analysis with finance and insurance being the most concentrated industry group in the New York CMSA and administrative and support services being the least concentrated. Looking at the changes over time within the analyzed period shows that

[3] Employment is total non-farm payroll employment, source: Bureau of Labor Statistics, Economy.com. Source of population estimate: U.S. Census Bureau: State and County QuickFacts.

all office-using industries have experienced employment decentralization to varying degrees throughout the analyzed period with the sole exception of the information industry (NAICS code 51).

[TABLE 2 SEE BELOW]

The gamma indices reported in Table 3 point in a similar direction. The decentralization process is less pronounced in the gamma values, however. While the information industry experienced significant centralization during the observed period, the five other major office-using industry groups remained relatively close to their initial levels. The general interpretation of the γ is not straightforward, however. Some empirical studies apply a rule of thumb where $\gamma > 0.05$ are defined as highly concentrated whereas $\gamma < 0.02$ are defined as not very concentrated (Ellison and Glaeser 1997, Rosenthal and Strange 2001), which we also follow in our interpretation. While management of companies (55) and administrative and support services (56) are not significantly concentrated, finance and insurance (52) exhibits an extraordinarily high degree of concentration that persists throughout the analyzed period. The high value is indicative of individual industries in the financial services industries contained in this group that are clustered in a few selected locations in Midtown and Downtown Manhattan. In the next step, the 2-digit industry groups are decomposed into 4-digit industry groups and the spatial units are disaggregated from counties to zip code level to obtain a more fine-grained analysis.

[Table 3 SEE BELOW]

In addition to the measures reported in the tables above, the spatial dynamics of office employment in the New York region can be illustrated with a series of maps.[4] Figure 2 shows the density distribution of office employment per square mile for the CMSA counties. With an average of 40,000 office workers per square mile, Manhattan exhibits by far the greatest density of all counties. This extraordinary density and the small-scale agglomeration spillover effects resulting from it are the basis of a more detailed zipcode-level analysis in the next step. Employment density diminishes gradually departing from Manhattan, resulting in a pattern of three concentric rings around the regional core. Figure 3 shows the percentage changes in office employment

[4] Maps in this article were generated using the software system ArcGIS 9.1 by ESRI.

from 1998 until 2001 and Figure 4 from 2001 until 2002 at the county level (annual averages). During the first period (1998-2001) all counties experienced growth in office employment with the exception of only two counties (Essex and Pike Counties). The highest relative growth occurred predominantly in the New Jersey counties of the CMSA whereas Manhattan experienced the highest growth in absolute numbers. In the second period (2001-2002), the combined effect of the economic recession and the September 11 attack resulted in significant losses of office employment in most areas except some counties in the New Jersey in the southern and southwestern part of the CMSA. Manhattan experienced some of the sharpest declines in office employment both in absolute and relative terms. Two counties in the immediate vicinity of Lower Manhattan, Hudson County and Brooklyn showed an increase in office employment even after 9/11 due to office-using companies relocating from Manhattan to these neighboring office clusters in the wake of the attack.

[FIGURES 2, 3, 4 SEE BELOW]

Long-term trends in regional office employment

How do the trends of the short time period analyzed above fit in the longer-term employment trends of the New York region? Since consistent county-level datasets for this longer series (1983-2004) are not available, this longer-term analysis is limited to a comparison between Manhattan (New York County), and the CMSA counties at the aggregate level as well as national aggregates.[5] It is therefore not possible to calculate Gini or E-G gamma indices for the long time series. Instead, location quotients (LQs) are calculated as a measure of relative spatial concentration.

Table 4 presents LQs for Manhattan and separately for the CMSA counties outside of Manhattan. Overall, office industries continue to make up a significantly larger proportion of Manhattan's employment than it does in both the outer CMSA and the national level. Over the last two decades, however, the share of Manhattan's office using industries in overall employment, particularly the finance and insurance sector (NAICS 52), has been decreasing continuously. It is also noteworthy that the CMSA

[5] The foundation of the U.S. statistical program has been the Standard Industrial Classification (SIC) system. Since 1997, however, all economic census data is collected under the new North American Industrial Classification System (NAICS). The conversion to NAICS represents a significant change in the way economic census data are collected and reported. The data prior to 1997 reported in this study were converted from SIC to NAICS by Economy.com to allow for the construction of long-term time series data.

counties outside of Manhattan exhibit no significant overall specialization in office industries compared to the US average. Despite large gains in absolute employment numbers, no clear specialization pattern emerges in the CMSA over the last 20 years based on the analysis of LQs. The region appears to have gained somewhat from Manhattan's relative decline in the securities and commodities exchange industry (NAICS 5232) but does not exhibit any particular specialization. While a county or zip-code-level analysis reveals small-scale specialization patterns, a general regional specialization is not detectable at the CMSA level. Turning to the columns reporting the values for Manhattan it becomes obvious that the specialization in the securities industry remains one of the most striking characteristics of the Manhattan economy despite the ongoing decentralization process. A number of industries show a declining LQ in both Manhattan and the rest of the CMSA, however. This parallel decline hints at locational shifts at a higher aggregation level, in particular due to the more dynamic economic development of the southern and southwestern regions of the US.

[TABLE 4 SEE BELOW]

Productivity comparisons of office-using industries

The analysis of employment data demonstrates that Manhattan's share of office activities in the region is declining by all accounts. Similarly, office employment has become more evenly distributed in the CMSA region in the last two decades as office firms are relocating partially or fully to suburban areas and smaller office cores in the New York region.

Apart from being an indicator for the industrial composition of regional and local economies, employment data are also subject to relative changes in productivity and capital endowment which are prone to having a distorting impact on the spatial analysis. It is therefore useful to analyze output measures such as output per worker in addition to employment data. Labor productivity is the most important indicator of the efficiency and competitiveness of local and regional economies. For the purpose of this research, it is simply defined as real output per office worker since reliable data on average working annual working hours were not available to the author. Figure 5 shows real output per office worker for three entities: Manhattan, the CMSA outside of Manhattan, and the national level. The results are strikingly different from the comparison of employment levels. In terms of productivity Manhattan seems to have

accumulated a considerable advantage over both the CMSA and the national aggregate in the last two decades. An analysis of the components of productivity confirms that real output in the office-using industries has grown by 138 percent in Manhattan from 1983 to 2004 whereas employment in the same sectors has contracted by approximately two percent during the same period with pronounced cyclical swings as shown. It is remarkable that economic growth in Manhattan's office-using industries is brought about almost exclusively by productivity increases and not by virtue of an expanding work.

Comparing the trajectories of employment and productivity over time reveals that the events of 9/11 and the ensuing economic recession had a profoundly negative impact on employment levels while productivity remained unscathed by the events. In fact, output per worker has been increasing throughout all phases of the business cycle in the last two decades which is particularly remarkable since labor productivity tends to stagnate or fall during a recession as companies cut production more rapidly than employment at the onset of a recession. While there were hardly any productivity gains during much of the 1990s at both the CMSA and the national level, Manhattan added productivity gains of nearly 100,000 dollars per office worker within the last decade.

How can the productivity advantage of Manhattan's office firms be explained? In principle, higher productivity in one area over another can come from two sources. The first one is the industrial composition advantage which arises when a local or regional economy has a disproportionately high share of highly productive industries. In this case, overall labor productivity in the area will be high even if productivity by industry is only average.

[FIGURE 5 SEE BELOW]

The second possible source is an intra-industry competitive advantage, which means that local industries achieve higher productivity levels by virtue of a more efficient use or higher quality of input capital. An ad-hoc measure that allows for distinguishing both sources is useful in this context. The so-called competitive advantage can be measured by applying the US industry mix to Manhattan at the four-digit NAICS level to correct for the effect of unequal industrial composition in both entities. The difference between the aggregated hypothetical values and the observed values is defined as the competitive advantage and the residual of the observed productivity difference is then interpreted as the industrial composition advantage. This simple

method is derived from the standard shift-share framework of regional analysis, originally developed by Dunn (1960). Figure 6 demonstrates that Manhattan's productivity advantage over the national aggregate is based on both industry composition and competitive advantages. The share of both factors in explaining the difference has changed considerably in the last two decades, however, as has the magnitude of the difference. While the industrial composition advantage has remained largely steady around $50,000 per office worker, the competitive advantage has increased from $8000 in 1987 to $152,000 in 2004 in real terms. The preponderance of the competitive advantage over the industry mix suggests that Manhattan's office-using industries have been more adept at implementing productivity and efficiency-enhancing practices than establishments of the same industries elsewhere in the US since the 1980s.

This conclusion may not necessarily be warranted, however. Productivity advantages of Manhattan office firms vary greatly by industry and one could suspect that the productivity differential is an artifact generated by a few high-revenue companies, particularly in the financial services and securities industry. Decomposition by industry reveals, however, that 79 percent (41 out of 52) of Manhattan's office-using industries at the four-digit NAICS code level had higher output per worker in 2003 than the national aggregate. Thus, competitive advantages are not only found for high-revenue generating financial companies but also for legal, technical and a variety of business-oriented services.

One caveat in this context is that higher productivity levels may be caused by a small number of high-revenue key industries. The highest productivity differences (over $500,000 per worker) are found in the four industries Securities and Commodity Contracts Intermediation and Brokerage (5231), Securities and Commodity Exchanges (5232), Offices of Real Estate Agents and Brokers (5312), and Activities Related to Real Estate (5313). Thus, higher productivity levels may simply be explained by Wall Street's function as a global financial hub or the generally higher price volumes of Manhattan real estate. Genuine factors that are capable of explaining differences in productivity as recognized in the research literature include higher quality of physical capital, a generally higher skill level of the local labor force, more efficient workplace practices and institutional arrangements as well as knowledge spillovers due to spatial proximity. It is virtually impossible, however, to extract the contribution of each of these factors from the general output per worker figures in the framework of this

study. Regardless of these methodological and definitional difficulties, the analysis of the Manhattan data demonstrates clearly that real output and real output per worker of office firms have increased dramatically in the last two decades whereas employment has by and large stagnated.

[FIGURE 6 SEE BELOW]

Zipcode level analysis of office employment

The analysis of county-level data of the previous section yielded some important insights into the changing dynamics of office employment in the regional context. To examine small-scale spillover effects that cannot be captured at this level of aggregation I additionally include zip-code level employment data of Manhattan in the analysis. Figure 7 shows the density of office employment per square mile at the zip code level. The two major office clusters of Midtown and Downtown Manhattan are clearly discernable. Some of the smaller zip code areas within these central business districts reach a density of well over 100,000 office workers per square mile. In the presence of densities of this order of magnitude, the question of micro-scale spillover effects is of particular relevance. To demonstrate the microlocational dynamics in recent years, Figure 8 visualizes the changes in office employment in zip code areas from 2000 to 2001 in percentage points of overall share based on ES-202 employment data. Strong losses of office employment were recorded in the area surrounding the World Trade Center site in Lower Manhattan following the 9/11 terrorist attack. Another area of disproportionate employment loss is the Midtown South area where the collapse of information technology companies in 2000 and 2001 lead to heavy losses of office employment. A large share of these IT companies was clustered in Midtown South in the area dubbed 'Silicon Alley' so that the effects of the crisis became particularly visible in this district. Figure 9 illustrates the changes in the following year from 2001 to 2002 with a very similar pattern. Areas with relative net gains of office employment in both years include the Midtown West area where a number of new office buildings were finished during the analyzed period and the Wall Street section of the Lower Manhattan submarket.

In order to study the question of spillover effects, a further disaggregation not only of the spatial units but also of the industries to the 4-digit level appears necessary. Table

5 reports Ellison-Glaeser γ values for the fifteen most important office-using industries and Table 6 shows selected examples of industries with highly correlated spatial distribution patterns. Surprisingly, very few industries exhibit excess concentration (γ>0.05) at this level expect Securities and Commodity Exchanges (5232) which is highly concentrated. The lack of highly concentrated industries may simply indicate that choosing Manhattan as a frame of reference leads to underestimating the concentration of industries since Manhattan itself is highly concentrated in office employment at the aggregate level. Moreover, no clear time-series pattern is detectable in the years analyzed.

[FIGURES 7,8,9 SEE BELOW]

To further investigate the question of industry spillovers, we analyze if the agglomeration patterns of 4-digit industries are correlated. Again, the difference between a zip code area's share in total employment is calculated and compared to the share of that area in a particular industry. The resulting differences between both are then correlated over all office industries. I then sort the resulting correlation matrices according to significance levels and find that 25.6% of 1305 possible industry pairs are significant at the 5% level.

Tables 5 and 6 report the results by industry while Figure 10 shows the frequency distribution over all industries in a histogram. Industries with significant correlation coefficients above 50% can be considered coagglomerated in the sense that significant spillover effects appear to operate at the small-scale level as discussed in the first section of this article. For instance, office administrative services (5611) show an excess agglomeration pattern that is very similar to that of the securities and commodity exchanges (5232). The same is true for management of companies and enterprises (5511) and legal services (5411). It is likely that spillovers occur simultaneously between a number of industries located in a given zip code area and not just between the pairs measures in the correlation analysis. Nevertheless, it is possible to identify industries that appear to share locational preferences due to agglomeration spillovers at these microlocations.

[TABLE 5, FIGURE 10, AND TABLE 6 SEE BELOW]

1.3 Conclusions

This article set out to answer three basic questions. 1) How concentrated is office employment in Manhattan, the center of the New York region and what changes have occurred in the ratio between the urban core and the suburban periphery in recent years? 2) Is labor productivity in office-using industries similar in the core and periphery and how can potential differences be explained by structural features? 3) What conclusions can be reached from zip code level analysis of co-agglomeration of office industries regarding the existence of small-scale spillovers?

This work finds evidence of significant concentration of office-using industries in Manhattan despite ongoing decentralization in many of these industries over the last twenty years. Financial services tend to be highly concentrated in Manhattan whereas administrative and support services are the least concentrated of the six major office-using industry groups. Although office employment has been by and large stagnant in Manhattan for at least two decades, growth of output per worker has outpaced the CMSA as well as the national average. A shift-share type analysis reveals that the productivity differential is mainly attributable to competitive advantages of office-using industries in Manhattan and not to differences in industry composition. Although this may serve as an indication of knowledge spillovers due to spatial proximity, other reasons may account for the higher productivity of Manhattan office firms, such as higher quality of physical capital, a generally higher skill level of the labor force, more efficient workplace practices and institutional arrangements.

The zip-code level analysis of the Manhattan core area yielded further evidence of the existence of significant spillover effects at the small-scale level. Co-agglomeration of office-using industries at the micro-level is particularly strong between FIRE industries and business-oriented service industries, confirming earlier reports of extensive linkages between these industries. All in all, about one quarter of all office-using industries are coagglomerated at the zip code level.

In general, this article provides a number of model-based descriptive features of office employment in the New York region. Although the calculated concentration measures yielded some insights regarding potential explanatory factors, no reliable conclusion can be derived regarding the causal forces leading to the phenomena observed.

Therefore, further studies are needed to explore the causal relationships of agglomeration effects and the locational behavior of office-using industries. More specifically, the empirical base of the zip-code level analysis needs to be broadened to arrive at generalizable results by including suburban zip code areas and a longer time series, an endeavor that has up to now been hampered by the transition from the SIC to the NAICS industry classification system.

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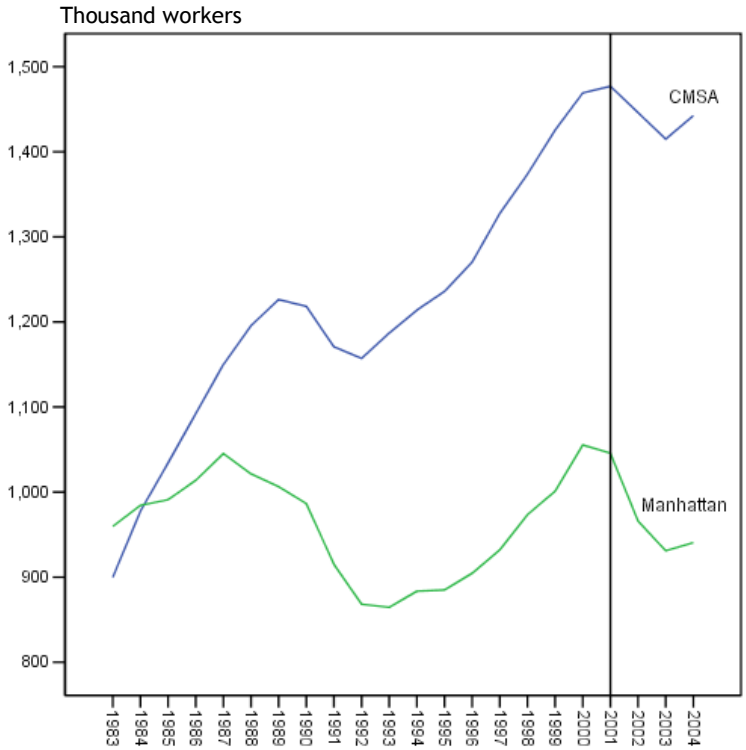

Figure1: Office employment in Manhattan versus the CMSA counties outside of Manhattan from 1983-2004 in thousands of workers. Sources: Bureau of Labor Statistics, Economy.com

Table 1: County-level Hirschman-Herfindahl Indices of office-using industries by county in the NY-NJ-CT CMSA

	1998	1999	2000	2001	2002	2003
Information (NAICS code 51)	1710	1876	1859	1982	1904	2016
Finance and Insurance (52)	2606	2830	2692	2618	2355	2339
Real estate (53)	1811	1542	1491	1646	1583	1431
Professional and technical services (54)	1968	1929	1913	1846	1758	1587
Management of companies (55)	1484	1246	1124	1313	1447	970
Administrative/support services (56)	1171	1078	1048	1052	976	937
all office-using industries	1836	1736	1683	1771	1658	1472

Table 2: Spatial Gini of office-using industries in the NY-NJ-CT CMSA

	1998	1999	2000	2001	2002	2003
Information (NAICS code 51)	0.12822	0.1835	0.1845	0.16897	0.15675	0.19920
Finance and Insurance (52)	0.25487	0.31203	0.28815	0.25431	0.24884	0.26286
Real estate (53)	0.15992	0.18180	0.13999	0.12586	0.17281	0.15249
Professional and technical services (54)	0.18782	0.21992	0.21254	0.18344	0.16453	0.16971
Management of companies (55)	0.19299	0.21146	0.18006	0.15525	0.19046	0.19462
Administrative/support services (56)	0.07784	0.10138	0.09099	0.05896	0.05245	0.07497
all office-using industries	0.15110	0.18354	0.17253	0.13999	0.15675	0.14200

Table 3 : Ellison-Glaeser gamma indices of office-using industries in the NY-NJ-CT CMSA

	1998	1999	2000	2001	2002	2003
Information (NAICS code 51)	0.054	0.154	0.116	0.103	0.058	0.134
Finance and Insurance (52)	0.223	0.290	0.262	0.222	0.217	0.232
Real estate (53)	0.142	0.167	0.119	0.103	0.158	0.133
Professional and technical services (54)	0.184	0.220	0.212	0.180	0.159	0.164
Management of companies (55)	0.045	0.069	0.028	0.005	0.043	0.047
Administrative and support services (56)	0.040	0.067	0.056	0.019	0.012	0.037
all office-using industries	0.098	0.136	0.123	0.085	0.106	0.087

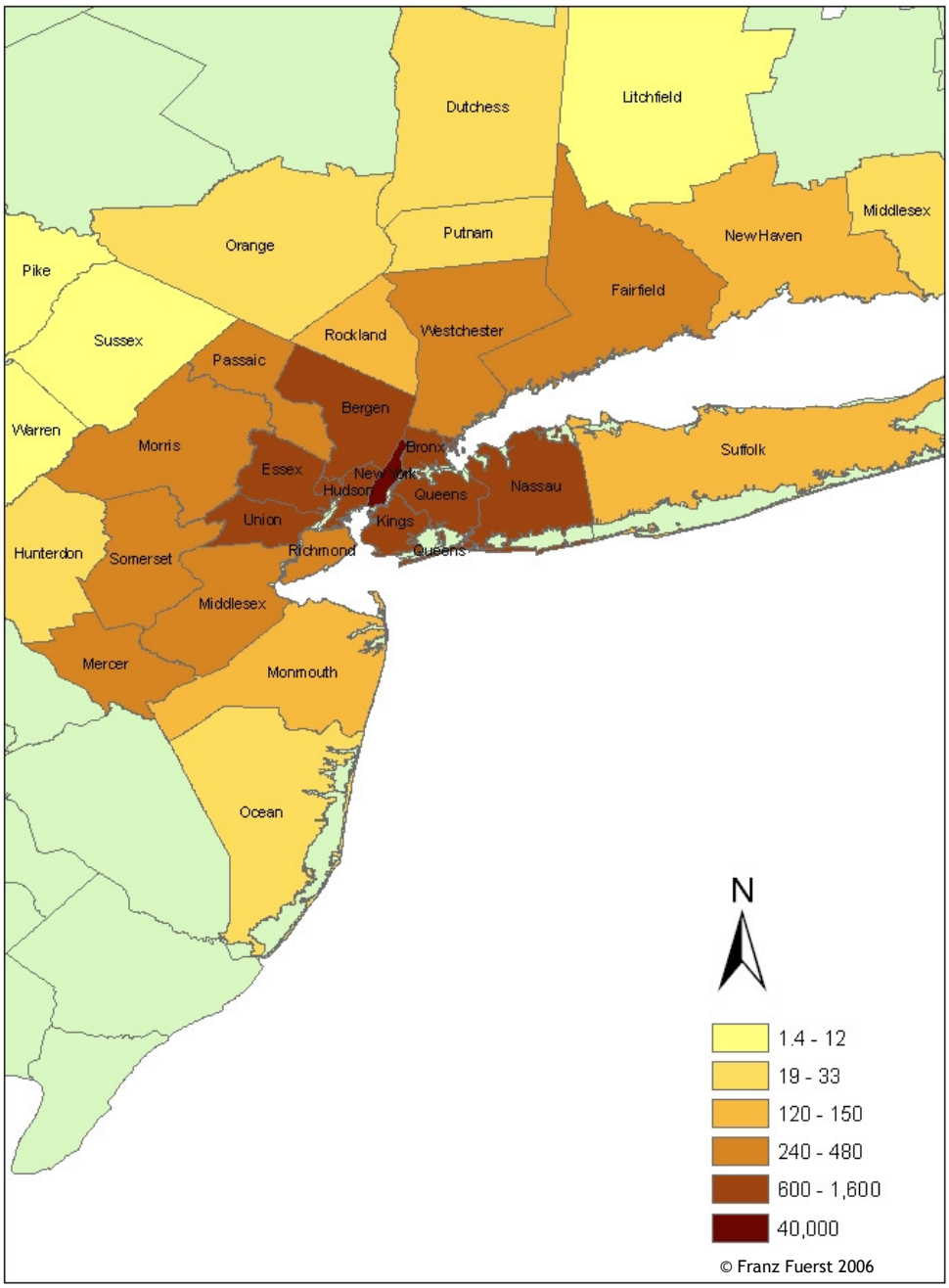

Figure 2: Office employment per square mile. Data: County Business Patterns, 2002

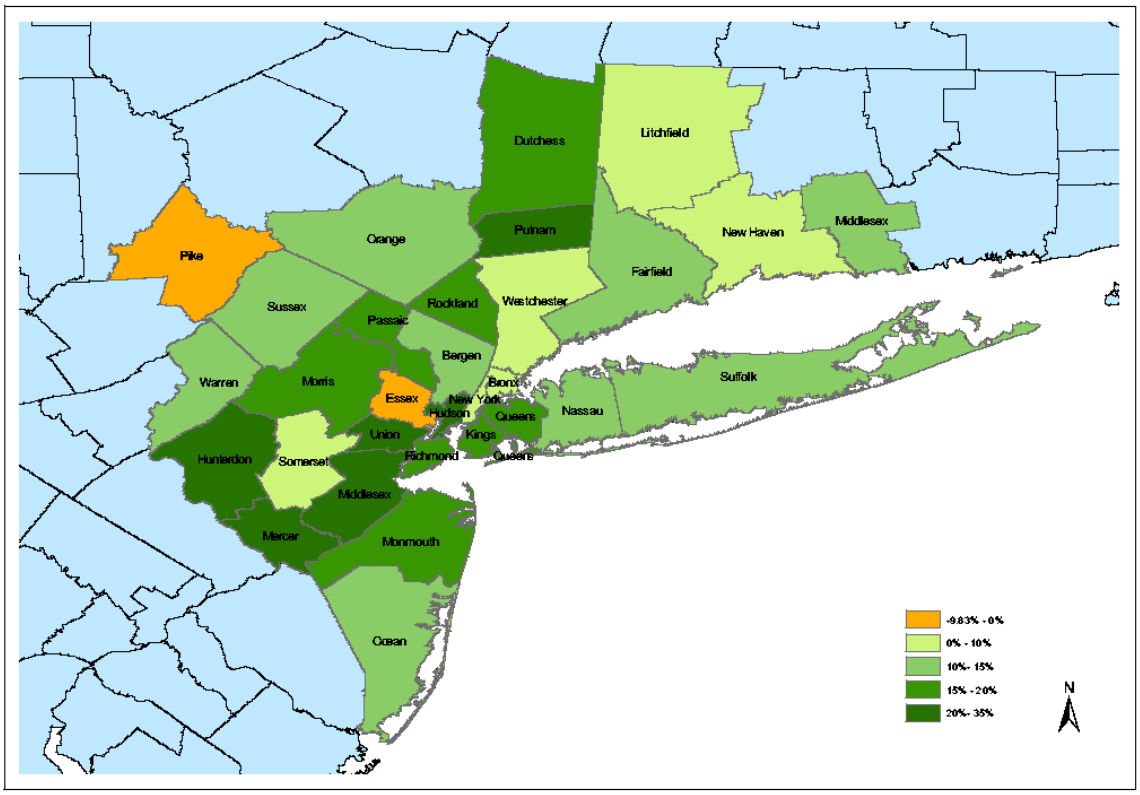

Figure 3: Percent change in office employment in New York CMSA counties from 1998 until 2001.

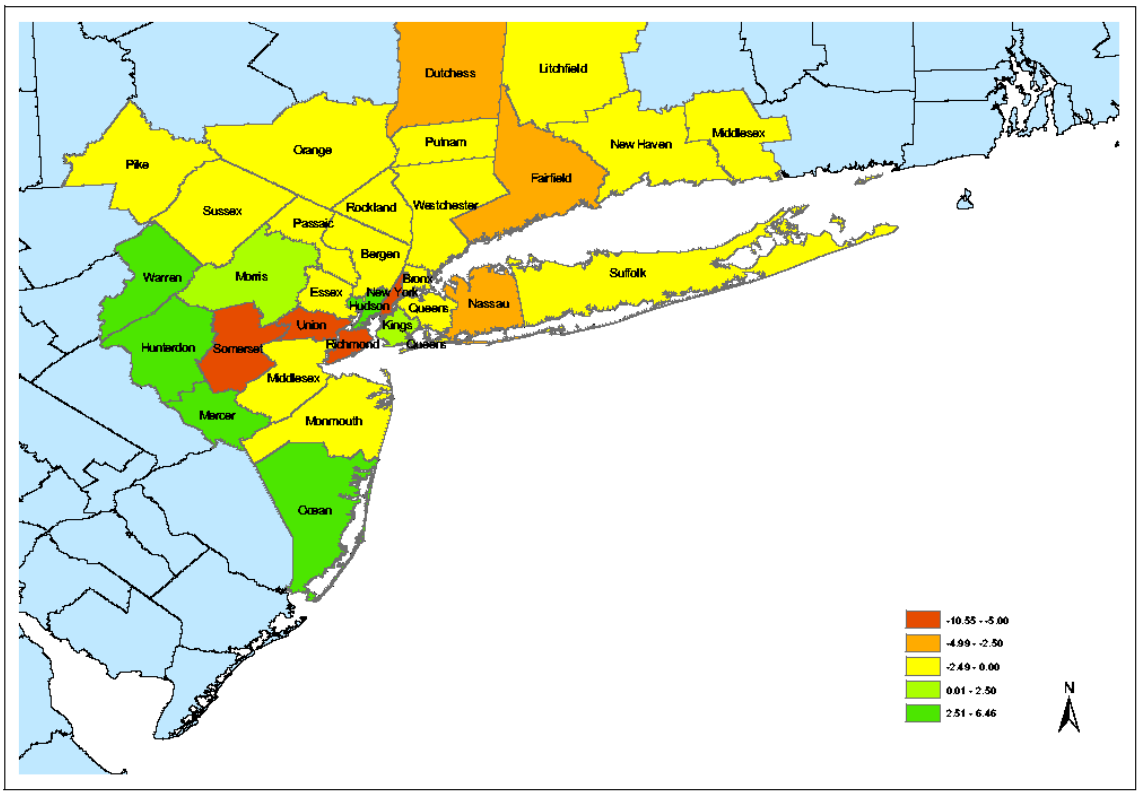

Figure 4: Percent change in office employment in New York CMSA counties from 2001 until 2002

Table 4: Location quotients of predominantly office-using industries in Manhattan and the CMSA

		CMSA (excluding Manhattan)					Manhattan				
NAICS	*Industry*	*1984*	*1989*	*1994*	*1999*	*2004*	*1984*	*1989*	*1994*	*1999*	*2004*
	All office-using industries	1.01	1.08	1.10	1.07	1.06	2.51	2.39	2.23	2.09	1.99
51	Information	1.19	1.20	1.24	1.13	1.09	3.05	2.62	2.62	2.38	2.52
5111	Newspaper, Periodical, Book & Directory Publishers	1.26	1.23	1.16	1.21	1.21	3.84	3.42	3.26	3.25	3.56
5171	Wired Telecommunications Carriers	1.47	1.60	1.90	1.64	1.27	2.20	1.72	1.90	1.50	0.85
5172	Wireless Telecom. Carriers (except Satellite)	3.95	4.16	2.34	1.02	0.63	12.29	9.61	4.54	1.78	0.65
52	Finance and Insurance	1.63	1.71	1.69	1.65	1.48	3.62	3.65	3.47	3.25	2.72
5211	Monetary Authorities - Central Bank	0.36	0.45	0.42	0.35	0.39	4.23	4.32	3.92	3.38	2.41
5221	Depository Credit Intermediation	0.91	1.08	1.09	0.92	0.85	2.85	2.76	2.41	1.99	1.46
5222	Nondepository Credit Intermediation	0.90	1.07	1.06	0.99	0.87	2.26	2.33	1.88	1.36	1.07
5232	Securities and Commodity Exchanges	0.82	1.22	1.66	1.98	2.15	17.07	18.10	17.38	15.77	14.47
5239	Other Financial Investment Activities	0.62	0.68	0.94	0.91	0.87	11.58	11.91	10.91	9.59	7.40
5241	Insurance Carriers	0.90	1.01	1.00	1.14	1.13	2.10	1.77	1.60	1.40	1.29
5242	Agencies, Brokerages, and Other Insurance	1.07	1.18	1.25	1.24	1.19	2.06	1.79	1.67	1.41	1.08
53	Real estate	1.39	1.35	1.37	1.37	1.39	2.10	1.98	2.03	1.93	1.97
5311	Lessors of Real Estate	1.35	1.38	1.42	1.51	1.54	3.44	3.49	3.59	3.78	3.98
5313	Activities Related to Real Estate	0.86	0.97	0.97	1.02	0.93	2.13	1.95	1.89	1.58	1.45
54	Professional and technical services	1.46	1.50	1.50	1.47	1.33	2.44	2.48	2.42	2.38	2.17
5411	Legal Services	0.93	1.06	1.19	1.21	1.16	3.30	3.76	3.92	3.96	3.32
5412	Accounting, Tax Preparation, Payroll Services	1.01	1.11	1.17	1.23	1.31	3.26	2.67	2.73	2.63	2.49
5413	Architectural, Engineering, and Related Services	0.82	0.94	0.89	0.84	0.80	1.06	1.22	1.02	0.84	0.57
5416	Management, Scientific, and Technical Consulting	1.89	1.51	1.38	1.22	0.95	3.04	2.83	2.49	2.35	1.99
5418	Advertising and Related Services	1.13	1.02	1.19	1.21	1.15	6.83	6.13	6.21	6.96	7.16
55	Management of companies	0.94	1.01	1.15	1.21	1.31	1.26	1.37	1.55	1.59	1.85
5511	Management of Companies and Enterprises	0.82	0.90	1.02	1.09	1.15	1.28	1.38	1.55	1.58	1.84
56	Administrative and support services	1.18	1.10	0.97	0.95	1.01	1.81	1.14	0.82	0.82	0.94
5613	Employment Services	0.74	0.78	0.63	0.63	0.72	1.80	1.55	1.26	1.35	1.49
5614	Business Support Services	0.88	0.94	0.93	0.87	0.93	1.11	1.11	0.82	0.72	0.64
5617	Services to Buildings and Dwellings	1.24	1.29	1.30	1.19	1.15	1.53	1.27	0.99	1.03	1.09

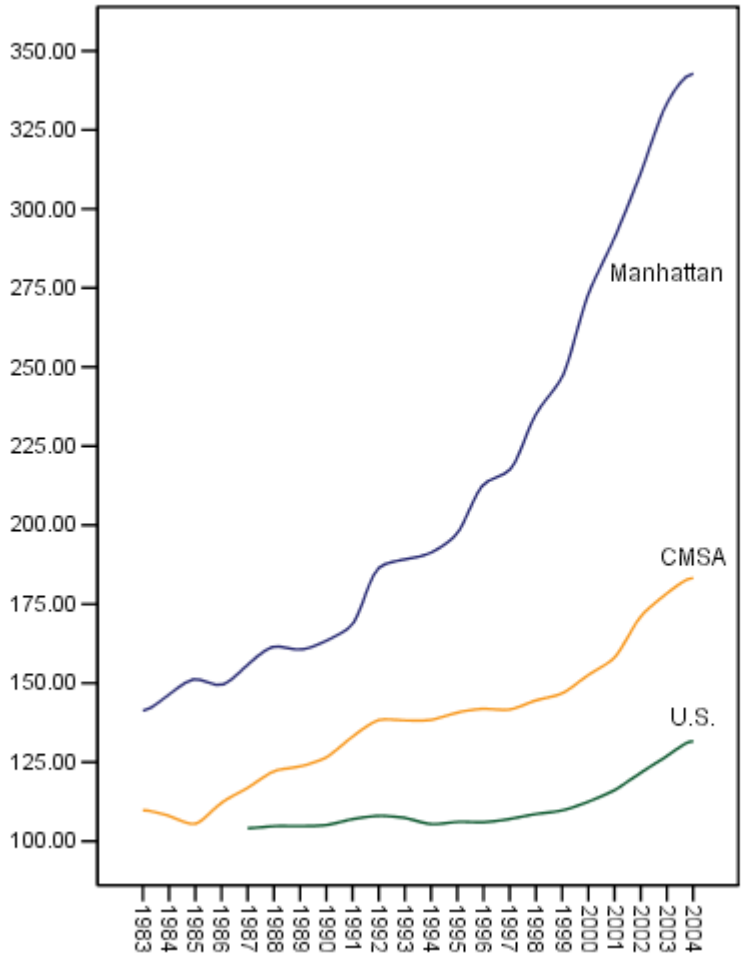

Figure 5: *Real output per worker in office-using industries in Manhattan, CMSA (minus Manhattan) and the US in thousands US dollars. Data: Economy.com, U.S. Bureau of Labor Statistics*

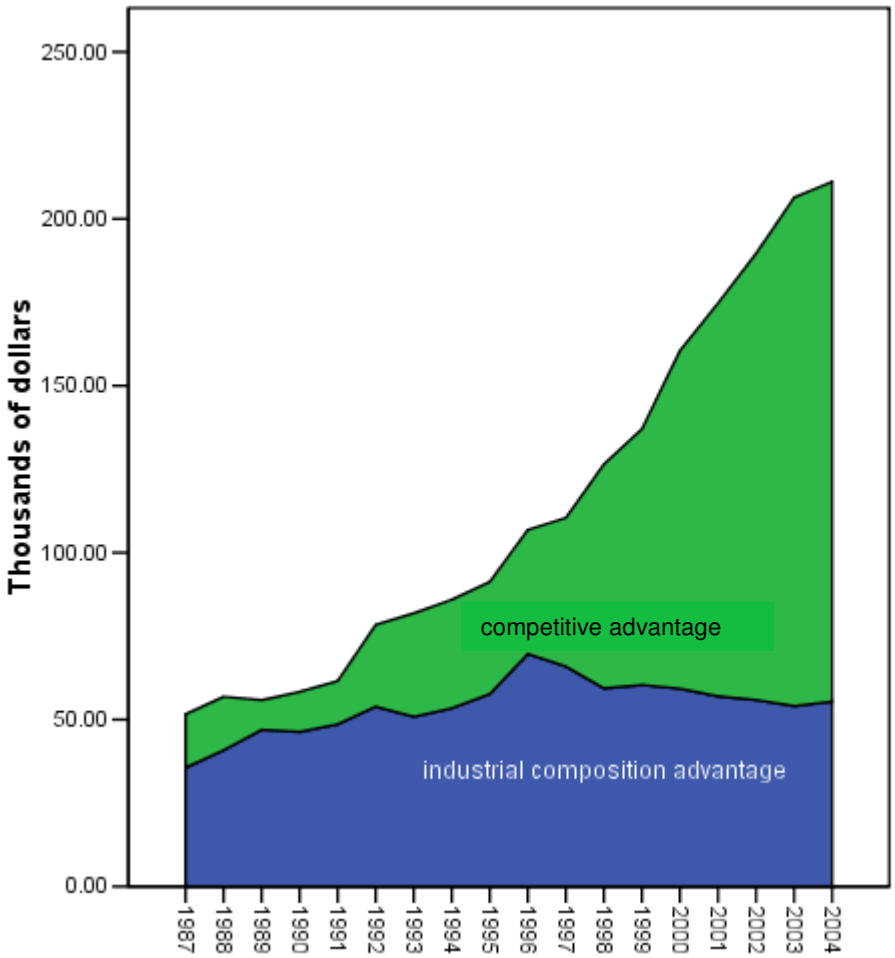

Figure 6: Decomposition of productivity advantages of Manhattan's office using industries over U.S. average figures. Data: Economy.com, Department of Labor

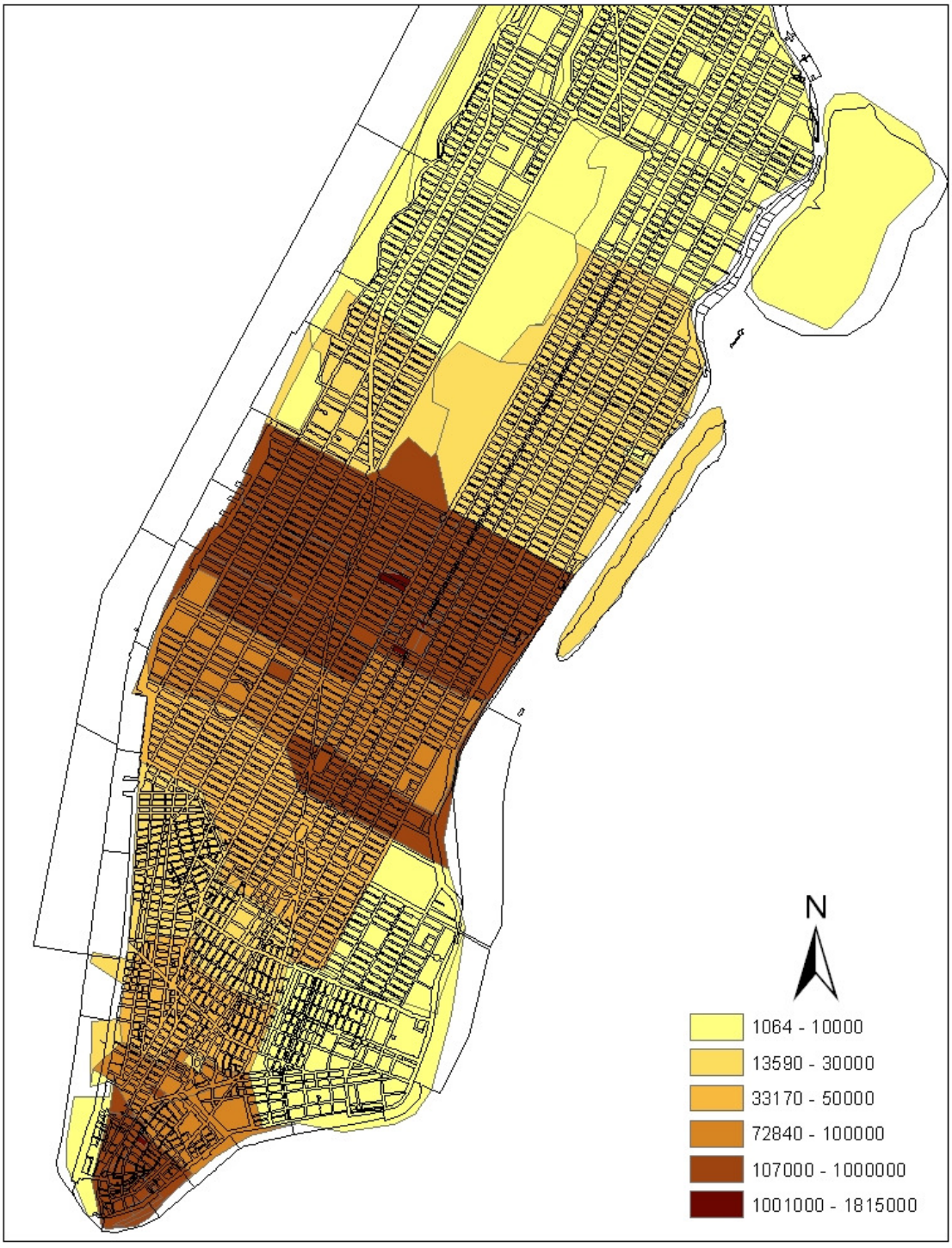

Figure 7: Density of office employment by zip code area (office jobs per square mile)
Data: Bureau of Labor Statistics

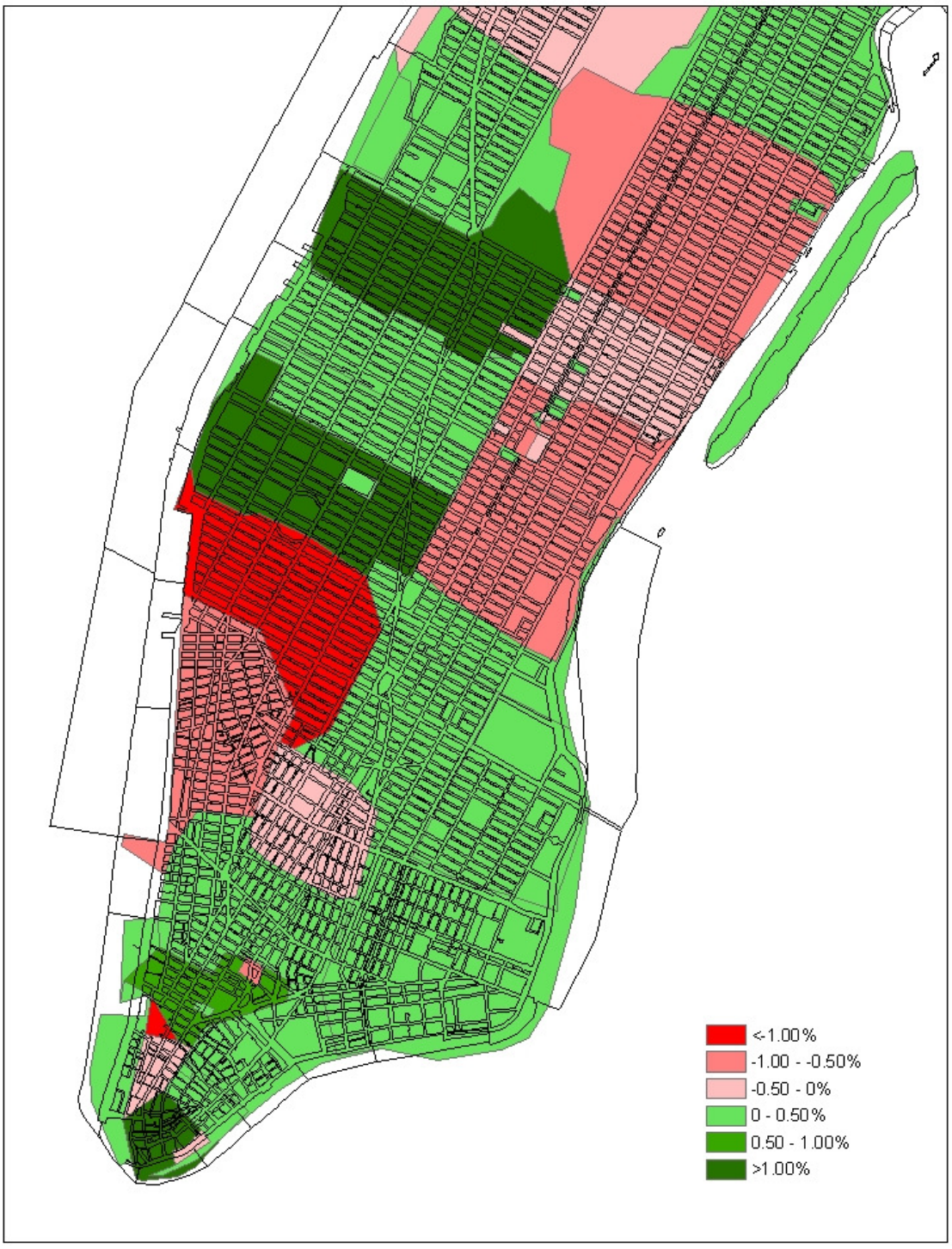

Figure 8: Change of share in Manhattan office employment from 2000 to 2001 for zip code areas (in percentage points of overall share). Data: Bureau of Labor Statistics

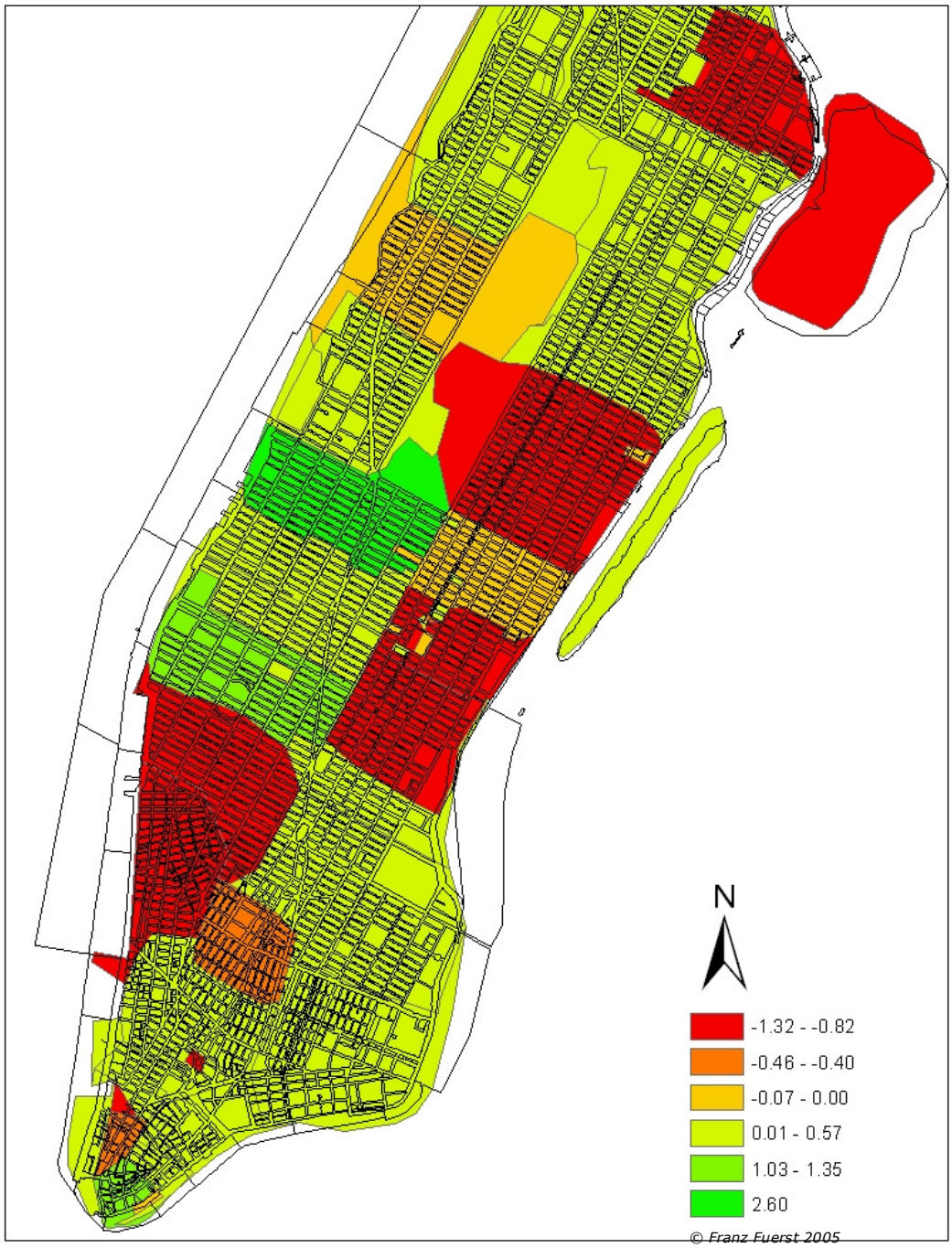

Figure 9: Change of share in Manhattan zip code area office employment from 2001 to 2002 (in percentage points of overall share). Data: Bureau of Labor Statistics

Table 5: Ellison-Glaeser γ index values for Manhattan zip-code level areas.

		2000	2001	2002	2003
5221	Depository Credit Intermediation	0.0115	0.0124	0.0112	0.0169
5222	Nondepository Credit Intermediation	0.0280	0.0258	0.0250	0.0305
5223	Credit intermediation	0.0029	0.0256	0.0254	0.2036
5231	Securities and Commodity Contracts	0.0032	0.0151	0.0106	0.0199
5232	Securities and Commodity Exchanges	0.1044	0.1582	0.1605	0.2537
5239	Other Financial Investment Activities	0.0202	0.0226	0.0226	0.0304
5241	Insurance Carriers	0.0061	0.0030	0.0019	0.0029
5411	Legal Services	0.0490	0.0262	0.0225	0.0299
5412	Accounting and payroll services	0.0185	0.0233	0.0331	0.0092
5413	Architectural, Engineering,	0.0035	0.0025	0.0112	0.0150
5415	Computer system design	0.0145	0.0114	0.0116	0.0260
5416	Management, Scientific, and Technical Consulting	0.0132	0.0101	0.0075	0.0295
5418	Advertising and Related Services	0.0432	0.0283	0.0273	0.0132
5611	Office administrative services	0.0166	0.0012	0.0002	0.0261
5614	Business Support Services	0.0195	0.0164	0.0121	0.0074

Significant at 5% level: 25.6% of 1305 industry pairs. Data: Bureau of Labor Statistics

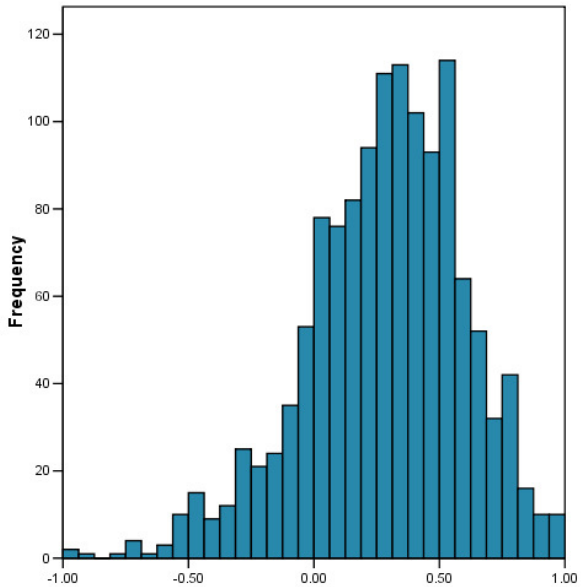

Figure 10: Frequency distribution of Pearson correlation coefficients of co-agglomerated industries at the 4-digit industry level

Table 6: Selected examples of industries with highly correlated spatial distribution patterns

Industry 1	Industry 2	R^2
Office Administrative Services (5611)	Securities and Commodity Exchanges (5232)	0.98
Facilities Support Services (5612)	Software Publishers (5112)	0.96
Facilities Support Services (5612)	Computer Systems Design Services (5415)	0.96
Legal Services (5411)	Other Financial Investment Activities (5239)	0.95
Insurance and Employee Benefit Funds (5251)	Nondepository Credit Intermediation (5222)	0.95
Facilities Support Services (5612)	Radio and Television Broadcasting (5151)	0.94
Management, Scientific/Technical Consulting (5416)	Activities Related to Real Estate (5313)	0.93
Facilities Support Services (5612)	Insurance Carriers (5241)	0.93
Offices of Real Estate Agents and Brokers (5312)	Depository Credit Intermediation (5221)	0.91
Employment Services (5613)	Insurance and Employee Benefit Funds (5251)	0.89
Management of Companies and Enterprises (5511)	Offices of Real Estate Agents and Brokers (5312)	0.88
Legal Services (5411)	Activities Related to Real Estate (5313)	0.87
Office Administrative Services (5611)	Advertising and Related Services (5418)	0.86
Management of Companies and Enterprises (5511)	Legal Services (5411)	0.85
Activities Related to Real Estate (5313)	Other Financial Investment Activities (5239)	0.83
Office Administrative Services (5611)	Management of Companies and Enterprises (5511)	0.83
Legal Services (5411)	Depository Credit Intermediation (5221)	0.83
Office Administrative Services (5611)	Insurance and Employee Benefit Funds (5251)	0.82
Activities Related to Real Estate (5313)	Offices of Real Estate Agents and Brokers (5312)	0.81
Employment Services (5613)	Office Administrative Services (5611)	0.81

Data: Bureau of Labor Statistics