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Spatial Organization of Firms

*Kristin Aarland, James Davis,
J. Vernon Henderson and Yukako Ono*

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- The decision to split production and administration -

Kristin Aarland

Brown University

James Davis

US Census Bureau

J. Vernon Henderson

Brown University

Yukako Ono

*Federal Reserve Bank
of Chicago*

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Abstract

A firm's production activities are often supported by non-production activities, such as administrative units including headquarters, which process information both within and between firms. Firms may physically separate such administrative units from their production activities and create stand-alone Central Administrative Offices (CAOs). However, activities in multiple locations may cause internal communication costs. What types of firms are more likely to separate such functions? If firms separate administration and production, where do they locate CAOs? This paper examines firms' spatial organization using micro-level data from the U.S. Census Bureau.

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1. Introduction

Firms' production activities are supported by various non-production activities such as management, marketing and administration. While these administrative functions can in principle be performed at the same site as production, many firms favor stand-alone Central Administrative Offices (CAOs), for a variety of reasons. First, management may want more pleasant office facilities than offered in typical production plants, separating administrators from noise and pollution. However, for sectors such as finance and service industries, there may be less need for a physically separate office for management.

Second, plants in manufacturing, for example, may be located in smaller cities near resource inputs where land and labor costs are also low. Yet the firm's management and administration may outsource a variety of business services such as advertising, specialized legal services, and the like (Ono, 2003). A firm may find it advantageous to locate headquarters and administrative functions in a large metro area with better availability, quality, and diversity of business and financial services, away from its manufacturing production facilities. "Functional specialization" across cities is modeled in Duranton and Puga (2005).

Third, management may require highly educated white-collar workers, who may have thin labor markets in small cities where production is concentrated. Differences in input requirements between management and production and the difference in input availability across space may result in the physical separation of management and production.

CAOs may also benefit more from agglomeration effects in large cities than production facilities, gathering information from other CAOs and from service firms (Davis and Henderson, 2004; Lovely, Rosenthal, and Sharma, 2005) about market conditions. Moreover, a firm may want a CAO "representative" in large markets, to market the firm.

However, a stand-alone management office requires fixed costs. Small firms may not have sufficient scale to justify having a separate management and administrative office. A separate CAO can also incur communication and monitoring costs (Holmstrom, 1979). Advances in transportation and communication technology have made it easier to

operate in multiple locations, but it is more costly to monitor and communicate from a distance.

While the first order effect of separation may be higher communication costs within the firm, it may be advantageous to separate management from production. Cremer (1995) shows that a firm may choose a lower level of monitoring since more accurate monitoring reduces agents' incentives to work hard to signal high ability. See also Aghion and Tirole (1997). A firm's choice of a lower level of monitoring could be reflected in its decision to physically separate administration from production. According to Puga and Trefler (2002), Boeing believes that separation encourages local managers to take initiative. Eccles (1985) discusses the related idea that suspicion among plants about unfair treatment can corrupt a firm's incentive schemes. Physical separation of headquarters from all production plants could signal impartiality.¹

Our goal is to document some facts as a baseline for future theoretical and empirical work. We present a variety of evidence on the nature and roles of CAOs. CAOs account for about 2.5 million workers, but fewer than 5% of US firms have CAOs, and they tend to be large firms. Among the set of large firms, we explore what firm characteristics and organization determine whether a firm has a CAO.

In Section 2, we describe the data. In Section 3, we present various facts about CAOs roles and firms that have CAOs. In Section 4, we examine the relationship between the likelihood of having CAOs and firm characteristics. In Section 5, we describe where CAOs are located.

2. Data

Our main data set is micro-level data from the Auxiliary Establishment Surveys (AES) compiled and organized by the U.S. Census Bureau. The AES is a census performed every five years that captures the activity of all auxiliary establishments. Auxiliary establishments do not perform production or transaction activities; they manage, service,

¹ Our discussion describes manufacturing firms. In retail, CAOs of a department store chain coordinate the functions of the "production facilities" spread over many small and large metro areas, and purchase intermediate service inputs for the firm. A similar comment applies to finance and banking.

or support the activities of, and are physically separate from, other establishments in the firm.

Auxiliary establishments are classified by type such as central administration, R&D, computer data processing, communications, central warehouses, and trucking. We want to identify establishments engaged primarily in central administration, and which are thus CAOs. The survey asks questions about an establishment's primary function, as well as a breakdown of employment by function. Before 1997, the function question has many missing values, while the employment function questions almost universally record responses. Many auxiliaries self-classify, but in any Census about 1/3 are classified by surveyors. Before 1997 this classification (as opposed to self reported) was applied to the employment function questions, where a high proportion of responses are bunched at a single number such as 100% of employees all in management (probably due to imputation). For AES census years before 1997, we treat the surveyors' classification based on "inside knowledge" as accurate, and define a CAO as an establishment for which the joint category of management, administrative and clerical employees dominates each of the other employment categories. In contrast, the 1997 data set has missing values for employment by function but complete data for the auxiliary's function, indicating that surveyors then used function to classify auxiliaries.² Thus, for 1997 we base our definition on the question regarding the main function reported by each auxiliary establishment.³

CAOs in 1997 are auxiliaries identified as a "corporate, subsidiary, or regional managing office or office of a holding company, providing a range of services to other establishments of the enterprise such as long term strategic and organizational planning,

² With the introduction of the NAICS industry classification system, auxiliary "kind of business or activity" functions now map one to one with separate 6-digit NAICS codes. A 1997 Refile Survey was sent to establishments in the business register for which SIC economic activities were reclassified into a new industrial sector under NAICS. Additional information on the auxiliary's function may have become available from self reported responses to the pre-census classification and company organization surveys with the introduction of the NAICS. Overall, about 15 to 20% of establishments are non-respondents. (U.S. Census Bureau, 2001d).

³ Of 14,518 CAOs (with our 1992 CAO definition), which survived in 1997, 88.5% are identified as a CAO with the 1997 definition.

financial management, payroll and personnel management, centralized billing, advertising, and public relations” (U.S. Census Bureau, 2001b), which corresponds with the definition of NAICS industry 551114. Establishments with managerial responsibility are distinguished from what we call “back offices” in the sense that, “the establishment primarily engaged in providing a range of day-to-day office administrative services, such as financial planning, billing and recordkeeping, personnel, and physical distribution of logistics are classified in NAICS 56111 (Office administrative services)” (U.S. Census Bureau, 2001b). While CAOs have a specific definition, the question is whether CAOs perform the same functions that people have in mind in using the non-technical term, headquarters [HQs]. Before 1997, the AES survey asked whether an auxiliary is a HQ. We report some information about these self-identified HQs, but they are problematic. The definition of HQs was not given in the survey, and in 1992, about 30% of auxiliaries surveyed did not answer this question.⁴

The other important data set for our study is the Standard Statistical Establishments List (SSEL), the master register of all private establishments in the US used by the Census Bureau to conduct the economic censuses as well as to draw samples for various firm and establishment surveys. The SSEL includes basic information such as location, industry, and total employment. We restrict attention to multi-establishment firms in the SSEL that have at least one production plant plus at least one other establishment of any kind (plants, sales offices, auxiliaries, retail outlets, etc.).⁵ Establishments under common ownership or control, as self reported in the Company Organization Survey, share a common firm identifier in the SSEL which can be used to construct firm level characteristics.⁶ This information is then linked to CAOs in the AES

⁴ The question on the survey asks "Is this establishment the corporate headquarters, executive office or head office of your entire enterprise?" It is not clear from the definition of an “enterprise” given on the attachment survey instructions page that only one establishment of a firm is intended to be indicated as the HQ.

⁵ In principle, we could include all single unit [SU] firms in parts of the analysis, but practical reasons mitigate against this. The SU file for the SSEL is not very “clean” and consists of millions of tiny establishments for whom a CAO would be infeasible.

⁶ The Census definition of firm (identified by identifier “alpha”) differs from the IRS concept of a business firm, defined as the legal entity used for tax reporting purposes. Some corporations are affiliated through

file using this firm identifier. We record by firm the main production activity (industry), degree of industrial diversification, the geographical relationship among production facilities and CAOs, the location where the main production activity is performed, and so forth.⁷

3. What are CAOs and what do they do?

Who has CAOs?

Table 1 provides a view of firms that have CAOs in 1997 in the contiguous USA. Excluded from Table 1 are about 5.1 million single-establishment firms employing 44.3 million workers (U.S. Census Bureau (2001a)). This leaves us 167,126 multi-establishment firms employing 58.5 million workers in 1997; these are the largest and generally older firms. About 11% of these firms have CAOs. Multi-establishment firms with CAOs are much bigger than those without. Average employment of firms with CAOs is about 14 times that of firms without CAOs. Firms with CAOs have on average 40 plants, and those without CAOs have 4.4. Plants affiliated with firms with CAOs are also 1.4 times larger than those without CAOs. For firms with CAOs, on average 4 plants share one CAO. Table 1 also contains information for 1992. The 1992 data indicate firms who identify their CAOs as HQs. HQs are slightly larger than CAOs.

Table 2 classifies firms by industry. We could uniquely identify the main industry for 166,522 firms based on within firm employment by industry. There are large differences across industries in the propensity to have CAOs and in the relative size of firms with CAOs. There are more CAOs in heavy manufacturing and fewer in finance, insurance and real estate (FIRE). Manufacturing has a greater incentive to locate administration away from production facilities, because of noise and pollution associated with production, and the propensity to locate plants in smaller cities and rural locations. It is notable that, relative to other industries, FIRE and retail firms with CAOs are much bigger than those without CAOs; with average employment of firms with CAOs about 20

common ownership or control with other corporations yet file separate tax returns, and a Census firm identifier may include establishments of several IRS EIN tax identifiers.

⁷ Sales offices are not considered as auxiliary establishments in the Census. They are categorized in the wholesale sector and covered under the Census of Wholesale Trade.

times higher. These two industries also have a high number of plants per firm, presumably because they have many outlets to serve customers.

The definition of CAOs does not identify a single main headquarters, but includes regional and subsidiary headquarters. Therefore, some firms have several CAOs for different regions as well as for different industry activities. In the AES, CAOs are also asked to report the activity that they support, which we turn to next.

CAOs and supported production activities

Table 3 presents a breakdown of the relative use of CAO's by different industries and how that has changed over time. Production activities that CAOs service are concentrated in certain industries. In 1997 about 44% of CAOs and 33% of CAO employment support retailing, and about 21% of CAOs and 39% of CAO employment support manufacturing. Together, manufacturing and retailing account for 65% of CAOs and 73% of CAO employment, compared to their 44.2 % share of national private employment. CAOs supporting manufacturing are much larger than other CAOs.

The activities relying on CAOs have changed over time. First, average CAO employment (in contrast to production units) has risen over time in all industries, and doubled for construction, business services, and other services. The number of CAOs grew fastest between 1977 and 1997 in personal services. In SIC 83 (residential living, job training, and day care), there are no CAOs in 1977 but almost 1,300 in 1997. This may reflect a move from "mom and pop" operations to corporations.

Finally, industry growth is not necessarily accompanied by an increase in the number of CAOs, suggesting heterogeneity across industries in spatial configuration and the role of CAOs.

CAO activity: employment by function

Consider CAO employment by function (U.S. Census Bureau, 2001b).⁸ About 20% are executives or general managers. In contrast, executives and general managers are 8% of the employees of auxiliaries that identified their main activity as one of advertising,

⁸ We describe the published numbers for employment by function in the subject series of 1997 Economic Census. The published numbers almost exactly correspond to the micro-data for firms who respond to the questions of employment by function.

bookkeeping, legal, or personnel (but not central administration), which comprise 4% of all auxiliaries.

CAO employees engage in a variety of administrative activities, including accounting and bookkeeping, computer system design, marketing, personnel, as well as legal and advertising. This contrasts with other administrative auxiliaries such as accounting centers, data-processing centers, legal centers, etc., which are specialized. For example, 63% of employees of auxiliaries specializing in bookkeeping and accounting, engage in the core activity. In legal center auxiliaries, 90% of employees work on legal activities.

Outsourcing

We next examine the extent of outsourcing. The notion of “functional specialization,” is that a primary role of CAOs is to outsource, or to purchase business and financial services for their production units. In our data, the purchases of financial services are not observed (loan rates and contract terms are not available in our data), but there is information on some outsourced business services. The AES asks auxiliaries for their expenditures on services such as legal and accounting in 1992, and also advertising services in 1997. In Table 4, we report propensities to outsource for CAOs. We also compare the outsourcing propensity of CAOs with that of all other auxiliaries, and in 1992, with CAOs self-defined as HQs. In both years, CAOs have greater outsourcing rates than other types of auxiliary establishments, and more so for CAOs that also identify as HQs in 1992.

How does the propensity to outsource differ between CAOs and plants? For manufacturing plants, the Annual Survey of Manufactures (ASM) also provides information for purchased services in legal, accounting and advertising. Using the plant level data from the 1997 ASM, Table 5 reports the outsourcing propensity of plants broken down by those affiliated with firms that have CAOs and those that do not. Plants with CAOs have a lower propensity to outsource. When a firm has CAOs, it is the CAOs that outsource for the firm, which supports the view of functional specialization.

For CAOs that report outsourcing in 1997, we compute expenditures on outsourcing as a fraction of the wage bill. Expenditure rates differ across business service inputs, reflecting both the importance of each intermediate input in production and the

extent of in-house versus outsourced activity. Overall, outsourced accounting expenditures equal 13.4% of CAO wage bills, legal expenditures 15.2 %, and advertising 36.6%. Advertising draws CAOs to cities offering diverse and high quality advertising firms. Advertising is more important for CAOs supporting retailing, on average 59.5% of CAO wage bills, as compared to manufacturing, where it is 24.4%. Given the extent of services outsourced and the need for face-to-face interaction in service delivery, co-location with service providers may be important for CAO establishments (Davis and Henderson, 2004; and Ono, 2003).

Outsourcing a particular function is often thought to replace in-house production. However, CAOs that outsource legal services, accounting, or advertising have a 2 to 3 fold higher percentage of employees working internally at that function. When a CAO outsources a particular function, the CAO itself has a bigger in-house unit, perhaps for monitoring, coordinating, and partnering with suppliers. CAOs then require access to suppliers of business services as well as highly educated white collar workers for in-house services.

4. Firm characteristics and CAOs

In this section, we examine the firm characteristics that are associated with having a CAO. Firm characteristics include firm size, measured by the number of plants and total plant employment within a firm, a measure of industrial diversification, measures of geographical dispersion among plants, and the size of the local market where production is performed, as well as industry dummies. We examine all 167,126 multi-establishment firms in the contiguous USA.

Table 6 shows the summary statistics for variables used in the sample of all multi-establishment firms, and Table 7 presents probit results. We show the impact on the probability of a marginal change as well as a one standard deviation (s.d.) change in the variables. For dummy variables, we present the impact of a switch from zero to one. For these exercises, we set the base probability at .0750, the predicted propensity of a firm with average characteristics (instead of .107, the CAO propensity among all 167,126 multi-establishment firms).

First, bigger firms are more likely to have CAOs. A one s.d. increase in firm employment and in the number of plants raises the base probability by .0614 and .0213, respectively. The former is an 82% increase in the probability. A bigger scale allows firms to pay the fixed costs of setting up a stand-alone management office, as well as the costs of communication and monitoring, which would increase with separation.

Next, consider the degree of industrial specialization and a firm's propensity to have CAOs. 85.4 % of the multi-establishment firms operate in only one of ten primary industries and 77% operate in only one 2-digit SIC industry. We include a dummy indicating firms that operate in only one 2-digit SIC industry. For firms with two or more (2-digit SIC) activities, our specialization index is the sum of squared shares of a firm's plant employment in each of the 2-digit SIC industries. This measure is smaller when the firm is more diversified. The probability of having CAOs is lower for specialized firms. The effect of specializing in only one 2-digit SIC industry is large, .0823 on average. Similarly, firms that operate multiple 2-digit SIC industries that have a lower degree of specialization have a higher likelihood of a CAO. As a robustness check, we also use a dummy variable indicating specialized firms and specialization indices based on 3-digit SIC as well as 4-digit SIC. We observe the same patterns. If a firm's plants are diversified, an evaluation authority separate from any plant may be necessary, to coordinate across diverse activities, or to avoid suspicions of unfair treatment. However, the measure of industrial specialization may be correlated with firm size, which may not be fully captured by firm plant employment and the number of plants. It is possible that the measure of industrial specialization captures also some scale effects.

Having plants in two or more counties raises the probability of having a CAO by .0131. The higher the maximal distance between any two counties with plants, the higher the probability of having a CAO. The same is true of the (weighted by number of plants in each county) average distance for firms with plants in three or more counties.

Finally, we consider functional specialization. If a firm wants to outsource services in a bigger city (Ono, 2006), it may need to physically separate these functions from production facilities in rural areas.⁹ A firm may be more likely to have CAOs when

⁹ Ono (2003) finds that production plants rely on their CAO for outsourcing business services when the size of the local service market is large for the CAO and small for the plant.

their production site is in a small city. For firms with plants in two or more counties, there is not a significant association between the total employment of a county in which a firm has its dominant production activity (as defined by the firm's plant employment at the county level), and the propensity for a firm to have a CAO. However, in a probit based on the sample from 1992 data using the definition of HQs (in Table A.2 in the full Appendix at www.chicagofed.org/publications/workingpapers/WP2003-30REV.pdf), the coefficient of the city size of the main production site is negative and significant, consistent with functional specialization. It is also consistent with Table 4, that self-reporting HQs outsource more. We return to this issue later.

Finally, as noted earlier, industry matters. The base case is light manufacturing. All other industries except for agriculture are less likely to have a CAO. Business services and FIRE are much less likely to have CAOs.

Robustness Analysis

Firms with only one plant are included in our sample only when they have at least one auxiliary establishment or CAO. This increases the propensity to have a CAO for firms with one plant in our sample and may bias the coefficient on the number of plants downward. We perform the same probit analysis by limiting the sample to firms with two or more plants not counting auxiliaries. Table A.3 in the full Appendix shows that the results are similar. A Tobit analysis reported in that table uses the number of CAOs as a dependent variable. We found that factors that are positively (negatively) associated with a firm's probability to have CAOs are also positively (negatively) associated with the number of CAOs.

Differences across industries

CAOs may play different roles in different industries. In Table 7, industry dummies indicate that firms in FIRE and business services are much less likely to have CAOs than light manufacturing, *ceteris paribus*. It may be that the effects of firm characteristics on the probability of having CAOs differ between service and non-service sectors. The service sector is defined to include retail, wholesale, FIRE, business services, communication, and other services. Some results are presented in Table 8. While the magnitude of the impact of many variables differs between service and non-service sectors, for most of the variables the direction of the impact is the same. In the case of

having a plant in two or more counties (D2), one has to calculate the effect of D2 based not just on the intercept but also the interaction with distance and county size variables. For the typical maximal distance (943) and size of the dominant county (11.7) for the non-service sector, the overall effect of having plants in two or more counties is -.0105, and while for the service sector it is .0213. However, in the non-service sector, where a significant number of firms have plants in three or more counties (a subset of D2), at a typical average weighted distance (650) the overall effect becomes .004. For service it rises to .027 at a typical average weighted distance of 337. In these calculations, the key variable driving the overall effect is the size of a firm's dominant county. For the non-service sector, the effect of production facilities in a large county is negative, while for the service sector it is positive. For the non-service sector, we hypothesize this reflects the functional specialization idea, firms with plants in bigger counties with better outsourcing possibilities have less need to set up a CAO. For services, a firm may have more plants or outlets in a big city. A greater number of outlets in a local market may increase the need for an independent CAO to coordinate, monitor, and evaluate outlets there.

In addition, the slope coefficient for firm size is greater in the service sector and is smaller for the number of plants. The degree of industrial specialization has less effect than before, but greater specialization is still negatively associated with a firm's probability to have CAOs. The effect of geographical dispersion among production activities is also smaller for the service sector.¹⁰

5. Are CAOs located close to production?

Where do firms locate CAOs? In our sample of firms with CAOs, only 25% have their CAOs in a county where they do not perform any production activities. Most retail or

¹⁰ The industry dummies only broadly control for industry specific factors. In manufacturing, there is heterogeneity in degree of noise or unpleasant smell from production, which influence the propensity to separate administration. We perform the probit analysis including 2-digit level SIC dummies for firms specializing in manufacturing. The results remained qualitatively the same for all of the key variables. Printing and publishing industries have a typical propensity of having a CAO. Industries with greater propensities are petroleum, chemical, primary metal, stone and clay industries. Those with lower propensities are furniture and industrial machinery.

service firms have an outlet or store in their CAO county, since they have many small operating establishments, which are spread throughout a region for geographic coverage. We define CAOs as being collocated if they are in the same county as production units of the firm. The 75% collocation rate suggests that being close to production facilities is important for firms.¹¹ There are various reasons why firms create CAOs and locate them close to plants, as discussed in the introduction. Here, we examine what kinds of firms create CAOs in a county without any production activities, hereafter called non-collocated CAOs.

Table 9 presents the results of a probit analysis that examines characteristics associated with firms that have non-collocated CAOs, given the set of firms with CAOs. We use the same set of firm characteristics as in Table 7, but we add a control for the total number of CAOs for each firm since the probability of having any type of CAO may increase when firms have more CAOs. We also performed the same probit analysis limiting the sample to firms with only one CAO; these results are similar to those in Table 9.

In Table 9, the coefficients on the industry dummies suggest that, among firms that have CAOs, there are vast differences across industries in the propensity to have a non-collocated CAO. As before, the base category is light manufacturing. All industries except for agriculture, heavy manufacturing and communications have significantly lower propensities to have a non-collocated CAO than light manufacturing. Retail, wholesale, and personal service sectors have much lower propensities to locate their CAOs away from their core business areas. In these sectors, many CAOs may coordinate a firm's shopping outlets in a given local market. In contrast, manufacturing, agriculture and mining firms operate with fewer and bigger plants that are not focused on selling in local markets, and a CAO may be located away from rural production sites.

The probability that a firm has at least one non-collocated CAO increases with industrial diversification and geographical dispersion. Firms may choose locations for co-

¹¹ It is possible that within the same county, for manufacturing firms, CAOs are located downtown while production is in less-populated suburbs. Our definition of collocation is therefore crude. But if the plant and CAO are in the same county, they have access to the same local intermediate services and local output market.

ordinating CAOs that are central to all plants. Also, firms with production in larger cities tend to have more collocated CAOs. Firms with production facilities in smaller cities and rural areas may have CAOs in large cities with the access to diverse service inputs. Firms with production facilities in large cities have less need for a non-collocated CAO.

The probability of a non-collocated CAO increases with the number of CAOs. This could be a statistical artifact of having more draws on the possibility of non-collocation. Controlling for the number of CAOs, firms with larger plants are less likely to have non-collocated CAOs. However, as we will see below, these scale effects apply more to the non-service sector.

Finally, one unexpected result is that the probability that a firm has a non-collocated CAO is much greater for firms specializing in one 2-digit SIC industry. (The slope coefficient is not significant for the specialization index.) When a firm's production is specialized in only one 2-digit SIC industry, the probability increases about 58% from the base probability of .225. Specialized firms may have less diverse information sources and may choose non-collocated CAOs to gather information from other locations.

Differences across industries

Again, we examine whether the slope coefficients differ between service and non-service sectors. The results are shown in Table A.4 in the full Appendix. The directions of the effects of variables are similar. For both the service and non-service sectors, the propensity to have a non-collocated CAO is lower when a firm's main production site is in a big city. Firms in the service sector are less likely to have a CAO if they operate in a small city; and if they have a CAO, they are more likely to locate it in a bigger city. In terms of scale variables, only for non-services does having more CAOs increase the chances of non-collocation, consistent with the functional specialization argument for manufacturing. But for both sectors, average plant employment size effects are negative.

6. Where are CAOs?

In this final section, we examine where CAOs locate. We begin by comparing CAO employment between areas with high and low employment density.

We use County Business Patterns (CBP) for 2000 to categorize counties into four groups based on the degree of employment density. Our measure of employment density

for each county, based on Holmes and Stevens (2003), calculates neighboring employment as the sum of employment of all counties within 30 miles including the own county. We rank counties based on density and categorize them into four groups with equal total employment. From the lowest employment quartile, the numbers of counties in each group are 2724, 271, 82, and 36. For each quartile, total employment is about 28 million. For each group, we calculate location quotients [LQs] for CAOs as well as for other industries. The LQ is the ratio of a group's share of national employment engaged in a certain industry/activity to its share of national private employment, and measures the relative concentration of a given activity.

The LQs are reported in Table 10. Manufacturing is concentrated in rural areas. The concentration of CAO employment (NAICS 551114) in the top quartile of the U.S. counties is over 50 % higher than the concentration of other activities in that quartile.¹² However, not only CAOs are concentrated in high density areas. Business services follow a similar pattern. For some finer service categories, the concentration in the high density areas is even more pronounced. For example, the advertising LQs are .33, .69, 1.13, and 1.85.

Next, we look at the spatial distribution of CAOs, by calculating the LQ for each county. We again use the 2000 CBP. In CBP, the county employment for a certain industry is sometimes suppressed due to disclosure issues and a categorical variable is reported. We use a version of CBP with an inferred employment number in these cases.¹³ Figure 1 plots each county's LQ against the log of the county's employment density measure as defined above for counties with at least 20,000 employment.¹⁴ There is vast diversity in the concentration of CAOs even within counties of similar employment density. The calculations using quartiles indicate that more dense counties tend to have high relative shares of CAOs. In the upper quartile of the figure, there are relatively few counties with LQ below one. LQs are high for many counties in high density areas. The

¹² In order to measure the concentration of CAOs by their number, we also calculate LQs by using each county's share of the total number of CAOs. The LQs are .71, .95, 1.18, and 1.18 – rather moderate concentration in the dense areas.

¹³ We thank Northern Illinois University for these employment estimates.

¹⁴ Small counties are not plotted; many have one or two CAOs, which causes a lumpy LQ measure.

Manhattan LQ is 1.34, and Cook County (central Chicago) 1.45. Some mid-density counties, such as Midland, MI; Roanoke, VA; and Benton, AR, appear to specialize in CAO activity.

In contrast, some big counties like Manhattan are less CAO centers than business service centers, exporting services to the rest of the country.¹⁵ Compared to its 3% share of national CAO employment in 1997, Manhattan has higher shares of national security brokers, advertising, legal, accounting, employment agencies, and management and public relations, which are, respectively, 24.5%, 14.7%, 7.24%, 5.10%, 6.22% and 4.25%. Only 1.9% of the CAOs that report themselves as HQs in 1992 are in Manhattan.¹⁶

In sum, the patterns indicate possible heterogeneity, whereby some CAOs are located in larger urban counties with concentrations of business services, others in specialized HQ cities like Midland and Roanoke, and yet others co-located near their production plants.

7. Conclusion

In this paper, we attempt to contribute to the limited empirical literature on firms' internal spatial organization. Many firms operate in multiple locations, locating different functions in different areas. Empirical work can help us understand why some functions are concentrated and why some functions are separated from the main physical location.

Our paper analyzes firms' decisions to construct stand alone central administrative offices - CAOs. There are significant differences between firms with and without CAOs. Firms with CAOs are much bigger than those without. CAOs typically support manufacturing and retail and wholesale businesses of firms. Firms with geographically dispersed production plants are more likely to have CAOs, possibly to

¹⁵ If we focus on only big companies' main headquarters, the concentration in Manhattan might be greater. The 2000 Compustat data used by Klier and Testa (2002) of publicly traded companies with 2,500 or more employment indicate that 5.2% have their main headquarters in Manhattan. Our data contain CAOs of both publicly traded and non-publicly traded companies and do not reveal whether a CAO is a company's main headquarter.

¹⁶ This seems to differ from a view that headquarters provide the economic base for some big cities (Ginzberg, 1977; Aksoy and Marshall, 1992).

locate the CAO in a central place to enhance coordination as well as monitoring. More industrially diversified firms more likely have CAOs, perhaps to ensure the fair treatment for different sectors. Firms that operate in small cities are more likely to have CAOs and to locate them in bigger cities, consistent with functional specialization. Functional specialization is less apparent for service firms, which have many small retail outlets in major cities.

References

- Aghion, P., and J. Tirole (1997), "Formal and Real Authority in Organization," *Journal of Political Economy*, 105 (1), pp.1-29.
- Aksoy, A., and N. Marshall, (1992), "The Changing Corporate Head Office and Its Spatial Implications," *Regional Studies*, 26, pp.149-162.
- Cremer, J. (1995) "Arm's Length Relationships", *Quarterly Journal of Economics*, May 1995, pp.275-295
- Davis, J. and J.V. Henderson, (2004) "Headquarters' Location Decisions," CES Working Paper 04-02, U.S. Census Bureau, Center for Economic Studies
- Duranton, G. and D. Puga, (2005), "From Sectoral to Functional Urban Specialization," *Journal of Urban Economics*, Vol. 57, No. 2, pp.343-370
- Eccles, R. (1985), "Transfer Pricing as a Problem of Agency", *Principals and Agents: the structure of Business*, edited by Pratt and Zeckhauser, Harvard Business School Press, Boston
- Ginzberg, E. (1977). *The Corporate Headquarters Complex in New York City*. Columbia University Press.
- Holmes, T.J. and J.J. Stevens, (2004), "Spatial Distribution of Economic Activity in North America," in *Handbook of Regional and Urban Economics*, Volume 4, Cities and Geography, eds. J. V. Henderson and J-F. Thisse, Amsterdam: North Holland. pp.2797-2843.
- Holmstrom, B., (1979) "Moral Hazard and Observability", *The Bell Journal of Economics*, Vol. 10, No. 1, (Spring 1979), pp.74-91
- Klier, T. and Testa W., (2002), "Location Trends of Large Company Headquarters during the 1990s", *Economic Perspectives*, Federal Reserve Bank of Chicago, 2Q, pp.12-26.
- Lovely, M.E., Rosenthal, S.S., and Sharma, Shalini, (2005), "Information, Agglomeration, and the Headquarters of U.S. Exporters", *Regional Science and Urban Economics*, 35(2), pp.167-191.
- Ono, Y., (2003), "Outsourcing Business Services and the Role of Central Administrative offices," *Journal of Urban Economics*, 53(3), pp.377-395.
- Ono, Y., (2006), "Market Thickness and Outsourcing Services," forthcoming at *Regional Science and Urban Economics*.

Puga, D. and Trefler D. (2002), “Knowledge Creation and Control in Organizations”, NBER working paper 9121, September 2002

U.S. Census Bureau, (2001a), *Company Summary, 1997 Economic Census Company Statistics Series*, Washington D.C.

U.S. Census Bureau, (2001b), “*1997 Economic Census: Auxiliaries, Excluding Corporate, Subsidiary, and Regional Managing Offices, Subject Series.*” Washington D.C.: U.S. Government Printing Office.

U.S. Census Bureau, (2001c), *1997 History of Economic Census*, Washington D.C.: U.S. Government Printing Office.

Table 1: Firms with and without CAOs

	No. of firms	Avg. firm emp.	Avg. No. of plants per firm	Avg. emp. per plant	Avg. No. of CAO per plants	Avg. emp. per CAO
1997						
Firms without CAOs	149,218	147	4.42	33.11	NA	NA
Firms with CAOs	17,908	2,042	39.5	47.25	.246	72.76
1992						
Firms without CAOs	160,605	136	4.26	31.72	NA	NA
Firms with CAOs	15,148	1,958	39.7	44.76	.236	66.06
Firms with HQs	10,906	2,211	42.6	46.90	.205	77.72

(Source: Authors' calculations based on the AES and the SSEL.)

Table 2: Firms with and without CAOs: by industry (1997)

Firm's main industry	No. of firms	Fraction w/ CAOs	Avg. firm emp.		Avg. No. of plants per firm		Avg. emp. per plant	
			Firms w/out CAOs	Firms w/ CAOs	Firms w/out CAOs	Firms w/ CAOs	Firms w/out CAOs	Firms w/ CAOs
All	167,126	.11	147	2,042	4.42	39.5	33.11	47.25
Agriculture	1,076	.20	170	834	4.20	12.97	40.54	52.87
Construction	1,925	.10	193	1,135	3.26	15.24	59.04	68.44
Light Mfg.	6,070	.24	303	2,718	3.66	23.60	81.95	99.55
Heavy Mfg.	8,567	.22	309	3,367	3.55	26.24	86.77	114.33
Transport & utilities	6,187	.10	291	2,957	5.76	36.13	50.46	77.19
Retail & wholesale	67,496	.12	71	1,560	3.71	45.26	18.87	31.28
FIRE	18,605	.03	182	3,446	7.69	132.84	23.63	24.72
Business, legal, Professional services	16,387	.06	202	2,951	3.83	38.10	52.49	74.15
Communications & motion pictures	1,299	.13	379	5,887	9.31	110.88	40.48	50.84
Other services	38,910	.10	151	1,519	4.18	27.62	36.10	51.60
Sub total	166,522*							

(Source: Authors' calculations based on the AES and the SSEL)

* Some firms operate in more than one industry. We categorize firms into industry sectors, by the industry with the highest employment share within the firm. Excluded are firms for which we cannot uniquely identify a dominant industry.

Table 3. CAOs and supported production activities

Production activity CAO supports	1997				1977		1977-1997 growth	
	No. of CAOs	Avg. CAO emp.	Share of national CAO emp. (%)	Share of national empl. (%)	No. of CAOs	Avg. CAO emp.	CAOs (%)	Industry emp. (%)
Agriculture	758	87	2.7	1.2	821	76	-7.7	32.1
Construction	305	71	.87	5.4	261	36	16.9	54.4
Manufacturing	7,139	136	39	17.1	6,192	122	15.3	-5.77
Transport & utilities	1,243	77	3.9	4.6	N/A	N/A	N/A	67.4
Retail & wholesale	14,901	54	33	27.1	12,424	47	19.9	61.3
FIRE	1,339	49	2.6	7.2	N/A	N/A	N/A	63.2
Business, legal, Professional services	2,007	58	4.7	12.1	742	29	170	264
Communications & motion pictures	310	60	.76	1.6	N/A	N/A	N/A	37.7
Other services	5,960	52	12	23.8	1,532	25	289	131
All	33,962	73	100	100	21,972	67	N/A	
Totals		2.47 M.				1.46M.		

(Source: Authors' calculations based on the AES and the CBPs)

Table 4. Propensity to outsource business service*Share of units outsourcing

	Legal		Accounting		Advertising
Year	1992	1997	1992	1997	1997
CAOs	.544	.637	.377	.578	.545
HQs	.741	N/A	.561	N/A	N/A
All other auxiliaries	.20	.184	.132	.166	.193

(Source: Authors' calculations based on the AES.)

* Because of changes in the way the micro-level data were edited, we use different criteria to identify establishments responding to the outsourcing questions. Auxiliary establishments that are included for the calculation of outsourcing propensities are those who respond to the function or HQ question for 1992, and those who respond to the function employment questions for 1997.

Table 5. Outsourcing of manufacturing plants with and without CAOs

Manufacturing plants in the ASM sample belonging to multi-establishments firms

	Plants without CAOs	Plants with CAOs
No. of plants	8,923	22,825
Advertising	.70	.28
Bookkeeping and accounting	.43	.06
Legal services	.70	.28
Data-processing	.56	.39

(Source: Authors' calculations based on the AES and the ASM.)

Table 6. Summary Statistics

Characteristics of firms included in the analysis (167,126 firms)

	Mean	s.d.
Log. Firm plant employment	3.94	1.46
No. of plants	8.18	72.16
No. of firms specializing in one 2-digit SIC industry: 129,282 firms		
Specialization index (calculated for 37,844 firms with 2+ SIC industries)	.684	.183
No. of firms with 2+ counties with production activities: 106,342 firms (A)		
No. of firms with 3+ counties with production activities: 48,999 firms (B)		
Max. distance between plants: calculated for firms in (A) (in miles)	513.1	841.4
Avg. distance between plants: calculated for firms in (B) (in miles)	395.1	495.6
Emp. of the dominant production county (in log.): calculated for firms in (A)	11.86	1.74

(Source: Authors' calculation based on the AES and SSEL.)

Note: The definitions of variables are found in A1 in the appendix.

Table 7. Probit analysis: What kind of firms have CAOs? (1997)

All multi-establishment firms: 167,126 firms

Dependent variable: =1 if a firm has CAOs

	Coef. ;dF/dX	(Robust s.e)	Effect of 1 s.d.
<i>ln</i> (firm employment in plants)	.042***	(.000605)	0.0614
No. of plants	.000295***	(.0000706)	.0213
D1:=1 if a firm is specialized in only one 2-digit SIC industry	-.0823**	(.00634)	NA
(1-D1) × Firm specialization index	-.0794***	(.00616)	-.0146
D2 = 1 if a firm has plants in two or more counties	.0131**	(.00526)	NA
D2 × Max. distance b/w counties with plants	.0000103***	(1.68e ⁻⁶)	.00867
D3 × Avg. weighted distance between plants (D3:=1 if a firm has plants in 3+ counties)	.0000187***	(3.12e ⁻⁶)	.00926
D2 × ln (emp. of a firm's dominant production county)	.000334	(.000454)	.00058
Primary industry dummies (Base category; Light manufacturing)			
Agriculture	.0254***	(.00903)	NA
Construction	-.0391***	(.00371)	NA
Heavy manufacturing	-.0191***	(.00288)	NA
Transport & utilities	-.0388***	(.00274)	NA
Retail wholesale	.00378	(.00310)	NA
FIRE	-.0735***	(.00167)	NA
Business services	-.0598***	(.00179)	NA
Communication and motion pictures	-.0303***	(.00550)	NA
Other services	-.0162***	(.00290)	NA
Pseudo R ²	.182		
Predicted probability at mean characteristics	.075		

(): Huber/White robust standard error

*** is significant at 1% level. ** is significant at 5% level. * is significant at 10% level.

Table 8. Difference in the slope coefficients between service and non-service sectors for Probit analysis: What kind of firms have CAOs? (1997)

All multi-estab. (167,126 firms)

Dependent variable: =1 if a firm has CAOs

	Coef.; dF/dX	(Robust s.d.)
\ln (firm employment in plants)	.0345***	(.00176)
\ln (firm employment in plants) \times Dservice [†]	.00782***	(.00192)
N. of plants	.000762***	(.000283)
N. of plants \times Dservice	-.000505*	(.000290)
D1:=1 if a firm is specialized in only one 2-digit SIC industry	-.0986***	(.0126)
D1 \times Dservice	.0195*	(.00987)
(1-D1) \times Firm specialization index	-.114***	(.0108)
(1-D1) \times Firm specialization index \times Dservice	.0540***	(.0141)
D2: = 1 if plants in two or more counties	.0578***	(.00954)
D2 \times Dservice	-.0683***	(.0137)
D2 \times Max. distance b/w counties with plants	.0000252***	(3.14e ⁻⁶)
D2 \times Max. distance b/w counties with plants \times Dservice	-.0000189***	(3.76e ⁻⁶)
D3 \times Avg. weighted distance between plants (D3=1 if a firm has plants in 3+ counties)	.0000223***	(5.35e ⁻⁶)
D3 \times Avg. weighted distance between plants \times Dservice	-5.15e ⁻⁶	(6.60e ⁻⁶)
D2 \times \ln (emp. of a firm's dominant production county)	-.00787***	(.000934)
D2 \times \ln (emp. of a firm's dominant production county) \times Dservice	.0103***	(.00107)
Primary industry dummies		Yes
Pseudo R ²		.186

(Source: Authors' calculations based on the AES, SSELS, and the CBPs)

(): Huber/White robust standard error

*** is significant at 1% level; ** is significant at 5% level; * is significant at 10% level.

†: **Dservice** indicates firms in service sectors (Retail & wholesale, FIRE, Business services, Communication & motion picture, and other services)

Table 9. Probit Analysis: Does a firm has non-collocated CAOs? (1997)

17,908 firms with CAOs

Dependent Variable: =1 if a firm has a non collocated CAO

	Coef.; dF/dX	(Robust s.e.)
<i>ln</i> (firm employment in plants)	-.0351***	(.00267)
No. of plants	-.0000209	(.0000333)
D1:=1 if a firm operates in only one 2-digit SIC industry	.130***	(.0176)
(1-D1) × Firm specialization index	.00167	(.0251)
D2: = 1 if plants in two or more counties	.235***	(.0151)
D2 × Max. distance between counties with plants	.0000964***	(8.79e ⁻⁶)
D3 × Avg. weighted distance between plants (D3:=1 if a firm has plants in 3+ counties)	.0000454**	(.000019)
D2 × <i>ln</i> (county employment of dominant firm county) ³	-.0285***	(.00227)
No. of CAOs	.00875***	(.00140)
Primary industry dummies (Base category; Light manufacturing)		
Agriculture	-.0322	(.0251)
Construction	-.170***	(.0137)
Heavy manufacturing	-.0196	(.0131)
Transport & utilities	-.104***	(.0138)
Retail wholesale	-.238***	(.0109)
FIRE	-.146***	(.0114)
Business services	-.100***	(.0120)
Communication and motion pictures	-.0324	(.0294)
Other services	-.216***	(.00813)
Pseudo R ²		.133
Predicted probability at average characteristics		.225

(Source: Authors' calculation based on the AES, SSELs, and CBPs.)

(): Huber/White robust standard error

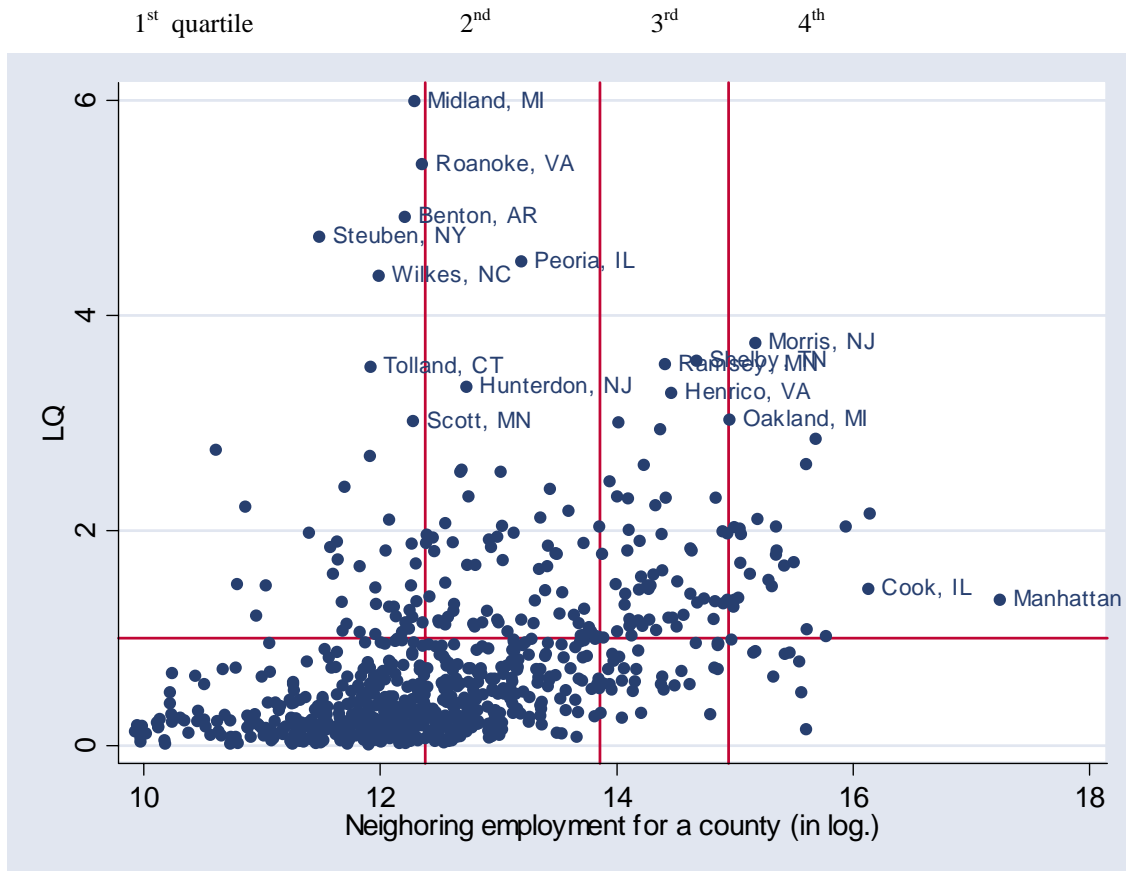
*** is significant at 1% level. ** is significant at 5% level. * is significant at 10% level.

Table 10. Location Quotients for four employment density quartiles

	1 st quartile	2 nd quartile	3 rd quartile	4 th quartile
CAOs	.39	.79	1.31	1.54
Business service	.52	.79	1.18	1.52
Advertising	.33	.69	1.13	1.85
Manufacturing	1.44	1.07	.76	.76

(Authors' calculation based on CBPs)

Figure 1. Location quotients for CAOs



(Source: 2000 County Business Patterns)

Appendix¹⁷

A.1 Definition of variables

Firm employment in plants

The sum of employment working at plants of a firm. This exclude employee working at any auxiliaries including CAOs of the firm.

Maximal distance between plants

Maximum distance among the all pairwise distance distances between plants (where that distance is zero for plants in the same county). Distances are calculated between centroids of counties with a firm's plants.

Average weighted distance between plants

This is the average of all pairwise distances between plants (where that distance is zero for plants in the same county). Distances are calculated between centroids of counties with a firm's plants.

This is equivalent to calculating all pairwise distances among plants and averaging. The average distance between plants is $\sum_i \sum_j d_{ij} / n(n-1)$ for all plant pairs i and j within a firm, and d_{ij} is the distance between the centroid of plant i 's county and the centroid of plant j 's county ($d_{ij}=0$ if two plants are located in the same county.). Instead of calculating pairwise distances among all plants and averaging, for computational performance reasons we calculate pairwise distances between counties in which a firm owns plants and take the average weighted by the number of plants in each county, i.e. for all county pairs k and m , $[\sum_k \sum_m P_k P_m d_{km} / n(n-1)]$ where P is the count of the firm's plants in the county.)

Specialization index

The index is the sum of squared shares of firm plants' employment in the 2-digit SIC.

Dominant production county

The dominant production county for a firm is the county with the plurality of the firm's plant employment. The size of such count is measured by the county's total private employment in logarithm.

¹⁷ The full appendix including Tables A.2, A.3, and A.4 can be downloaded at www.chicagofed.org/publications/workingpapers/WP2003-30REV.pdf.

Spatial Organization of Firms

– The decision to split production and administration –

Kristin Aarland	James Davis	J. Vernon Henderson	Yukako Ono
<i>Brown University</i>	<i>US Census Bureau</i>	<i>Brown University</i>	<i>Federal Reserve Bank of Chicago</i>

The revised version of this paper is forthcoming at the Rand Journal of Economics. Below is an unpublished part of the appendix from the paper.

Table A.2 Probit analysis: Does a firm have a stand-alone HQ (1992)

All multi establishment firms: 175,753 firms

Dependent variable: =1 if a firm has auxiliaries reporting as HQs.

	Coefficient (dF/dX)	Robust s.d.
<i>ln</i> (firm employment in plants)	.0277***	.000373
No. of plants	.0000574***	.0000143
D1: =1 if a firm is specialized in only one 2-digit SIC industry	-.0539***	.00444
(1-D1) × Firm specialization index	-.0535***	.00402
D2: =1 if plants in two or more counties	.0259***	.00335
D2 × Max. distance b/w counties with plants	4.54e ⁻⁶ ***	1.16e ⁻⁶
D3 × Avg. weighted distance between plants (D3:=1 if plants in 3+ counties)	9.70e ⁻⁶ ***	2.35e ⁻⁶
D2 × <i>ln</i> (emp. Of dominant production county)	-.00105***	.000307
Primary industry dummies (base category: light manufacturing)		
Agriculture	.0342***	.00743
Construction	-.0214***	.00243
Heavy manufacturing	-.00795***	.00199
Transport & utilities	-.0266***	.00156
Retail wholesale	.00895***	.00203
FIRE	-.0447***	.000945
Business services	-.0325***	.00122
Communication and motion pictures	-.0220***	.00287
Other services	-.00815***	.00191
Pseudo R ²	.189	

(Source: Authors' calculations based on the AES, SSELs, and the CBPs.)

Huber/White robust standard errors were calculated.

*** is significant at 1% level. ** is significant at 5% level. * is significant at 10% level.

Table A.3 Robustness Check: Probit analysis: Does a firm have a stand-alone CAO? (1997)

All multi-establishment firms: 167,126 firms

	Probit		Tobit	
Dependent variable	D:=1 if a firm has CAOs		No. of CAOs	
	Firms with 2+ plants (165,525 firms)		All multi-estab. firm (167,126 firms)	
	Coef. (dF/dX)	Robust s.d.	Coef.	Robust s.d.
<i>ln</i> (firm employment in plants)	.0402***	.000530	1.910***	.0287
No. of plants	.000209***	.0000534	.0214***	.000287
D1:=1 if a firm is specialized in only one 2-digit SIC industry	-.0971***	.00635	-3.847***	.233
(1-D1) × Firm specialization index	-.0781***	.00547	-4.710***	.319
D2 = 1 if a firm has plants in two or more counties	.0384***	.00425	.357	.307
D2 × Max. distance b/w counties with plants	8.93e ⁻⁶ ***	1.47e ⁻⁶	.000246***	.0000934
D3 × Avg. weighted distance between plants (D3:=1 if a firm has plants in 3+ counties)	.0000153***	2.80e ⁻⁶	.00128***	.000194
D2 × ln (emp. Of a firm's dominant production county)	-.0000399	.000402	.0363	.0255
Primary industry dummy (Excluded category: Light manufacturing)				
Agriculture	.0250***	.00851	1.18***	.376
Construction	-.0288***	.00372	-2.43***	.354
Heavy manufacturing	-.0165***	.00256	-1.023***	.187
Transport & utilities	-.0251***	.00284	-2.269***	.235
Retail wholesale	.0256***	.00289	-.0602	.155
FIRE	-.0563***	.00168	-5.994***	.222
Business services	-.0450***	.00177	-4.036***	.197
Communication and motion pictures	-.0198***	.00556	-2.101***	.410
Other services	.00953***	.00299	-.928***	.163
Constant			-15.270***	.311
Pseudo R ²	.218		.120	

(Source: Authors' calculations based on the AES, SSELs, and the CBPs.)

Huber/White robust standard errors were calculated.

*** is significant at 1% level. ** is significant at 5% level. * is significant at 10% level.

Table A.4 Difference in the slope coefficients between service and non-service sectors for Probit analysis: Does a firm have a non-located CAO?

17,908 firms with CAOs

Dependent variable: =1 if a firm has non-located CAOs

	Coef.; dF/dX	Robust s.d.
\ln (firm employment in plants)	-.0217***	.00525
\ln (firm employment in plants) \times Dservice	-.0240***	.00597
No. of plants	-.000742***	.000231
No. of plants \times Dservice	.000745***	.000233
D1:=1 if a firm is specialized in only one 2-digit SIC industry	.120***	.0246
D1 \times Dservice	-.0115***	.0359
(1-D1) \times Firm specialization index	.0649*	.0353
(1-D1) \times Firm specialization index \times Dservice	-.0905*	.0483
D2: = 1 if plants in two or more counties	.254***	.0247
D2 \times Dservice	-.0232	.0599
D2 \times Max. distance b/w counties with plants	.0000458***	.0000136
D2 \times Max. distance b/w counties with plants \times Dservice	.0000664***	.000018
D3 \times Avg. weighted distance between plants (D3=1 if a firm has plants in 3+ counties)	.0000488*	.0000277
D3 \times Avg. weighted distance between plants \times Dservice	.0000184	.0000381
D2 \times \ln (county emp. of dominant firm county)	-.0348***	.00395
D2 \times \ln (county emp. of dominant firm county) \times Dservice	.00741	.00488
No. of CAOs	.0591***	.00691
No. of CAOs \times Dservice	-.0534***	.00727
Primary industry dummies	Yes	
Pseudo R ²	.148	

(Source: Authors' calculations based on the AES and the SSEL)

Huber/White robust standard errors were calculated.

*** is significant at 1% level. ** is significant at 5% level. * is significant at 10% level.