THE AGGLOMERATION OF HEADQUARTERS

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Abstract

This paper uses a micro data set on auxiliary establishments from 1977 to 1997 in order to investigate the determinants of headquarter agglomerations and the underlying economic base of many larger metro areas. The significance of headquarters in large urban settings is their ability to facilitate the spatial separation of their white collar activities from remote production plants. The results show that separation benefits headquarters in two main ways: the availability of differentiated local service input suppliers and the scale of other headquarter activity nearby. A wide diversity of local service options allows the headquarters to better match their various needs with specific experts producing service inputs from whom they learn, which improves their productivity. Headquarters also benefit from other headquarter neighbors, although such marginal scale benefits seem to diminish as local scale rises.

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1 Overview

The executives who make decisions on how their firms will be organized often find it advantageous to locate headquarter facilities away from production facilities, in different metro areas. Given that intra-firm communication becomes more cumbersome and expensive with physical separation, why is separation beneficial?

There are two competing explanations. First headquarters choose to locate in metropolitan areas comprised of a wide variety of business service suppliers. Headquarters need information, advice, and services from specialists in law, advertising, and finance. Acquiring such information and services involves repeated face-to-face interaction and close spatial proximity between buyers and sellers. We know service firms are disproportionately concentrated in larger cities, so headquarters locate in these service cities away from smaller production oriented cities, because they benefit from the variety of differentiated suppliers. The second explanation is that headquarters cluster together to exchange information among themselves and acquire information about market conditions. This exchange, whether it involves deliberate "trades" or "spillovers", informs headquarters about production, input and technology choices for their plants. For example Lovely, Rosenthal and Sharma (2002) find exporter headquarter activity is more agglomerated than other headquarter activity because export related information is difficult to acquire. These competing explanations have implications for how we model cities in an urban system, how we model agglomeration economies, and how we think of the nature of outsourcing decisions.

These competing explanations are also at the heart of current investigations into the nature of scale economies that lead economic activity to agglomerate into cities. The traditional model (Fujita and Ogawa (1982)) is one of information spillovers; and in urban systems modeling (Henderson (1974), Duranton and Puga (2001)) these externalities are viewed as internal to the own industry, consistent with empirical evidence for manufacturing (see Rosenthal and Strange (2003) for a review). Own industry scale externalities lead to urban specialization, where cities specialize to exploit own industry scale, relative to general urban diseconomies such as commuting and congestion costs. So we observe textile, steel, auto, insurance, entertainment and so on type cities (Black and Henderson (2003)), among medium and small size metro areas.

What about large metro areas, which have more diverse, service oriented economic bases (Kolko (1999))? One literature follows the scale externality explanation. Some large metro areas like New York City are viewed as being specialized in headquarters activity, where presumably headquarters experience own industry scale externalities. But, since headquarters purchase business and financial services, they draw, almost incidentally, these activities into large metro areas as well (Ginzberg (1977), Aksoy and Marshall (1992)). However the recent economic geography literature deriving from Krugman (1991), has a somewhat different perspective on essentially the same phenomenon.

In the new economic geography literature, agglomeration externalities derive from diversity in local intermediate input service sectors (Abdel-Rahman and Fujita (1990)). In a Dixit-Stiglitz-Ethier (1982) framework, greater scale and hence diversity in local business service inputs makes final local (headquarter) production more efficient. So Duranton and Puga (2002) model "functional" specialization (see also Davis (2003)). Smaller cities are specialized in production activities, while headquarters co-locate with large scale business service activity because of the scale economies from diversity in intermediate inputs, in large metro areas and away from production.

The main objective of this paper is to distinguish and quantify these two types of scale effects for headquarters' activity, the role of own industry scale externalities versus the role of diversity scale externalities, and thus improve our understanding of the agglomeration forces governing certain larger metro areas. Do both scale effects exist and, if so, how important are they? This is the first time that we know of that an empirical scale externality paper has looked at a service activity, as opposed to just manufacturing production. As such, one might anticipate results to be quite different. In manufacturing, external scale elasticities tend to be in the 0-.12 range (Rosenthal and Strange (2003)), so, at most, a 10% increase in local relevant scale increases efficiency by 1.2%. Manufacturing is found in smaller cities. For headquarters to pay the much higher wage, input, and real estate rental costs in larger cities we might expect to see much greater scale effects.

Apart from learning more about the fundamentals of agglomeration, the existence and magnitude of local scale externalities has implications also for local public policy. In urban systems models (Henderson (1988), Duranton and Puga (2001)), achieving efficient city size requires application of the Henry George Theorem. Land rents (or land taxes from property) are used to subsidize and internalize externalities, in a competitive urban system. Metro areas are heavily involved in such subsidization activity, with 9/11 putting this issue up-front in Lower Manhattan. The magnitude of externalities will determine the appropriate extent of subsidies, and later in the paper we will interpret our results in this context.

Finally this paper suggests out-sourcing behavior is an important aspect of production organization today, as documented in Ono's (2001) work. While clustered headquarters learn from each other and in-house many of their service activities, the ability to locally out-source special service activities explains why large market centers specialized in such activities are attractive locations. Some out-sourcing activities are observable (e.g., legal, accounting services) while others such as financial can only be inferred.

Data on Headquarters

The establishment data on headquarters are from the U.S. Census Bureau's Economic Census data set on Central Administrative Office and Auxiliary Establishments [CAO] covering the period 1977-97 in five-year intervals.[1] An auxiliary is any establishment of the company whose principal function is to manage, administer, service, or support the activities of other establishments of the company (Census(1996)). This includes administration and management, R&D, computer data processing centers, communications, central warehouses and trucking.

What we focus on is something called central administrative units, which we identify informally as headquarters [HQ][2]. As Table 1 reveals these comprise 73% of all auxiliaries in 1997. These facilities produce services that are consumed by the operating units and plants of their firms. Examples include strategic planning, business, financial and resource planning, as well as centralized ancillary administrative services such as legal, accounting, and the like. Some of these services may be out-sourced, given out-sourcing is also a central function of HQ's. Starting in 1997, the Census also identifies a small percent of auxiliaries that specialize in legal, accounting, advertising or personnel functions for their firms. Our focus is just on HQ's.

Each HQ unit is assigned an SIC code that corresponds to the industry of the operating units it services. We distinguish between manufacturing, retail, service and other categories since they do exhibit fundamental differences.[3] Table 2 shows the industrial composition breakdown of HQ's in 1977 and 1997. Manufacturing and retail/wholesale are the major HQ sectors, together accounting for 65% of HQ's in 1997 and growing about 18% in counts from 1977 to 1997. In this data overview, we show both establishment counts and employment numbers, though in estimation we focus on counts as the underlying model will suggest. The employment picture is however also of interest for comparison with the overall economy. Manufacturing HQ's are much larger in employment than other HQ's, 143% larger than the average size of all non-manufacturing HQ's in 1997. However the rapidly growing sector, as with

[1] Auxiliaries are surveyed as part of the Enterprise Statistics Program under Economic Census Special Programs. Auxiliaries are identified by multi-establishment company in the prior year as part of the Report of Organization questionaire for the Company Organization Survey and all reported auxiliaries are subsequently surveyed. This is a rarely used data set whose features we are still learning about. Earlier studies that used this data are Lichtenberg and Siegel (1990) who researched the labor effect of ownership change, and Siegel and Griliches (1992) who used the CAO to complete the view of service and computer inputs to manufacturing plants so as to investigate the impact of outsourcing on total factor productivity.

[2] In some years (1982-1992, but not 1977 or 1997), about 70% of central administrative units are designated as actual headquarters. Since we can't make the distinction consistently over time and many who are not identified as headquarters are due to non-response, we use the central administrative unit designation and call all of these headquarters for the remainder of the paper.

[3] The "other" category includes industries that were not in scope through the whole sample period of 1977 through 1997, and was excluded in estimation so that HQ birth measures would not reflect changes in the scope of the Economic Census over time.

the economy, is business services, as well as personal services in the "rest". Note that for 1977, finance, real estate, insurance, and communications were out of scope in the sample frame. By 1997 these plus business services account for 11% of HQ's.

Like operating plants, HQ's have high "birth" and "death" rates. In Table 3, the birth rate every five years is about .6. A birth is a new HQ in a county as identified by a new company plant identifier appearing in the county. Within a county, moves by a company HQ are not counted as births; but, for example, only .2% of surviving HQ's within counties from 1992-97 report a new location-plant identifier (PPN), although a much higher 17.8% appear to have a new zip code. Auxiliaries (CAO's) that switch from being a non-HQ to a HQ are also not counted as births (these would increase the number of births by 15% from 1992-97). However buy-outs (which change the company identifier) are. Buy-outs in 1992-1997 are about 5.8% of births, as inferred by HQ's that have a new company identifier (CFN), but the same plant-location identifier (PPN). Before 1987 we can't distinguish since we don't have PPN's for those years. Deaths are a HQ company-plant identifier disappearing from a county.

Table 3 shows that about 50% of HQ's die out each five-year period. Such a high death rate initially struck us as odd. HQ's belong to mature firms. What appears to be the case is that many of these larger firms have many HQ's, one or two of which are the main operational HQ which may be "permanent." Of the 1977 HQ's, 15% remained in the sample through the last year of our data in 1997. Firms perform a lot of experimentation with both location choices for other headquarters and a lot of experimentation with whether to have a fourth or fifth, or tenth HQ facility. The fixed financial cost of setting up an office is not that high. It is this experimentation, as well as decisions of firms without a HQ as to where to locate their first HQ, which generates the births in our data. That will allow us to identify the effects of changing local economic conditions on HQ profits.

The next issue is location of HQ's. In Table 4 we aggregate counties into four groups by employment size rank. The groups are the top 10 largest employment counties, the next 11-75, the remaining urban counties, and rural counties. From Table 4, the largest 10 counties in 1997 have a .15 share of all national private employment and .21 share of all HQ employment, or a relative quotient of HQ share to total employment share of 1.38. Likewise, mid to large sized counties ranked 11-75 collectively have a .29 share of national employment and .39 share of national HQ employment, a quotient of 1.35. HQ's are found in greater numbers in the large centers relative to what one would expect given total employment there. In contrast, the relative HQ quotient for the remaining urban counties is .87 and for rural counties .33. HQ are clearly under-represented in rural counties and we focus on urban counties for the remainder of the paper. We find a similar pattern for major business services, with high relative share quotients of 1.43 and 1.29 for the top 10 and 11-75 groups respectively, and low quotients for both smaller urban and rural counties. Service industry data are from County Business Patterns and the Standard Statistical Establishment List (SSEL) for 1977-1997, covering all private establishments in the U.S. This is in contrast to manufacturing, shown in Table 4 to have greater representation in smaller urban and rural counties. HQ and business services tend to be co-located in central counties of larger cities.

Though Table 4 shows HQ's are a large county phenomenon, Figure 1 reveals substantial urban specialization in HQ's. The figure plots for all urban counties the location quotient, the ratio of the share of HQ establishments to the share of total private establishments, against the log of the number of total establishments in the county. The wide variance in location quotients indicates concentration of HQ into counties that specialize in HQ production.

Two points are worth mentioning. First, we did not find that HQ either are overwhelmingly concentrated into the very largest counties such as New York, L.A. or Cook county of Chicago, as can be seen in the right most portion of Figure 1, nor did we find that HQ activity dominates the local economy in the largest metro areas as implied by some earlier literature. For a sample of 10 central HQ counties of the largest 10 CMSA, on average HQ employment in each is only 3.9% of its total employment in 1997. HQ are an important part of the local economies of large cities, but the notion of these large metro areas as HQ cities above all else is not apparent. New York county (essentially Manhattan) offers an interesting example. While New York has 1.9% of all private U.S. employment and 3.0% of HQ employment in 1997, it has 5.3% of national commercial banking, 25% of securities, 7.6% of investment holding companies, 15% of advertising, and 7.2% of legal services. New York appears more of a business service city than a HQ city per se. Comparing similarly sized industries, commercial and investment banking and securities industries are the same size nationally as the HQ sector but they account for about 14% of NY county's employment, as compared to 4% for HQ's. Advertising, legal, and accounting are about 7% of New York's employment base, even though nationally these industries collectively are about 20% smaller than the HQ sector. The second point worthy of note is that we did not find in the data a substantial suburbanization trend for HQ. For eight of these large 10 central HQ counties of CMSA (L.A. and Phoenix are single county PMSA), their shares in relation to the rest of their own PMSA did fall 9% from 1977 to 1997, but this parallels a similar fall of 8% in total employment over the period. [4]

Finally, we have asserted that a key function of HQ's is out-sourcing, information on which we use later to interpret coefficients. We have direct data on legal, accounting, and advertising out-sourcing. Out-sourcing for consulting, R&D, and the like are not recorded. Second, out-sourcing in the financial sector is not "observed"; it is buried in

[4] For this same sample of 10 central HQ counties, their share of CMSA HQ's does drop from 69 to 60% from 1977 to 1997, but that seems part of a general decentralization movement where the top 10 CMSA's share of national CA's falls from 33 to 30% and the share of the central PMSA in CMSA CA's for the top 10 declines from 81 to 74%.

loan costs and rates of return. Table 5a shows the propensity of HQ's to out-source for each of the three reported industries. We note that in 1997 about a third of HQ's do not fill out detailed information on questionnaires, and our numbers are based on HQ's who do respond to the questionnaires. Out-sourcing propensities for HQ's in 1997 are 55-65% each of accounting, legal, and advertising. Among those HQ who out-source, Table 5b shows their share of out-sourcing expenditures for each industry in the HQ wage bill. These direct numbers suggest for these three inputs alone out-sourcing is 65% of the wage bill. Of these three, it is clear advertising out-sourcing is an important function of HQ's. These advertising expenditures are presumably billings and reflect a high proportion of money going for air time and ad space in the media, as opposed to just compensation paid to advertising agencies per se. On the other hand they don't reflect company advertising decided by headquarters, but assigned as billing expenses handled by other units of the company once an advertising campaign is underway.

In the paper we will be thinking of a model in which for certain cities, HQ's are a raison d' $\widehat{e}$tre. But we note that the very largest metro areas like New York may not embody this idea. The idea may be more applicable to metro areas like Charlottesville, VA, Milwaukee, WI, Rapid City, SD, and New Brunswick, NJ, examples with large location quotients (see Figure 1).

2 Modeling Headquarters' Location

We now turn to modeling headquarters' activities, with the intent of deriving a profit function for such activities. With a profit function, we can assess the role and importance of local wages, service offerings, and HQ agglomeration in the technology of producing headquarters' activities. Of course headquarter profits are not observed per se. But we will take the model structure and use it to examine patterns of births of HQ's. From that we will determine the relative effect on inferred profits of different attributes of counties, in terms of relative wage, service offerings, and local agglomeration.

Headquarters Technology.

We assume headquarters produce service outputs Y consumed by their within firm production plants. The HQ production function is given by

$$Y = A(HQ,.)L_1^{\alpha_1} \prod_{j=2}^{m} \left(\sum_{i=1}^{n_j} X_{ji}^{\rho_j} \right)^{\frac{\alpha_j}{\rho_j}} \tag{1}$$

Headquarters face costs

$$C = wL_1 + \sum_{j=2}^{m} \sum_{i=1}^{n_j} q_{ji}\; X_{ji} \tag{2}$$

$A(HQ,.)$ is the level of technology in HQ production and L_1 is headquarter labor. $A(\cdot)$ will be specified to be a function of the number of other local headquarter facilities nearby, under the assumption that this measure of the count of sources of local information spillovers represents the degree of local scale externalities, as will be consistent with the econometric results. The subscript j represents the $(m-1)$ separate service industries. X_{ji} is the purchase by a headquarter from firm i in service industry j, where n_j is the number of sellers in the local market in service industry j. q_{ji} is the price charged by firm i in industry j. We will generally work with 10 different input service industries. The parameter ρ_j is the technological need for variety of differentiated service inputs from industry j in headquarters production, and the α_j's are share parameters. $0 < \rho_j < 1$. The closer ρ_j is to one the more substitutable are inputs from industry j and the less important diversity is to headquarter's production. Note $\sigma = 1/(1-\rho)$, where σ is the elasticity of substitution.

With the symmetry that will result in equilibrium, the production function can be rewritten

$$Y = A(HQ,.)L_1^{\alpha_1} \prod_{j=2}^{m} \left(n_j^{\frac{\alpha_j}{\rho_j}} X_j^{\alpha_j} \right) \tag{3}$$

Because each service is differentiated, n_j gives the variety of service offerings in industry j available to the HQ locally. Differentiated service inputs bought by headquarters are assumed local to each city due to the need for face-to-face interaction during service purchase and delivery. Increased varieties offer a better match between service offerings and HQ need, increasing efficiency as specified in the technology of the production function as shown in (3). Note other things being equal, in this Dixit-Stiglitz varieties formulation, HQ's would prefer more varieties ($n_j^{\frac{\alpha_j}{\rho_j}}$) as opposed to more of any one variety ($X_j^{\alpha_j}$ where $\alpha_j < \frac{\alpha_j}{\rho_j}$). However the cost structure in X_j production limits the number of varieties.

Each service provider belongs to only one industry, and firms within each industry face local monopolistic competition among each other. The labor L_{ji} required by a differentiated service firm to produce total local output $\tilde{X}_{ji}$ is

$$L_{j_i} = f_j + c_j \tilde{X}_{ji} \tag{4}$$

Firms within each industry are assumed identical local monopolistic competitors facing increasing returns. Service production processes include a fixed cost of labor f_j and a constant marginal cost c_j. The local cost of labor to producers in the industry is w_j. Note all local providers in industry j face identical technology, demand, and costs. Solving the symmetric equilibrium[5] for each industry gives local prices of

$$q_j = \frac{w_j c_j}{\rho_j} \tag{5}$$

[5] See Dixit and Stiglitz(1977), Abdel-Raman and Fujita(1990) or Davis(2003) for more details.

for service industry $\tilde{X}_j$. As usual, ρ_j indicates the extent of the price markup by the monopolistic competitor.

Headquarters maximize profits where, from (1) and (2), profits are $pY - C$. p is the unobserved (shadow) price, or unit value of an headquarter's activities to the firm. That would depend for example on the unobserved distances in this data set from the headquarter to the various plants or establishments of the firm. The fact that neither p nor Y are observed raises econometric issues for analysis below. Keeping this in mind, maximizing headquarter profits, with the assumption of symmetry among service input suppliers within each industry, the problem[6] reduces to satisfying

$$L_1 = \frac{p\alpha_1 Y}{w} \qquad\qquad X_j = \frac{p\alpha_j Y}{n_j q_j} \tag{6}$$

The next step is to define the profit function for headquarter's activity. Given profits are $pY - C$; by substituting (5) and (6) into (2), we can show profits are pY $(1 - \alpha_1 - \sum\limits_j \alpha_j)$. Existence of a profit function requires $(1 - \alpha_1 - \sum\limits_j \alpha_j) > 0$, so we can define α as the "owner's" residual share where

$$\alpha \equiv \ (1 - \alpha_1 - \sum_{j=2}^{m} \alpha_j) \tag{7}$$

By substituting (4) and (5) into (1) we can solve for Y and then for profits. The result is

$$\tilde{\pi} = Bp^{\frac{1}{\alpha}} \ A(\cdot)^{\frac{1}{\alpha}} \ I^{-\frac{1}{\alpha}} w^{-\alpha_1/\alpha} \tag{8}$$

where B is a parameter collection[7] and I is a "price" index for differentiated products. I is given by

$$I = \prod_{j=2}^{m} \left(\frac{w_j}{n_j^{(1-\rho_j)/\rho_j}} \right)^{\alpha_j} \tag{9}$$

The index, I, plays a critical role in birth analysis below and its measurement will be discussed. What this paper will attempt to sort out is the roles played by availability of service input varieties versus local scale externalities within the headquarter's sector in attracting headquarters to a city, in the profit function in (8).

Headquarters Agglomeration in a Systems of Cities Model.

In a systems of cities model, one type of city would be headquarter cities (Davis(2003)). For those types of cities the traded good output is headquarters' activity, and intermediate inputs are local business and financial services. In the standard city developer

[6] The first order conditions are $\frac{\partial \pi}{\partial L} = \frac{p\alpha_1 Y}{L} - w = 0$, $\frac{\partial \pi}{\partial X_{ji}} = \frac{p\alpha_j Y}{X_{ji}^{1-\rho_j} \sum X_{ji}^{\rho_j}} - q_{ji} = 0$.

[7] $B = \alpha \ \alpha_1^{\alpha_j/\alpha} \ \prod\limits_{j=2}^{m} \ (\alpha_j \ \rho_j/c_j)^{\alpha_j/\alpha}$.

model (Henderson (1988), Duranton and Puga (2001)), one can set up the developer's optimization problem. For that, the literature has internal space to cities and commuting costs, where workers live on lots of fixed size in a circular city and commute to work at the city center. Standard results yield total urban land rents of $\frac{1}{3}\pi^{\frac{-1}{2}}tN^{\frac{3}{2}}$ where t is the cost of commuting a unit distance and N is city population and work force.

The developer's optimization problem is to maximize

$$\frac{1}{3}\pi^{\frac{-1}{2}}tN^{\frac{3}{2}} - \tau_1 n - \tau_2 HQ - \tau_3 N \tag{10}$$

which is total urban land rents collected minus subsidies to intermediate producers (τ_1) where there is just one type of intermediate input with share α_2 for purposes of illustration, subsidies to each HQ (τ_2), and any subsidies to workers (τ_3). The developer faces two constraints. First, HQ's must earn the going profit rate in national markets (π_o), where per headquarter profits in equilibrium are revenue ($HQ^{\varepsilon}L_1^{\alpha_1}n^{\frac{\alpha_2}{\rho}}X^{\alpha_2}$) less costs ($wL_1$ and qnX) plus subsidies (τ_2). Second, workers must earn the going real income in national markets (I), where their income in the city is $w - \pi^{\frac{-1}{2}}tN^{\frac{1}{2}} + \tau_3$, where the middle term is per person rent plus commuting costs. In setting up the problem, two assumptions are made (consistent with a first best). First, wages w in the city are the marginal product of labor in the HQ sector. Second, for intermediate producers, profits are zero where profits are revenue ($q\tilde{X}$) minus wage costs wL plus subsidies τ_1 where $L = f + c\tilde{X}$.

If we do this optimization problem, with respect to τ_1, τ_2, τ_3, n, L, L_1, HQ, and N (where $N = nL + HQ\ L_1$), we can show the following standard results of relevance here:

$$\begin{aligned} &\tau_2 = \varepsilon HQ^{\varepsilon}L_1^{\alpha_1}n^{\frac{\alpha_2}{\rho}}X^{\alpha_2} = \varepsilon Y \\ &\tau_1 = fw \quad \text{and } \tau_1 n = \tfrac{\alpha_2(1-\rho)}{\rho}(HQ\ Y) \\ &\tau_3 = 0 \end{aligned} \tag{11}$$

The first term says, as always with externalities, that the subsidy equals the external benefit of an additional HQ: the spillover elasticity times the value of output. The second term says, under monopolistic competition, firms should be paid their fixed costs. But the real issue is the extent (n) of these fixed cost subsidies. Equation (11) tells us the total bill ($\tau_1 n$) is $\frac{\alpha_2(1-\rho)}{\rho}$ of total headquarter's output. It is increasing as ρ declines and inputs become less substitutable. $\tau_3 = 0$ because labor imposes no production externalities, in this formulation. These results will be used to give a public policy interpretation to econometric estimates later in the paper.

3 Headquarters' Location Choice

To model headquarters' location, we assume firms (whose other activities we don't observe in the CAO data set) look nationally and choose profit maximizing locations for their headquarters. We focus on the location of births - new (and relocating) HQ's of firms. Patterns of where firms locate new HQ's change over time, as economic conditions in different locations change over time. These conditions change, in large part exogenously to HQ's, in response to local shocks affecting the local service sector, amenities for consumers making migration decisions, and the local labor market as affected by other economic sectors. As relevant local economic conditions change, the comparative advantage of different locations for HQ's changes. We look at the impact of changing economic conditions on the location patterns of births, since births can readily respond to these changes. This will allow us to identify the effects of changing covariates in equation (8) on implied profits.

An alternative would be to look at the location of stocks, or of net changes in stocks. Stocks include some long term HQ's of firms where relocation costs would be very high, due to accumulated social and within firm human capital at a location. Net changes are composed of births and deaths. Other work on location (e.g., Davis, Haltiwanger and Schuh (1992), and Becker and Henderson (2000)) indicates the birth and death processes do not mirror each other, with deaths being largely due to idiosyncratic factors. Also there are switches where an auxiliary becomes an headquarter or no longer primarily performs headquarter functions. For these types of reasons, most authors focus on births, dating back to Carleton (1983).

To analyze location decisions for births, we conceptualize in a discrete logit framework (Goldberg (1995)), where firms look across locations to pick the profit maximizing location for their new HQ's. That is, given the total number of HQ's born in time t, firm i chooses location k if from equation (8)

$$\ln \widetilde{\pi}_{ikt} + f_k + \varepsilon_{ikt} > \ln \widetilde{\pi}_{ijt} + f_j + \varepsilon_{ijt} \qquad \forall j \tag{12}$$

where we define

$$\pi_{ikt} \equiv \ln \widetilde{\pi}_{ikt} = \ln B + \frac{1}{\alpha} \ln p_{ikt} + \frac{1}{\alpha} \ln A_{kt}(.) - \frac{1}{\alpha} \ln I_{kt} - \frac{\alpha_1}{\alpha} \ln w_{kt} \tag{13}$$

In the CAO data set, we have no characteristics of firms per se and no comprehensive coverage of characteristics of HQ's in this context other than their industry and location. Nor do location attributes vary within a location by individual HQ. Thus we have a standard conditional logit, where the only variation is from locational characteristics, not firm ones. Second, in (13) we do not observe the shadow price p_{ikt} for firm i. That effect, after controlling for county market potential and/or scale or CMSA scale, then is subsumed in the error structure in (12), for the draw on the "match," ε_{ikt}, for how well firm i matches to location k, based on the various locations of its production or sales facilities in relation to k. The ε_{ikt} are i.i.d. and for the moment we assume they are Weibull distributed. The "fixed effect," f_k, refer to unobserved time invariant location characteristics.

If the covariates in (13) are exogenous to contemporaneous shocks, then we could estimate the model by standard conditional logit methods, introducing regional "fixed" effects, or location dummies. However as Guimarães, Figueiredo and Woodward (2000) show, in a Poisson model where the probability of observing β_{kt} births in location k in time t is

$$prob(\beta_{kt}) = \frac{e^{-\lambda_{kt}}\lambda_{kt}^{\beta_{kt}}}{\beta_{kt}!} \quad , \tag{14}$$

if λ_j is parameterized as

$$\lambda_{kt} = \exp(\pi_{kt} + f_k) \quad , \tag{15}$$

then the problem may be equivalently estimated by a "fixed effects" Poisson, either adding locational dummies to an ordinary Poisson or conditioning out location dummies by modelling the sequence of births for a location over time, conditioned on total births over time for that location (see Hausman, Hall and Griliches (1984), as well as Wooldridge (1991), and Papke (1991) and Becker and Henderson (2000) for applications).

We will present ordinary Poisson and fixed effect Poisson results with standard errors robust to the Poisson assumption, where the coefficients are computationally identical to respectively ordinary conditional logit and ordinary conditional logit with location dummies. The approach is flexible, with the logit-Poisson equivalence holding with time dummies, and industry groupings (e.g. manufacturing, service and retail HQ's). Note that conceptually we are using either a discrete choice or discrete count model, rather than a continuous, or share specification (Berry (1994)) because of the nature of the dependent variable. Over half of our period-location observations will involve 5 births or less.

In estimation of the parameters of (13), births in time t are new HQ's that appear between t and $t+1$, where periods are spaced five years apart. A birth is a HQ in a location that is present in $t+1$ but was not present in t. Births that occur after t but die below $t+1$ are not observed. π_{kt} is a function of base period, t, location characteristics. So we are looking at the location decisions of waves of HQ births. Identification is based (see next) on how the spatial patterns of births change in response to changes in local economic conditions. As formulated, firms base birth-location decisions in time t on the county characteristics in time t, which, strictly interpreted, implies naive expectations in a dynamic model. We will comment more on this below.

Endogenous Covariates. In the ordinary and fixed effect Poisson we treat county characteristics such as prices and numbers of local business service providers as strictly exogenous. However local industry scale measured by the number of headquarters in the base period cannot be strictly exogenous. Contemporaneous errors which lead to greater births in t thus directly affect own industry scale in t which may be a covariate in $t+1$ births. Thus it is desirable to instrument for own industry scale. In addition treating own industry wages as exogenous is suspect. Similarly, aggregate county shocks affecting headquarter births may reflect phenomena affecting all economic activity throughout the county.

Given expected births, λ_{kt}, actual births, β_{kt} could be described by

$$\beta_{kt} - \lambda_{kt} = u_{kt}, \qquad \lambda_{kt} = \exp\left(\pi_{kt} + f_k\right) \tag{16}$$

where u_{kt} is a contemporaneous error term. Covariates are predetermined and orthogonal to u_{ks}, $s \geq t$. To estimate the model with instrumental variables, we follow Chamberlain (1992) and Wooldridge (1997) (see also Windmeijer (2002) and Blundell, Griffith and Windmeijer (2000)); and we use a quasi-differenced transformation to eliminate the fixed effect, where

$$s_{kt} = \beta_{kt} \exp\left(\pi_{kt-1} - \pi_{kt}\right) - \beta_{kt-1} \tag{17}$$

Then the moment condition[8]

$$E\left[s_{kt} \middle| z_k^{t-1}\right] = 0 \tag{18}$$

is utilized in estimation. Thus this is a distribution-free version of the Poisson count model. $z_k^{t-1} = (z_{kt-1}, z_{kt-2}, ...)$ are predetermined variables defined below. We stop at two periods of predetermined variables in all period (differenced) equations, except for the first period equation where we have only one period of predetermined variables. Estimation is by GMM (Hanson (1982), Windmeijer (2002)), with an efficient weight matrix computed from first-step parameter estimates.

In instrumenting we will use generally past levels of covariates as instruments for current changes (in the $(\pi_{kt-1} - \pi_{kt})$ expression in (17)). The issue for the own scale variable, HQ, in particular is why past levels are strong instruments. If all HQ's were perfectly mobile, then we would rely on mean reversion arguments. A high ε_{kt-1} would result in high HQ_{kt}. Then in t an expected lower ε_{kt} would result in a lower HQ_{kt+1}; then $HQ_{kt+1} - HQ_{kt} < 0$ and is negatively correlated with HQ_{kt}. But in estimating a birth model, we are clearly not assuming perfect mobility.

At the other extreme, we could assume compete immobility upon birth. Some degree of immobility is dictated by physical HQ relocation costs, and by social relocation costs (costs of rebuilding a social network). But for purposes of illustration, assume complete immobility. Second, assume more realistically that there is an "exogenous" death process where idiosyncratic firm level shocks that are not location specific put, on average, δ fraction of HQ's out of business each period. As noted earlier this is motivated by the empirical work of Davis, Haltiwanger and Schuh

[8]Note $s_{kt} = \lambda_{kt-1}\left(u_{kt} - u_{kt-1}\right)$.

(1992). These two assumptions imply a stock adjustment, or linear feedback, model $HQ_{kt+1} = HQ_{kt}(1-\delta) + B(HQ_{kt,}X_{kt,}\varepsilon_{kt})$, where X_{kt} are covariates influencing profits of births. Lets say the $B(.)$ function has a form $\gamma_o HQ_{kt} + \gamma_1 X_{kt} + \varepsilon_{kt}$. Then invoking the model for periods $t+1$ and t, and differencing we have $HQ_{kt+1} - HQ_{kt} = -\delta(1-\delta+\gamma_o)HQ_{kt-1} - \delta\gamma_1 X_{kt-1} + \gamma_o HQ_{kt} + \gamma_1 X_{kt} + \varepsilon_{kt} - \delta\varepsilon_{kt-1}$.[9] In practice HQ_{kt} and elements of X_{kt} are not exogenous to ε_{kt-1}. But we can see that $HQ_{kt+1} - HQ_{kt}$ is negatively correlated with both HQ_{kt-1} and X_{kt-1}, where in our data $\delta \approx 0.5$.

We do not impose nor estimate a linear feedback model for two reasons. First is leakage, a high proportion of "switches," or auxiliary units of firms that change status from non-HQ to HQ or vice versa, which we don't count as births. Second, we expect some dependence of δ on local economic conditions. However as long as there is a reasonable degree of immobility, with δ largely dependent on firm idiosyncratic shocks, that are not location specific, then past levels of covariates will be strong instruments for current changes.

In terms of specific details for variables such as $HQ_{t+1} - HQ_t$ or $X_{t+1} - X_t$, we experimented with instruments from t and $t-1$, as well as a more conservative approach with instruments from $t-1$ and $t-2$. For all covariates except own industry wage (the α_1/α coefficient in (13)), using the two approaches, results are almost identical. First stage regressions of covariates (in changes) on level instruments all produce F's well in excess of 10, and specification tests are strong. But under the more conservative approach, the own wage coefficient is much larger (in absolute terms). The concern with downward bias in the more aggressive approach is the following. Consider 92-97 births. A positive local own (HQ) sector shock in 1991 would not have time to substantially affect 87-92 births and stocks, but could strongly affect 1992 wages as local HQ's respond to the positive shock in the short-run by trying to hire more in the local labor market specific to HQ workers. For covariates other than own industry ones we instrument with t and $t-1$ covariates but for own industry ones (own wages and HQ stock) we use $t-1$ and $t-2$ covariates.[10] For own industry wages only, these lagged covariates are weak instruments; and we add lagged values for crime, federal employment, and local government expenditures, which helps considerably. Government expenditures provide positive amenities, and crime negative amenities. Workers must be compensated for increases in local crime if they are expected to continue to work in the county. Local changes in federal employment are both politically motivated as well as decisions that are made in Washington, and the local crowding effect of these external shocks linger through labor market adjustment.

[9] Note existence of long run stationary equilibrium where $HQ_{kt+1} = HQ_{kt}$ requires $\delta > \gamma_o$.

[10] One issue with this approach is for the earliest equation year, no HQ stock variable is available for an instrument. The F-statistic for first stage regressions is nonetheless still above 10 using the remaining other instruments, indicating as a practical matter that instrumenting is sufficiently strong even in the earliest equation year.

4 Empirical Implementation

In estimating eq. (13), we will distinguish separately births in three headquarter sectors – manufacturing, retail, and services. These represent traditional larger (manufacturing) and smaller (retail) size headquarters along with a rapidly growing sector (services). Coefficients are constrained to be the same across groups, with separate either time or sector-time dummy variables controlling for differential overall national sector growth. Identification comes from overtime variation in births within counties for each sector.

In addition to distinguishing three output/birth sectors, on the input side we potentially have ten sectors. Two are financial services – security and commodity brokers (6200) and holding offices (6700); and eight are business services – advertising (7310), employment agencies (7361), computer and data processing (7370), legal (8100), engineering and architectural (8710), accounting (8720), research and testing (8730) and management and public relations (8740).[11] To make the problem manageable, we make several assumptions focused around the construction of the I index in eq. (9).

Service Index. A major focus of the paper is to sort out the importance of diversity of business service inputs, which in part comes down to estimating ρ's for different inputs. In our primary results, we will assume after some experimentation, that service inputs may be grouped into two categories, business and financial services each with their own ρ's, each of which is assumed to be the same for all individual industries within the category. In looking across the three headquarter sectors we assume the labor share coefficient α_1 and the sum of input share coefficients , α_T, where

$$\alpha_T \equiv \sum_{j=2}^{11} \alpha_j$$

are the same, which means $\alpha = 1 - \alpha_1 - \alpha_T$ is the same over time and sectors. However we will allow the ratio $\frac{\alpha_j^d}{\alpha_T}$ to differ by sector, d, manufacturing, retail and business headquarters, and by year. The distinction allows for greater relative use of advertising in, say, the retail versus manufacturing sectors, and that relative use to change over time. We also experimented with allowing $\frac{\alpha_1}{\alpha}$ to vary for $\frac{\alpha_T}{\alpha}$ fixed, so α_T can grow as α_1 declines, but found no evidence of consistent movements in α_T.

For each output/birth sector in each year for each service input we calculate $\frac{\alpha_j^d}{\alpha_T}$ from input-output tables for the relevant input year. So for manufacturing in 1987, for advertising $\frac{\alpha_{jt}^d}{\alpha_T}$ equals expenditures by all manufacturers on advertising divided by expenditures by all manufacturers on all 10 service inputs. Then the I index in the

[11] Industry codings change over time. So 8710 is 8910 in earlier years and 8720 is 8930. SIC 8730 is 7391 plus 8922 plus 7397 through 1987 and then 8731 plus 8733 plus 8734 beyond 1987. SIC 8740 is 7392 through 1987 and then 8741 plus 8742 plus 8743 plus 8748 plus 8732 beyond.

profit function for business service inputs (IB) for sector d headquarters in location k in time t is

$$-\frac{1}{\alpha}\ln IB_{kt}^{d} = -\left(\frac{\alpha_T}{\alpha}\right)\sum_{j\epsilon B}\frac{\alpha_{jt}^{d}}{\alpha_T}\ln w_{jkt} + \left(\frac{\alpha_T}{\alpha}\ \frac{(1-\rho_B)}{\rho_B}\right)\sum_{j\epsilon B}\frac{\alpha_{jt}^{d}}{\alpha_T}\ln n_{jkt} \qquad (19)$$

The coefficients to be estimated are in parentheses. A similar index IF is calculated for financial service inputs, where ρ_F differs from ρ_B. In estimation (a) the wage index coefficient $\frac{\alpha_T}{\alpha}$ in (19) should be the same for financial and business services (b) the own industry wage coefficient $(\frac{\alpha_1}{\alpha})$ in equation (13) and the index wage coefficient in (19) $(\frac{\alpha_1}{\alpha_T})$ allow us to identify α_1 and α_T, and (c) the ratios of the n index coefficients to the wage index coefficients identify $\frac{(1-\rho_B)}{\rho_B}$ and $\frac{(1-\rho_F)}{\rho_F}$.

In estimation, we need observations on the ln w_{jkt} and ln n_{jkt} variables for all 10 input industries.[12] Wages, w_{jkt}, are median annual wages paid by establishments in county k in industry j in time t (from the SSEL files of the Census for all private establishments in the USA), where establishment wages are average wages per employee. The median is used to deal with the problem of outliers (small establishments with either incredibly high (e.g. $300,000+) or incredibly low wages (e.g. $500)) in counties with low n_{jkt}. Counts, n_{jkt}, are from County Business Patterns.[13]

Scale. Local scale of HQ's inducing for example information spillovers, is measured by a count of HQ's in the own county in the base period, as opposed to total HQ employment based on empirical evidence below. For each HQ sector, based upon experimentation, the scale variable is total HQ's, including the own and other two sectors. We also allow for urbanization economies as represented by local county or $PMSA$ employment and experiment with a variety of scale formulations.

Wages. Wages are average HQ wages in a county in a sector (manufacturing, services, retail) in the base period. That is they are average wages in existing HQ's prior to these births. Such a measure does not capture the diversity of types of HQ employees and their relative costs, but it is the only measure widely available. We also experiment with and get almost identical results using the median of the within HQ wage average for a county.

Headquarters' Price and Other Unobserved Prices. What internal price the HQ receives for its "output" is not observed. We hypothesize that the value of HQ

[12]The analysis is restricted to urban counties, since beyond urban counties most counties have missing observations on w_{jkt} or n_{jkt} for some j. Even with urban counties we must restrict the sample to birth counties in a year where all 10 w_{jkt} and all 10 n_{jkt} have non-zero values. That loses about 6% of urban county-year-sector observations.

[13]Why don't we use the SSEL for counts? The SSEL contains many irrelevant establishments that are flagged (e.g. historical establishments out of business in the year of observation). Even after eliminating flagged observation, SSEL counts don't match CBP, who further clean the data to retain only active establishments.

output to a firm increases with the size of the local or regional market and declines with distance from the associated plants of the firm, also unobserved and captured in the underlying matching error term between a location and facility. To capture market size effects, we experimented with a measure of "market potential" of the county the HQ chooses and also the size of the local metro area. Market potential in t is the sum across all counties of all private employment by county discounted by distances between the centroid of the receiving county and the other counties. This sum in each year is then normalized by the average sum for the year (so USA growth in employment over years is neutralized). Market potential (MP) had no consistent effect on results. A variable we haven't discussed is office rent, which varies across and within metro areas. We don't have office rent data by county. In estimation we experiment with some proxies, where, controlling for county employment (which reflects urbanization economies, market size effects on value of headquarter activities to a firm, and congestion), rents might be expected to rise with regional ($CMSA$) or metro ($PMSA$) overall size, negatively affecting profits.

5 Results

In presenting results, we start with our base set of results and then we turn to a detailed discussion of both scale effects and the geographic unit of analysis. The overall results are in Tables 6 and 7, where ordinary Poisson, county-sector fixed effect Poisson, and instrumental variable GMM results on the non-linear model are presented. Our focus will be on the GMM results, in Table 7.

Ordinary Poisson results in Table 6 are, predictably, unsatisfactory, with positive or weakly significant cost or wage index[14] coefficients, indicating high cost areas are ones with other unobserved good attributes. Fixed effect Poisson results start to take care of this problem by controlling for these attributes, giving significant own wage, and n index and w index coefficients of expected sign. However, under fixed effects, strict exogeneity of the covariates will be violated for the stock of headquarters variable. Own sector scale effects are of the wrong sign. In column (4) of Table 6 they are negative (mean reversion), and in column (5) insignificant, in strong contrast to GMM results in Table 7. Table 7 contains our key results and we now turn to them.

Service Diversity Effects.

We first look at the service input variables in column (1). From equation (19), the ratio of the n index to w index coefficients for business services equals $\frac{(1-\rho_B)}{\rho_B}$. In Table 7, column (1), this implies a ρ_B of .49. Standard errors for this non-linear

[14]Recall that the business services wage index is constructed with wages in the service industries, so the wage paid to the lawyer is a cost to the HQ.

transformation of the coefficients are given in Table 8, which shows the estimate is statistically significant. This ρ_B indicates a fairly low degree of substitutability among business service providers and a strong role for diversity. In terms of scale effects if the number of all business service providers increases 10%, the expected number of births (and profits) would rise by about 3.6%. That is a very large scale effect. Note we have scaled the coefficient by .75 to reflect that business service inputs (α_B) are only a fraction of total service inputs (α_T)[15]. If business service costs rise 10% as reflected in the wage index, the expected number of births declines 3.5%.

For financial services the implied ρ_F =.51, similar to that for business services. Under GMM the financial services variables themselves are either insignificant or weakly significant in Table 7. However, the ratio defining ρ_F yields a ρ_F that is significant in Table 8. But financial services is potentially troublesome because we do not have very precise measures of the components of financial services where local diversity is important. For example, we dropped banking because we couldn't break out components relevant to businesses.

Own Sector Scale Effects.

Turning to own industry, or headquarter external scale economies, in Table 7 column (1), the scale elasticity is high, .17, and significant (Table 8). To get the elasticity (ε) of .17, we scale the coefficient (ε/α) by α=.56.[16] Similar estimates for manufacturing production activities in the literature yield smaller estimates of, say, .03-.12. Column (2) suggests a non-linear form, where the scale variable is the inverse of the number of HQ's in the county. The elasticity starts high, at 3.5 for one headquarter and is ever declining with larger HQ scale. At the mean number of 60 headquarters, the elasticity is .058, and for example at 133 HQ the elasticity is .026, and from Table 8 the estimates are significant. Having a few other headquarters nearby to learn from is extremely beneficial, but as the number escalates those marginal benefits decline. This declining elasticity may explain the lack of very high concentrations of HQ's in the largest cities. Column (3) shows an alternative declining elasticity specification using a quadratic term. Here the elasticity starts at .55 for one headquarter and also then declines. At the mean number of headquarters the elasticity is .086, and the elasticity peters out to zero at 133 HQ in a county. However 11% of the counties in the sample have HQ scale larger than 133. Also, in Table 8, the precision of estimates declines sharply as scale increases for this specification in which the elasticity declines to zero.

While own sector external scale effects are very large, the evidence that they decline sharply suggests that these scale effects alone cannot explain why some larger cities

[15] The rise is $\frac{(1-\rho_B)}{\rho_B}\frac{\alpha_B}{\alpha}$ where α_B is the sum of business service input coefficients. If $\frac{\alpha_T}{\alpha}$ = .45 from the business w coefficient, we assign $\frac{\alpha_B}{\alpha} \approx$ .35, as business services comprise the majority of industries in α_T.

[16] From equations (13) and (19), the sum of the coefficients for HQ wage and business service wage cost is $\frac{\alpha_1+\alpha_T}{\alpha} = .78$. This, with $\alpha = 1 - \alpha_1 - \alpha_T$ from equation (7), gives $\alpha = .56$.

have high concentrations of headquarters. If marginal scale effects are minimal beyond, say, 130 headquarters, so there is little extra benefit from being in a county with 500 versus 130 headquarters, then having a significant number of counties with more than 130 HQ's suggests other forces are at work. These of course are the scale diversity benefits in large cities with large business service sectors. While some larger cities have a reasonable degree of specialization in HQ activity, they also have corresponding diverse business service sectors. But for enormous and expensive metro areas like New York which have absolutely but not relatively a large number of HQ's, the HQ's are there in large part to buy business and financial services.

Wage Effects.

From column (1) from the coefficient on HQ wages, the HQ labor share is .18, lower than we would expect, because combined with a share in business and financial services of .26, this implies a high degree of internal HQ decreasing returns to scale. However the ratio of the two coefficients is plausible. We have some service outsourcing expenditure information in the data we can use as a reference point. Specifically, for those HQ who out-source, the expenditures in accounting, legal and advertising in 1997 are about .65 of the wage bill. This represents three of our ten service categories. For all ten, from our coefficient estimates we expect a ratio of 1.44 (=.26/.18).

In terms of basic diagnostics, for the regressions of Table 7, errors exhibit first order serial correlation as expected by construction, but second degree serial correlation is always decisively rejected indicating a clean formulation of the error structure. Sargan specification tests pass resoundingly, indicating both instrumenting and model formulation are appropriate.

Other Scale Effects.

In Table 9, we consider other aspects of scale effects, including overall county and city size effects, as well as the extent to which agglomeration forces attenuate. In column (1) of Table 9, we first show why we use the number of HQ's as our own industry scale measure. The addition of a control for the ln (average HQ employment) has a coefficient of essentially zero. So if we decompose total HQ employment into the number of HQ's times average HQ employment, only the former matters. This does not offer direct evidence on labor pooling effects, however it would seem that if the own industry mechanism driving agglomeration were labor pooling, that variation in the scale of labor controlling for HQ establishment scale should make a difference. With only the number of headquarters mattering, it would seem that information spillovers among headquarters (where each HQ is an information source) is a more likely underlying force for scale economies

Turning to the rest of Table 9, in formulating scale effects as in Table 7, we should control for overall county, PMSA, and/or regional size, to represent positive items such as a bigger local labor market and a bigger regional "output" market and negative items such as land rents and congestion. We experimented with measures such as overall county employment, county market potential, PMSA population, and CMSA population. These variables are generally insignificant. In Table 9 column (2) for example, own county overall employment size has a positive coefficient that is weakly significant. Adding in overall $PMSA$ size in column (3) is insignificant (sometimes it was negative), and makes the coefficient on county employment weaker (experiments indicated it is generally insignificant).[17] Market potential (the sum of employment discounted by distance away) is positive and insignificant. In general we exclude these controls, and doing so has virtually no impact on other results, as we can see.

Geographic Scope.

We have estimated the model with the unit of observation being a county, rather than a metro area, or PMSA. We now explain that choice. First we explored the extent to which either nearby HQ scale effects or nearby services scale contributed additional agglomeration effects. Beginning with a runoff with both county and PMSA measures included together, we found the county measures remained significant and the PMSA were not. We then tried a measure for HQ scale in the rest of the PMSA beyond the own county, which had a coefficient of .14 that was insignificant. Introducing similar measures for service scale in the rest of the PMSA, these measures were insignificant for both business (coefficient was .0278) and financial (.117) services, and the coefficient for HQ in the rest of the PMSA became negative and remained insignificant. Agglomeration forces appear to be quite localized, with the strongest effects coming from the own county. Use of the county as the unit of observation appears a reasonable approximation of local geography in this context. If we do estimate the model at the PMSA level results are quite similar, in part because many PMSA's are dominated by one county (the PMSA sample size is only 24% smaller than the county one). For PMSA results the main issues are the HQ wage cost coefficient is insignificant, and the Sargan test is only weakly significant.

6 Conclusions and Policy Issues

We investigate the agglomeration of headquarters, and find strong positive effects both for the diversity of local service inputs and for the scale of other HQ nearby. Results show that a 10% increase in the number of local intermediate business service providers increases the expected HQ births in a county by 3.6%. An elasticity of substitution among business service providers at around 2 (a technological need for variety in HQ production of one half) indicates a low degree of substitutability and a strong role for

[17] We experimented with multi-county interactions with the overall scale variables. We did find some evidence of congestion effects, particularly for large CMSA, however these results were not very satisfactory, suggesting use of better measures of congestion might offer more promise. We tried a measure of commercial rent from publications of the Society of Office and Industrial Realtors with no success. However sample sizes were limited and only later years covered.

diversity. The same statement applies to financial services. We also find, as one of the first estimates for a service industry, a HQ own industry scale elasticity of .17 which is substantially higher than estimates in the 0-.12 range that previous studies have found for industries in the manufacturing sector. Using a non-linear form, we also find these effects initially very strong and subsequently tailing off. Experiments using overall urban scale effects produced weak results. We conclude that both HQ localization economies and business service input diversity matter, producing strong forces for HQ agglomeration, but the very large HQ count in a city like New York is explained more by the incredible concentration of business and financial services there.

The existence and magnitude of local scale externalities has implications for local public policy. Achieving efficient size agglomerations in an urban system requires subsidies from land rents or property taxes to internalize scale externalities as shown in the paper using a systems of cities model of headquarter agglomeration. The magnitude of externalities will determine the extent of subsidies. In equation (11), the optimal subsidy to HQ's, the external benefit of an additional HQ, is the spillover elasticity times the value of HQ output, or .17 for the constant elasticity case. Of course with a declining elasticity, desired subsidies peter out fairly quickly for additional HQ's. In addition, monopolistic service competitors should be paid their fixed cost. In this case, treating all services as one industry ($\alpha_2 = \alpha_T$ in equation (11)), given the same ρ ($\approx \frac{1}{2}$), the subsidies would be 26% of total headquarter output. In general, headquarter output would be expanded to include all the purchasers of such inputs in the county. Given these estimates and concepts, there becomes a clear rationale and motivation as to why localities so heavily subsidize certain local business sectors.

7 References

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8 Tables and Graphs

Table 1. Auxiliary Establishments in 1997

	Number	Percent
central administrative units (HQ's)	33962	73
warehousing and trucking	5770	12
legal, accounting, advertising, personnel	1897	4.1
research and development	1039	2.2
security, janitor, repair	816	1.8
other	3112	6.7
total	46596	100%

Source: Census of Central Administrative Office and Auxiliary Establishments.

Table 2. Central Administrative Units: Sizes and Counts by Industry, 1977 versus 1997

	1977 *HQ* Count	Average Employ.	1997 *HQ* Count	Percent	Average Employ.	77-97 Growth in *HQ* Count
Agriculture, Mining, Construction	1082	67	1063	3.1	82	-1.8%
Manufacturing	6192	124	7139	21	136	15%
Transport, Utilities	n.a.	n.a.	1243	3.7	77	n.a.
Retail, Wholesale	12424	47	14901	44	54	20%
Business Services	742	29	2007	5.9	58	170%
FIRE, Communications, Motion Pictures	n.a.	n.a.	1649	4.9	51	n.a.
Rest	1532	25	5960	18	52	n.a.
Total	21972		33962	100%	73	n.a.

Source: Census of Central Administrative Office and Auxiliary Establishments.

Table 3. Entry and Exit of HQ's

	Entry Rate	Exit Rate
77-82	.55	.48
82-87	.64	.53
87-92	.57	.52
92-97	.62	.53

Covers construction and mining (SIC 1), manufacturing (SIC 2 and 3), retailing and wholesaling (SIC 5), and services (SIC 7 and 8, except for 80, 82, and 86). Entry is appearance of a new HQ in a county, based on new company-plant identifier (excludes within county movers and auxiliaries which change from non-HQ to HQ status). Source: Census of Central Administrative Office and Auxiliary Establishments.

Table 4. National Share of Counties by Group in 1997

	Top 10	Ranked 11-75	Rest Urban	Rural
national private employment share	.153	.290	.394	.163
national HQ employment share	.211	.392	.343	.054
relative to total emp. share	1.379	1.352	.871	.331
national services emp. share	.219	.375	.335	.071
relative to total emp. share	1.431	1.293	.850	.436
national manufacturing emp. share	.133	.207	.402	.257
relative to total emp. share	.869	.714	1.020	1.577

U.S. counties are ranked by employment and aggregated into the four groups. The group share of the national sector total is followed by the sector share relative to the total employment share. Sources: County Business Patterns and Census of Central Administrative Office and Auxiliary Establishments.

Table 5. Importance of Out-Sourcing to HQ in 1997

a) Percent of HQ Units that Out-Source

	Propensity
Accounting	58%
Legal	64%
Advertising	54%

b) Out-Sourcing Expenditures as a Fraction of HQ Wage Bill For Out-Sourcers

	Expenditures
Accounting	13.4%
Legal	15.2%
Advertising	36.6%

Source: Census of Central Administrative Office and Auxiliary Establishments.

Table 6. Ordinary and Fixed Effect Poisson Results
(Births from t to $t+1$)

	Ordinary Poisson			Fixed Effects Poisson		
	(1)	(2)	(3)	(4)	(5)	(6)
ln(HQ wage in t)	.0329	.00756	.0212	-.120**	-.112**	-.106**
	(.0396)	(.0418)	(.0420)	(.0243)	(.0241)	(.0241)
wage index (t)	-.195*	-.218*	-.147	-.426**	-.426**	-.436**
business services	(.117)	(.129)	(.123)	(.0582)	(.0582)	(.0583)
diversity index (t)	.377**	.852**	.651**	.695**	.657**	.470**
business services	(.0572)	(.0341)	(.0637)	(.0323)	(.0305)	(.0359)
wage index (t)	.958**	1.50**	1.67**	-.340**	-.333**	-.313*
financial services	(.272)	(.304)	(.302)	(.160)	(.160)	(.160)
diversity index (t)	-.763**	.149	-.115	.551**	.460**	.00057
financial services	(.188)	(.218)	(.202)	(.118)	(.116)	(.124)
ln(number HQ in t)	.701**			-.0908**		
	(.0546)			(.0241)		
inverse(HQ in t)		-4.44**	-4.11**		.280	.702**
		(.540)	(.524)		(.262)	(.263)
ln(county employ.)			.260**			.561**
			(.0591)			(.0563)
time-industry dummies	yes	yes	yes			
time dummies				yes	yes	yes
county-ind. fixed effects				yes	yes	yes
observations	4345	4345	4345	4140	4140	4140
counties	490	490	490	446	446	446
Pseudo R^2	.73	.71	.71			

Standard errors are in parenthesis. Two ** indicate significance at 95%, one * at 90%.

Table 7. GMM Overall Results (Births from t to $t+1$)

	GMM		
	(1)	(2)	(3)
ln(HQ wage in t)	-.326**	-.341**	-.329*
	(.161)	(.161)	(.174)
wage index (t)	-.447**	-.396**	-.531**
business services	(.155)	(.164)	(.164)
diversity index (t)	.461**	.470**	.519**
business services	(.084)	(.0907)	(.101)
wage index (t)	-.489	-.507	-.343
financial services	(.412)	(.410)	(.450)
diversity index (t)	.464*	.468**	.426*
financial services	(.258)	(.236)	(.252)
ln(number HQ in t)	.308**		.978**
	(.107)		(.392)
inverse(HQ in t)		-6.00**	
		(1.63)	
ln(HQ in t) squared			-.0999**
			(.0449)
time dummies	yes	yes	yes
observations	2812	2812	2812
counties	429	429	429
Sargan value	47.68	45.63	43.50
p-value	.364	.446	.578

Standard errors are in parenthesis. Two ** indicate significance at 95%, one * at 90%.

Table 8. Estimates of the Elasticity of HQ Scale and the Need for Service Input Diversity

	Estimate	Standard Error
need for business services diversity (ρ_B)	.492	.0732
need for financial services diversity (ρ_F)	.513	.182
elasticity of HQ scale (ε), linear form	.174	.0627
elasticity of HQ scale, declining form		
evaluated at $HQ = 1$	3.46	1.11
$HQ = 60$	.0576	.0184
$HQ = 133$	.0260	.00831
elasticity of HQ scale, quadratic form		
evaluated at $HQ = 1$	.526	.210
$HQ = 60$	.0858	.0622
$HQ = 133$	.000349	.0693

Standard errors are calculated with the delta method using the covariance matrix from the second stage of the Table 7 GMM regressions.

Table 9. GMM Other Scale Effects (Births from t to $t+1$)

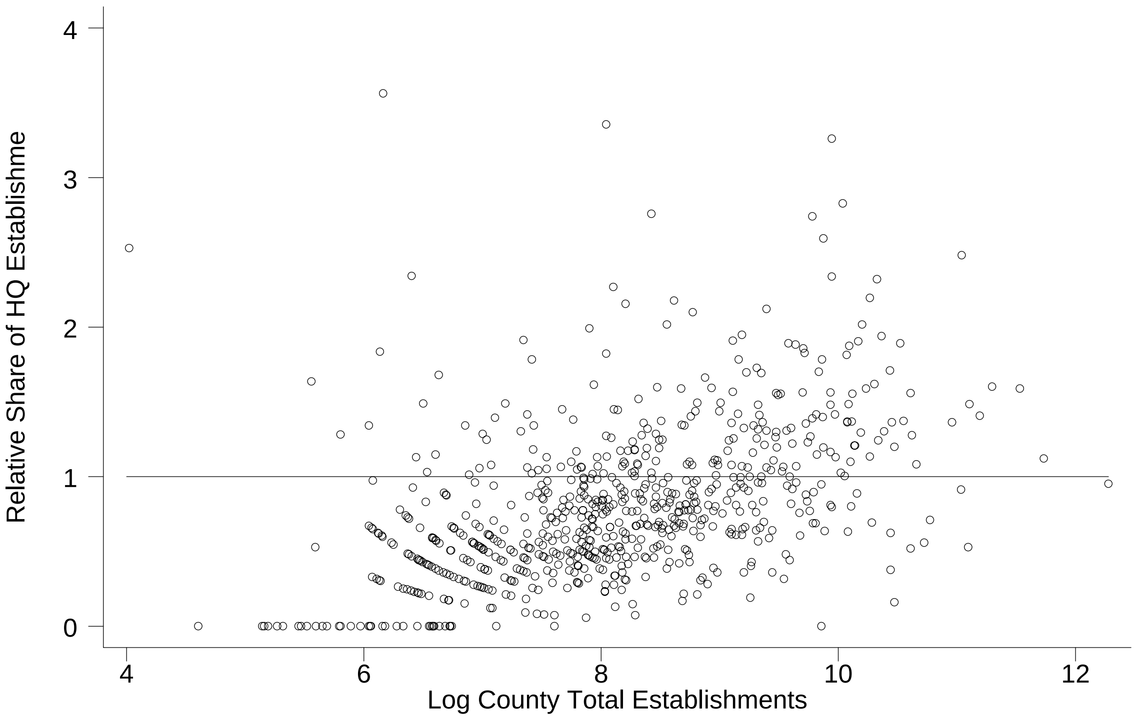
	(1)	(2)	(3)	(4)
ln(HQ wage in t)	-.309*	-.366**	-.374**	-.337**
	(.187)	(.125)	(.126)	(.160)
business wage index (t)	-.465**	-.486**	-.493**	-.418**
	(.159)	(.159)	(.160)	(.189)
business diversity index (t)	.466**	.518**	.521**	.492**
	(.0933)	(.0898)	(.0900)	(.0977)
finance wage index (t)	-.441	-.663*	-.654	-.558
	(.424)	(.399)	(.399)	(.419)
finance diversity index (t)	.450	.489*	.498*	.492**
	(.274)	(.260)	(.261)	(.248)
ln(number HQ in t)	.232**			
	(.113)			
inverse(HQ in t)		-5.55**	-5.51**	-6.05**
		(1.79)	(1.80)	(1.64)
ln(county employment)		.241*	.209	
		(.134)	(.152)	
ln(PMSA population)			.0987	
			(.231)	
ln(market potential)				.365
				(.673)
ln(average employment per HQ)	.0895			
	(.0973)			
time dummies	yes	yes	yes	yes
observations	2812	2812	2812	2812
counties	429	429	429	429
Sargan value	45.99	47.52	47.42	44.51
Sargan p-value	.390	.331	.297	.450

Standard errors are in parenthesis. Two ** indicate significance at 95%, one * at 90%.

Table 10. Summary Statistics

Variable	Mean	Standard Deviation
births	11.67	23.08
ln(HQ wage)	3.21	.403
business wage index	2.59	.297
business diversity index	3.29	1.10
finance wage index	.379	.105
finance diversity index	.444	.194
ln(number HQ)	2.09	1.28
$(\ln HQ)^2$	12.70	8.41
ln(HQ in rest of PMSA)	2.28	2.35
business diversity index in rest of PMSA	2.26	2.22
financial diversity index in rest of PMSA	.305	.329
ln(county employment)	11.54	.938
ln(PMSA population)	13.29	1.14
ln(average employment per HQ)	7.11	1.73

Figure 1: HQ Establishments Location Quotient for 1997 Counties



Observations include urban counties and are actually for all auxiliaries, which is public data. This graph looks very similar to one that includes only HQ. The HQ establishments relative share, or location quotient, is the ratio of the county's share in national HQ establishments to the county's share of total national establishments in all industries. Note that the curves in the lower left portion of the graph are due to the discrete nature of the establishment data. For example, one HQ establishment is a uniformly increasing share in total establishments in this way as the size of the county becomes smaller. Source: County Business Patterns.