Exploring the Form and Function of Employment Subcentres in London, England

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Summary

This works looks at the delineation of urban employment subcentres in London, England, and their sector based typologies. The location of these areas of high employment density are delineated using open source small area employment data and an algorithm based on an urban monocentric density decay. Broad comparisons of sector based business typologies in each area highlight how different employment hubs cater to varying businesses and local stakeholders.

KEYWORDS: Employment Subcentres; London; Open Data; Monocentric City; Business Registry

1. Introduction

Delineating the geography and spatial distribution of urban employment and workforce densities has an important role in better understanding the overall local economy, real estate and labour markets, transportation network and the broad links connecting these. When a municipality has multiple employment hubs, or subcentres, different patterns or spatial configurations can emerge ranging from spatially centralized, decentralized or polycentric, among others (Lucas and Rossi-Hansberg, 2002; Lee, 2007; Arribas-Bel and Sanz-Gracia, 2014; Manduca, 2020). Modelling these employment subcentres and variation across them in terms of business and amenity offerings can provide insights on local economic contexts.

This work explores a sector based breakdown of London's core urban employment centres and satellite subcentres. Subcentres are identified according to a minimum density based methodology (Giuliano and Small, 1991; Ban et al., 2017), where a monocentric decay model of urban employment density is assumed and parameterized. Local employment subcentres are delineated based on contiguous tracts of small area geographies in the peripheral areas away from the central business district (CBD) with total employment and employment density exceeding that which would be expected from this model.

Employment areas are characterized according to the type of business sectors represented within using granular business location data, available in open source for more recent years compared to the Census 2011 employment. The sectoral composition of different subcentres in the city are tracked using business registry locations and broad industry typologies, making particular distinction between those periphery subcentres and the employment core making up London's well defined Central Activity Zone (CAZ) - a central employment region itself on an international scale.

2. Data and Study Region

2.1. Granular Employment and Business Data

The most recent openly available and geographically granular data on employment is from the UK

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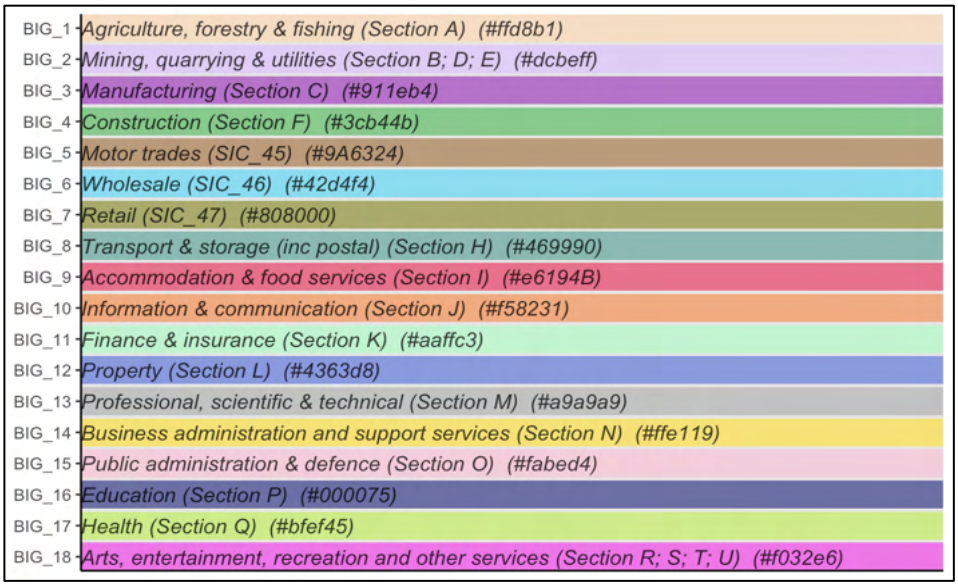
Census 2011. Detailed working day population is available for small area Workplace Zone (WZ) tracts allowing measures of total employment and density. While no choice of spatial unit to use for research and statistical purpose can be uniquely accurate, WZ boundaries provide the most granular detail in key employment areas. Other census geographic areas, such as Output Areas, are constructed with the aim of preserving consistent populations within each unit whereas WZ boundaries are built around consistent workers and better aligned with employment patterns (ONS, 2014).

To complement employment levels and better understand built and physical surroundings, we merge in yearly data on registered businesses from the Consumer Data Research Centre (CDRC) Business Census. While granular employment data is limited in terms of temporal frequency, more detailed and up to date open data is available for business registries which provides a broad SIC industry classification code[3] and post code location identifier. A series of data cleaning is done to retain active (non-dormant) companies with valid post code and SIC classification. Using the National Statistics Postal Lookup 2020 we obtain a proxy postcode latitude and longitude and respective WZ for each location. We use the first two-digits of the SIC code in the hierarchical scheme to get a distribution of broad industry grouping counts for different sectors (**Figure 1**).

Figure 1 Broad SIC Industry Group (BIG) Categorization



2.2. Study Region: London, England

The focus of this work is London, England, capital city with a workforce of around 6 million in 2019, an increase from 4.5 million in 2011 (ONS, 2020). The administrative boundaries of the city is spread over a total area of 1,573.5 km^2, divided across 8,154 WZ tracts. The map of WZ employment density deciles (**Figure 2**) reveal a clear central clustering pattern, however several peripheral employment hotspots are visible.

From an aerial perspective, London follows clear patterns of monocentricity centered around the city's geographic and historic centre. The assumed model for employment subcentre identification is built on the concept of exponential decay in employment density from some CBD, and it is thus important to verify these urban patterns beforehand. Similar patterns of registered business density deciles exist with marginal changes from 2013 to 2019, highlighting the importance and stability of the city centre.

The definition of the main CBD, from which distances are calculated, is important for the identification of employment subcentres. While there is much discussion on defining unique CBD points in urban areas, we choose the WZ with the highest employment density. In London this corresponds to

[3] https://onsdigital.github.io/dp-classification-tools/standard-industrial-classification/ONS_SIC_hierarchy_view.html

Plantation Place, one of the largest office developments. While choosing the densest employment tract may not necessarily correspond to a city's central location, in the case of London the CBD is centrally well placed, located in the main CAZ and almost directly halfway between Charing Cross - the conventional "Centre of London", and Canary Wharf - the well-known financial hub.

Figure 2 London Employment Density Deciles

(A) *(B)*

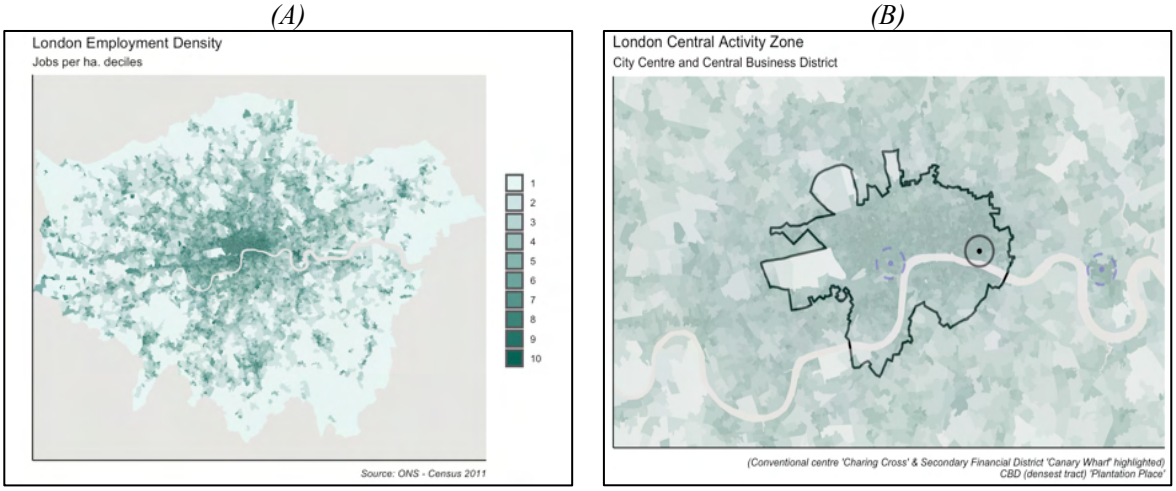


Table 1 shows the extent to which employment and (average small area) employment density fall as we move away from the CBD. Significant densities are found in the most central neighbourhoods corresponding to those inner CAZ areas responsible for a large portion of the workforce, output and economic activity of the city and country as a whole.

Table 1 London Spatial Employment and Density Patterns

Dist. to CBD	Employment	Percent Total	Density (per ha.)
100 meters	18,349	0.41	6,255.0
500 meters	120,379	2.67	2,423.8
1 kilometer	341,573	7.59	1,726.5
5 kilometers	1,717,616	38.17	852.0
10 kilometers	2,664,636	59.21	538.0

3. London Employment Subcentre Identification

The literature on employment subcentre identification is wide and employs a range of methodologies. The algorithm chosen here is based off a parametric urban economic model of monocentric exponential employment density decay from Giuliano and Small (1991) and Ban et al. (2017). The method uses estimated small area (WZ) values of total employment and density from the model as minimum thresholds against which observed employment levels are compared. Employment subcentres are those peripheral clusters of local tracts which have densities and totals exceeding this threshold.

The *method of exponentially decaying cut-off* (Ban et al., 2017) is undertaken in two parts: first by identifying candidate WZ tracts which have significant local employment density, and second in grouping contiguous candidate tracts and identifying subcentres via total employment. The general form of the model which defines employment density in a given urban space is given in Equation (1).

$$D_i = \overline{D} \cdot e^{-f(x)} \tag{1}$$

D_i: $employment\ density\ (jobs\ per\ hectare)\ for\ each\ WZ; \quad i = 1, \ldots, 8154$
x: $distance\ to\ the\ Central\ Business\ District\ (x = 0\ being\ the\ CBD)$
$\overline{D}$: $baseline\ CBD\ employment\ density$
$f(x)$: $functional\ form\ at\ which\ employment\ density\ decays\ from\ the\ CBD$

Candidate small area tracts are first individually identified if they have an observed employment density which exceeds $\widehat{D}_t$, which is the estimated threshold value from the above Equation (1) at the same given space (x). These individual candidate tracts which exceed this threshold are then grouped into $(s = 1, \dots, S)$ mutually exclusive clusters of candidate subcentres.

In the second stage total (aggregate) employment levels for the clustered candidate subcentres are calculated and again compared against an estimated total employment threshold from Equation (2).

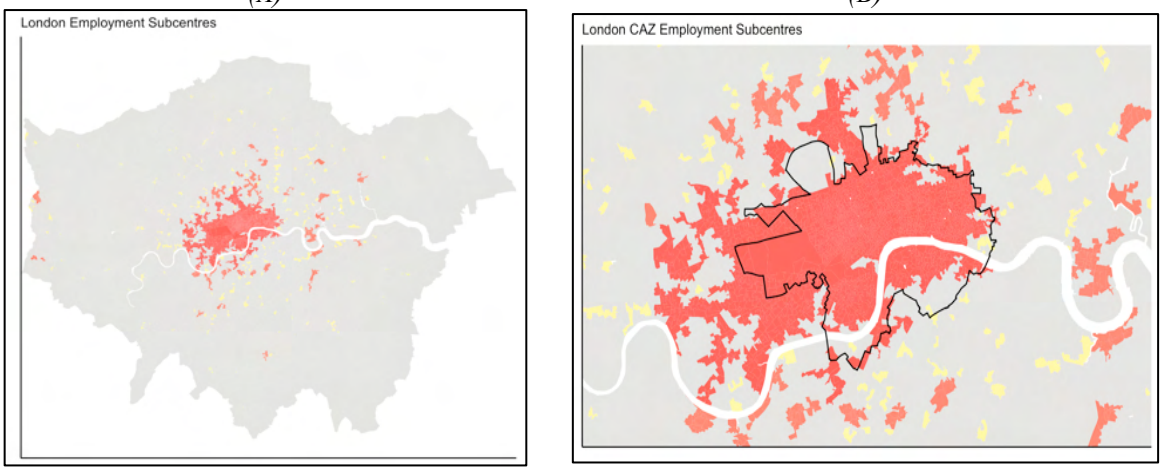
$$E_s = \bar{E} \cdot e^{-f(x)} \tag{2}$$

Similarly, $\bar{E}$ represents some a prior estimated or baseline total employment in the CBD. Candidate subcentres with total employment exceeding the estimated threshold expected from decayed CBD employment are promoted to full employment subcentres. These areas thus represent peripheral clusters of employment hotspots outside of the core city centre.

The model is fine-tuned for London by choosing the most appropriate functional form of $f(x)$ along with an accurate representation of the CBD total employment $(\bar{E})$ and employment density $(\bar{D})$. Estimated common employment decay gradients for $f(x)$ indicate a logistic functional form as best fit among linear and polynomial models. Baseline values of total employment and density are obtained for observed data values scaled to the CAZ. **Figure 3** shows a map of the delineated London employment centre and peripheral subcentres.

Figure 3 London Employment Density Deciles

(A) *(B)*



4. Decomposing London Subcentres By Industry Typologies

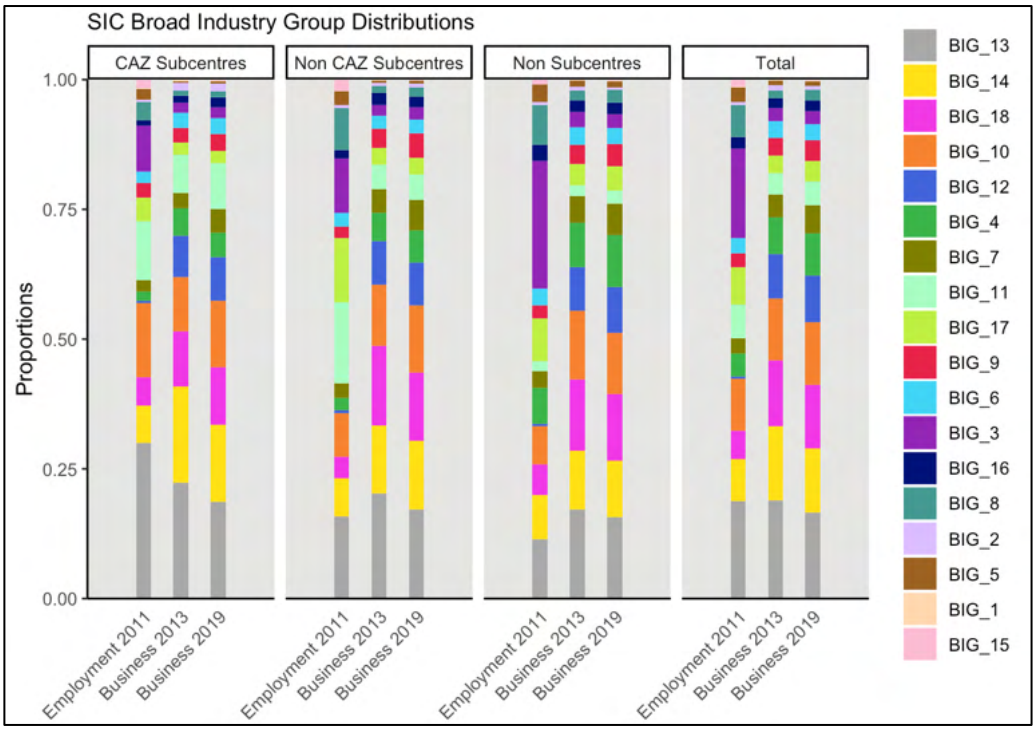
We decompose employment subcentres according to their (BIG) industry sectors of prominence, considering both (2011) employment and business composition between 2013 and 2019. In particular, we are interested in differences which exist between sectors (businesses) inside of employment subcentres, and in particular the core CAZ, and those which are not.

The most commonly identified sectors include Professional, Scientific and Technical (BIG 13); Business Admin and Support (BIG 14); Information and Communication (BIG 10); and Art, Entertainment and Recreation (BIG 18). On the whole, these businesses make up a large proportion of all those located within the city, however employment is concentrated towards the city centre (**Figure 4**). The Professional, Scientific and Technical sector is consistently the most prominent across employment hubs and city as a whole.

Finance and Insurance (BIG 11) is also represented, however with some particular patterns.

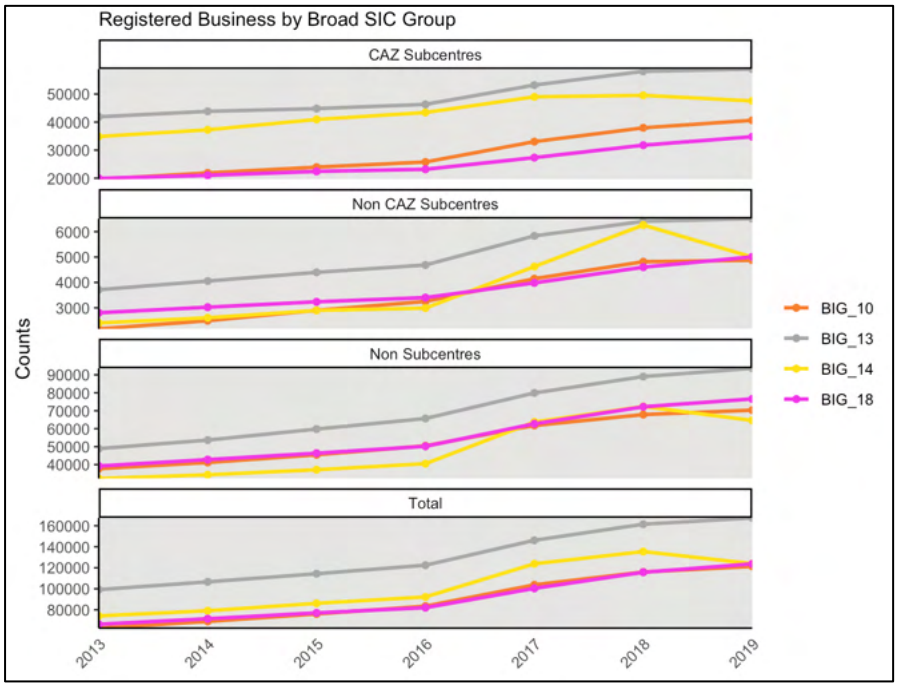
Employment in this sector is relatively larger than the number of businesses, and concentrated in employment hubs. Their location primarily in non-CAZ subcentres fits with the London employment geography with the traditional finance hub located outside of our working definition of the CAZ.

Figure 4 Subcentre Industry Decompositions



Looking at the growth in registered businesses in the past decade, particular spatial patterns can also be observed. Following 2016, we see particular growth in Business Admin and Support (BIG 14) firms in particular employment hub clusters outside of the CAZ and in the city periphery (**Figure 5**). Relatively, over this time in the main CAZ of London there were slightly larger growth in Information and Communication (BIG 10), and Art, Entertainment and Recreation (BIG 18) firms.

Figure 5 Yearly Growth of Top CBD Sectors



5. Conclusions

Employment subcentres, and their location, are inherently complex and linked to any number of urban dynamics from population densities, transportation links, urban or natural amenities. Using the distribution of registered businesses by industry sector located within subcentres can identify commonalities and differences between these key urban locations. As different sectors and industries of the economy can have varying workforces and geographic patterns, open source spatial and granular tools and data to explore these dynamics can be just one way to explore and highlight these dynamics for informed research-based decision making.

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