Entrepreneurship and economic development: the relative attraction of employment centres by firm size

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Abstract: Our research empirically explores the relative importance of firm size in fostering economic growth by using cross-sectional variation in the relative location of large and small firms in urban centres of employment. Our method compares the relative location of large and small firms between the older and established centres of employment with the newly emerging employment sub-centres. We conduct our cross-sectional examination of dynamic changes using data from 2010 for the Houston, Texas metropolitan area. We find that large firms are more likely than small to desire a central location not only in the CBD, but in the newly emerging sub-centres as well.

Keywords: firm size; polycentric cities; employment centres; sub-centres; firm location; employees; growth; economic development; entrepreneurship; sustainable development.

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1   Introduction

One of the outstanding research questions concerning economic development is the relative role played by entrepreneurship in large as opposed to small firms. On the one hand, many local and state governments have engaged in highly visible and expensive competitions for certain large industrial projects which certainly convey the idea that large firms are the engine of economic growth. Conversely, a high proportion of net new job creation is known to be coming from small firms. The research we conduct here attempts to illustrate the relative role of large and small firms in an urban growth context. Specifically, we use the recent research on urban employment centres[1] to develop a cross-sectional analysis of how firm size affects economic development. The research we report on in this paper addresses this question by asking whether large or small firms are more likely to be attracted to an agglomeration centre within a single city. Specifically, we report on whether firms of a specific size are differentially attracted to urban employment centres. A difficulty in our investigation is that to the extent a firm benefits from agglomeration, it may become large even if it started as a small firm. This possibility is consistent with new research that describes how the economies of cities operate (Glaeser and Kohlhase, 2004). We circumvent this difficulty by comparing new and emerging employment centres to older and established centres and assuming the pattern of urban development is similar throughout the urban growth process.

The polycentric urban context allows us to utilise cross sectional differences to make inferences about growth[2]. Specifically, we utilise firm-level data in 2010 for Houston, Texas. The advantage of Houston for this study is that land use is relatively unregulated, so the pattern of urban development is most likely to be consistent with our cross sectional view of urban growth dynamics. This is also consistent with the entrepreneurship resulting from Houston's status as one of the top US ports[3]. These data allow us to compare how entrepreneurship drives employment centre growth through variation in firm employment size.

Our cross sectional approach is possible because of the urban development path. The traditional urban model explains that the economic advantage to urban areas arises due to the agglomeration economies generated by the proximity of firms to each other such as is represented in the traditional downtown areas. A consequence of agglomeration however has been congestion. The economic response to congestion in large urban areas has been the formation of employment centres outside of the traditional downtowns that is employment sub-centres (Anas et al., 1998; Berliant and Wang, 2008). The idea behind sub-centres outside of the traditional downtown is that there are areas of agglomeration with significantly less congestion. Although urban theory is still somewhat incomplete, it

seems clear that as urban areas develop, the first ring of sub-centres will form. Only after further growth will a second ring of sub-centres form. Berliant and Wang (2008) for example make this speculation explicitly[4]. Empirically this speculation is likely to be correct because unlike the theoretical structure, the costs of moving employment sub-centres are likely to be prohibitively high. Thus further economic growth after the emergence of close-in sub-centres is likely to stimulate an additional set of sub-centres. Our research approach therefore will be to examine whether the newer or older sub-centres are more effective at attracting firms of a given size. While there is not yet existing theoretical work which characterises the growth of sub-centres, it seems natural to assume that employment concentrations closer to the central business district (CBD) are more likely to be older and more established than employment concentrations much farther from the CBD. This presents the opportunity to compare the close-in and CBD centres with employment sub-centres farther from the CBD.

We believe employment centres are an excellent way to determine the contribution of entrepreneurship to economic development through firm size. The economic advantage of cities is their agglomeration economies which occur not only at the CBD but within the market answer to the accompanying congestion which are the non-central employment sub-centres (Marshall, 1920; Duranton and Puga, 2004; Rosenthal and Strange, 2004; Berliant and Wang, 2008; Agarwal et al., 2012). Firms are attracted to employment concentrations because they desire to benefit from the externalities that are created which can occur in a wide variety of contexts. Clearly, proximity to either suppliers or demanders is an advantage but further opportunities may occur through more specialised labour matching or even in the transfer of technology. Firm size may affect the ability of firms to benefit from agglomeration, depending on whether small firms can benefit as well as large. A consequence however, may be that firm size also affects the ability of firms to generate externalities that make employment concentrations attractive. For example, if export activities are complex and involve significant fixed costs, or even if there are economies of scale in transportation it is possible large firms may be better at exporting products to the rest of the world. On the other hand if small firms are more specialised, they may be more attractive to the world's supply chain. It is also possible the heterogeneity from being organised in separate firms is more productive than workers in a single firm. In either case, it is possible that initial concentrations of either large or small firms will end up affecting the urban growth rate because of disparities in the relative burden of congestion externalities compared to the production of agglomeration externalities.

The approach we take is to examine whether firm size is a factor at determining the extent to which firms are attracted to employment centres. For example, if large firms are differentially attracted to employment centres, then we will infer they are differentially benefited by the positive externalities generated within the centre, net of congestion costs. Further, we will infer dynamics in this relationship by how firm size affects whether firms are more or less attracted to the new sub-centres located further from the city centre compared to the actual CBD and compared to the close-in sub-centres.

We estimate a probabilistic model to determine whether large or small firms are more likely to locate within, or near, an employment centre. This is informative because it would be expected that the export firms are most important to the economic success of a city and because export firms are most likely to be in an employment centre than randomly dispersed across the urban area. That is, in order to compete in worldwide markets export firms would need to exploit all of the available agglomeration economies.

Conversely, firms that primarily rely on local markets are more likely to be dispersed across the urban area rather than be located in or near employment concentrations. An important attribute of our logit examination is that we characterise the employment centres in Houston by their location relative to the CBD on the assumption that this is correlated with their age. That is, existing theory suggests that employment centres are a market-based reaction to the costs of congestion. Thus, when congestion costs are high relative to the generated agglomeration economies, employment sub-centres will emerge. The model in Berliant and Wang (2008) for example suggests that city size is correlated with the number of employment centres and with the distance of each sub-centre to the CBD as well[5]. And McMillen and Smith's (2003) empirical study of large US cities predicts that cities will form the first sub-centre (2nd employment centre) after population reaches about 2.7 million and the will add another employment sub-centre at about 6.7 million people.

We select employment centres using the locally weighted regression (LWR) technique in McMillen (2001) but supplemented by a measure of economic importance (Craig and Ng, 2001). Specifically, the areas selected by the McMillen technique are termed 'candidate sub-centres' but are only confirmed as being economically important if they are attractive to population[6].

The employment centres we examine in Houston are quite varied in their stage of development. We perform our economic analysis for each centre separately. For example, as in virtually all cities, the CBD is the oldest centre of employment in Houston. Other sub-centres have formed more recently and as we show below exert less influence on the surrounding urban areas. Thus, we use a logit specification to analyse the relative frequency of small firms in the newer sub-centres compared to the well-established areas. We also test the importance of firm size for explaining location close to the core of each centre (where close is defined as up to three miles from an employment centre).

2 Empirical specification

Our empirical work proceeds in three major steps. First we identify the employment centres in Houston using McMillan's LWR procedure. Second, we determine the 'market areas around each employment centre. And third, we estimate logit models describing the location choice of firms to be in or near any one of the seven employment centres. We limit the firms to be spatially located in our estimated market areas for each employment centre.

We operationalise the LWR procedure using census tract data for Harris County, the central county of the Houston metropolitan area. The variable we analyse is the natural log of employment density of each census tract (McMillen, 2001). The observations for each regression are those that fall within a given distance or bandwidth from the current tract of interest. Once the tracts that fall within the bandwidth are identified, they are weighted using a tri-cube kernel which is a negative function of distance from the tract of interest. Each LWR produces a predicted value of the natural log of employment density for each observation. Candidate employment centres are then defined as tracts or sets of contiguous tracts whose true value of employment density falls above the 95% confidence interval of its expected value.

Figure 1 Candidate employment centre in Harris country, Texas 2010 (see online version for colours)
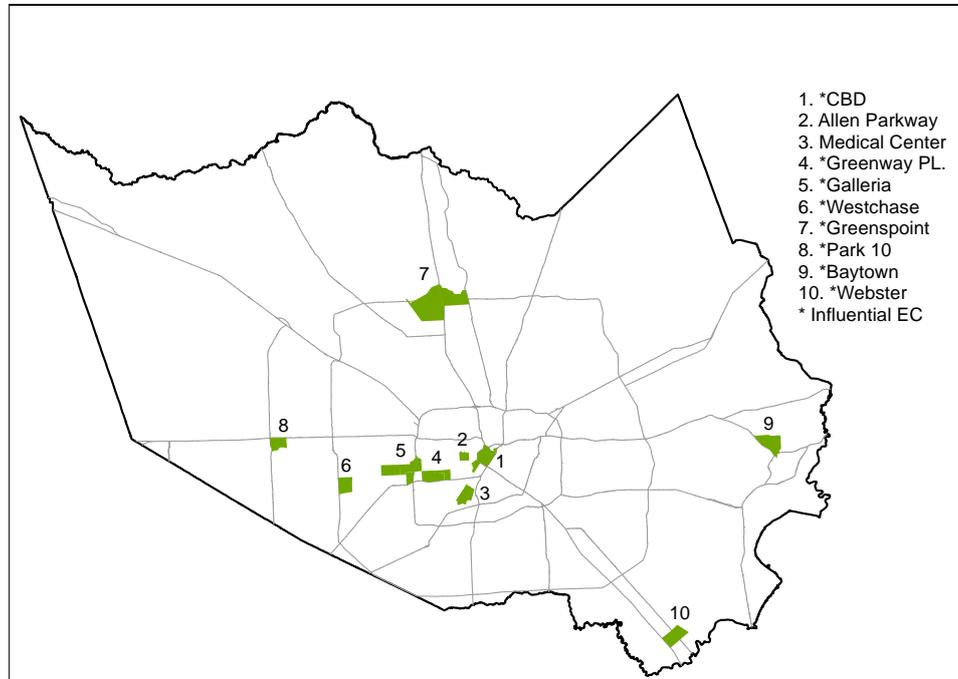
The McMillen methodology identifies ten candidate employment centres in the central county, Harris, of the Houston metropolitan area (see Figure 1). Employment centre candidates are not deemed employment centres however, unless they are found to significantly affect population density. We find seven areas (including the CBD) with significant population impacts and we focus on these seven employment centres to estimate whether there are differential impacts of firm employment size on the location choices of firms.

An important element of our approach is that the market areas of each employment centre need to be identified. We do so in this application using the census transportation planning package (CTPP) commuting data as suggested in Perdue (2012). In particular, we examine the number of employees in each census tract that commute to each employment centre. The edge of the market area is defined when the proportion of workers commuting to a specific area is no larger than the metropolitan-wide average. The only drawback to this methodology is that the 2010 commuting data is not yet available. Thus we estimate the market area using data from the year 2000 and apply that market area for the 2010 specifications. We find that the radii of most of the market areas are about 16 miles with the exception that the CBD's market area is all of Harris County with a maximum distance of about 34 miles (see Table 1).

Table 1   Characteristics of Houston Employment Centers 2010

Emp. centre	Distance to CBD (miles)	In employment centres			Share of tot. emp. in small firms[a]	< 3 miles of emp. centres		Within market area of emp. centres		
		Total firms	Total employees	Emp. In small firms		Total firms	Total employees	Total firms	Total employees	Radius of mkt area[b] (miles)
Near to CBD										
CBD	0.0	6,019	75,939	28,434	37%	12,896	149,378	150,256	1,613,430	All Harris cnty (max = 34.6)
Galleria/ Greenway	6.1	6,701	76,120	36,693	48%	17,048	177,112	96,592	1,049,324	15.4
Farther from CBD										
Westchase	12.9	452	8,355	3,213	38%	10,072	107,935	94,926	1,019,368	14.5
Greenspoint	13.4	2,172	25,985	13,164	51%	3,805	53,657	88,765	976,042	16.2
Park 10	18.8	199	10,597	1,146	11%	3,534	52,861	64,150	694,606	12.7
Webster	22.2	724	10,781	4,585	43%	3,012	37,761	28,765	333,446	19.6
Baytown	25.1	189	4,352	1,102	25%	1,844	20,542	26,602	308,170	19.5

Notes: [a] Small firms are defined as having 45 or fewer employees,
[b] Market area radius determined by commuting patterns

The third step in our empirical work is to estimate dichotomous location choice models. The specification we use to test whether large or small firms are attracted to employment centres is a probabilistic function showing the tendency of particular sized firms to locate in, or near, the urban employment centres. The methodology we use is first proposed in Craig and Kohlhase (2006) and Kohlhase and Ju (2007); the latter work studies specific two-digit standard industrial classification (SIC) industries. Specifically, we model the probability that a firm will be in an employment centre as opposed to being located elsewhere in the market area of an employment centre C_m by:

$$P\left(C_m = 1 \mid z\right) = \frac{\exp\left[f(z)\right]}{1 + \exp\left[f(z)\right]}, \quad m = 1, 2, \ldots 7 \tag{1}$$

where P(Cm) is an indicator variable equal to one when a firm is located within a particular employment centre Cm and zero if it is not; z is a vector of firm-specific variables including firm size as measured by the number of employees, industry and whether manufacturing is done on site. The firm-size variable is the key to the estimating equation as it indicates whether additional employees of a firm make the firm more likely to locate in a particular employment centre. Equation (1) is estimated for each of the employment centres including the CBD.

It is not clear what to expect from estimating equation (1). On the one hand, public officials put a lot of emphasis on the largest firms and often a large firm is identified with a particular industry in a metropolitan area. On the other hand small firms are known to be innovative and often more aggressive. In this case, it may be that a collection of small firms is the initial catalyst that causes an employment sub-centre to form. Another reason to suspect an important role for small firms is the industrial diversity we observe in existing employment centres.

Specifically, irrespective of whether a large firm is the anchor, small firms may form a central part of the supply chain and firms in a variety of industries may provide the creative energy to find ways to link to the large successful firm. The key result from (1) will be to determine whether the effect of firm size is different in the new and emerging sub-centres such as Greenspoint, Webster or Baytown, compared to the older and established employment centres including the Galleria/Greenway centre and the CBD.

A second variant we use to estimate (1) is to define the left hand side indicator variable as pertaining not just to the employment centre itself but to a relatively close radius (three miles) around each centre's centroid. Demand to be near but not within a centre is consistent with a firm that provides a support role for employment within a centre. These support roles are crucial since they represent cost savings that are part of the agglomeration cost advantage firms need in order to compete nation- or world-wide. Irrespective, the probabilistic method allows a detailed picture of how businesses support employment centres.

3   Data

We use three data sets in our analysis. The first is privately available micro-data to identify firm size and employment. The, second is US Census data to determine the economically important employment centres from the set of candidate centres. The third

is from the CTPP as described above to determine the market areas of the employment centres.

The firm-level employment data is from RefUSA for the year 2010. We exclude firms for which employment was unknown. Nonetheless, the data are quite comprehensive as they represent almost 82% of the total employment in Harris County, Texas as compared to employment reported by the Bureau of Labor Statistics[7]. The data include firm-specific characteristics such as the name and address of each firm, the number of employees, annual sales, industry and year established[8]. We use the employment data by firm to test whether larger firms are more attracted to employment centres than are smaller firms. In order to create spatially detailed variables, the addresses of the individual firms are geocoded using GIS software and a newly available more detailed address file. The original 166,193 establishments in the RefUSA date are reduced to 150,256 after selecting on private establishments and eliminating cases with missing data.

Table 1 reports descriptive statistics for the employment centres by presenting the total number of firms by employment centre and it presents the number of employees in those firms by whether the firms are larger or smaller than 45 employees[9]. We also report the number of firms and employees within three miles of each centre's centroid as an alternative definition of centrality and we report the total number of firms and employees for the commuting pattern-based market areas. Table 2, in addition, reports the industry sector breakdown in our study area and the proportion of employment that occurs in small firms.

Table 2   Employment characteristics by Industry, Houston 2010

	Number of firms	Total employees	Number of small firms[a]	Employees in small firms	Share of firms that are small	Share of total emp in small firms
Total Houston (Harris County)	150,256	1,613,430	144,839	836,670	96%	52%
By industrial sector						
Mining	1,607	39,015	1,504	10,745	94%	28%
Construction	11,289	128,300	10,810	63,542	96%	50%
Manufacturing	6,366	147,671	5,717	51,318	90%	35%
Transport and comm	7,613	102,442	7,240	45,304	95%	44%
Wholesale trade	10,067	143,811	9,537	66,074	95%	46%
Retail trade	35,342	409,786	33,844	233,346	96%	57%
FIRE	16,743	116,862	16,386	78,373	98%	67%
Services	61,229	525,543	59,801	287,968	98%	55%

Note: [a]Small firms are defined as having 45 or fewer employees.

From examining Table 1, it is clear that small firms are more prevalent in the Galleria/Greenway centre and for Greenspoint than for the other centres. The average of the total share of employment in small firms is about 43% for the two close-in employment centres and 34% for the five farther-out employment centres. That these averages do not tell us about the contribution of small firms is obvious when one considers the possibility that small successful firms are likely to grow.

Table 3 Marginal effect of firm size on the probability of locating in or near each employment centre (logit[a] estimation)

	Distance to CBD (miles)	In the centre of the employment centre				Within 3 miles of centre centroid			
		Marginal effect[b]	Smaller than CBD (t-statistic)	N[c]	Pseudo R^2	Marginal effect	Smaller than CBD (t-statistic)	N	Pseudo R^2
Near to CBD									
CBD	0.0	1.28e-05*** (4.05e-06)	-	150,256	0.04	1.85e-05*** (8.65e-06)	-	150,256	0.02
Galleria/Greenway	6.1	1.23e-05 (8.69e-06)	0.05	96,592	0.03	–9.27e-06 (2.10e-05)	1.22	96,592	0.02
Farther from CBD									
Westchase	12.9	2.32e-06** (1.04e-06)	2.51	94,926	0.02	1.82e-06 (1.54e-05)	0.94	94,926	0.01
Greenspoint	13.4	4.47e-06 (7.34e-06)	0.99	88,765	0.01	1.92e-05*** (7.49e-06)	–0.06	88,765	0.01
Park 10	18.8	1.75e-06*** (3.60e-07)	2.72	91,658	0.02	1.69e-05*** (4.78e-06)	0.16	91,658	0.01
Webster	22.2	1.29e-05* (6.74e-06)	–0.01	28,765	0.03	5.02e-05** (2.45e-05)	–1.22	28,765	0.02
Baytown	25.1	4.28e-06** (2.04e-06)	1.88	26,500	0.04	9.08e-06 (2.42e-05)	0.37	26,602	0.01

Notes: Statistically significant at 10%-level *, 5%-level ** or 1%-level ***. Standard errors are in parentheses,
[a] The original logit regressions include sales per employee, a dummy indicating if manufacturing is done on site and a dummy variable for each of the nine one-digit industrial sectors (manufacturing is the base category). The dependent variable = 1 if firm locates in area, 0 otherwise,
[b] Each cell represents the marginal effect as calculated from a separate logit on the observations (firms) within the market area of each centre,
[c] The number of observations (firms) varies by centre because each has a different market area as determined by commuting data (see Table 1)

4   Results

Results of our estimations are shown in Table 3. Each row of the table represents a separate regression, where we have converted the estimated coefficients in the logit regression into marginal effects of an additional employee on the probability of locating within the centre of the employment centre. As an alternative measure of centrality, Table 3 also presents similar results for firms deciding whether to locate within three miles of the centroid of the employment centre. The estimated marginal effects are positive in virtually all cases indicating that larger firms are more likely to locate within the core of the employment centre than are smaller firms. We differentiate the results for the CBD and the closest sub-centre Galleria/Greenway from the marginal effects for the farther out and thus newer sub-centres which are Westchase, Greenspoint, Park 10, Webster and Baytown.

For the CBD, we see that a firm with 1,000 more employees is about 1.3% more likely than an otherwise equivalent smaller firm to choose to locate within the actual centre and over 1.8% more likely to locate within three miles of the CBD centroid. Thus we find larger firms are more attracted to the core of the CBD consistent with finding that larger firms have greater benefits from the net-of-congestion agglomeration economies generated by the employment concentration even holding constant the one-digit industrial structure and revenue per employee[10].

The Galleria/Greenway is presumably not as established as the traditional CBD but it is an area only six miles from the CBD and has total employment that is slightly larger than the CBD's. Further, as shown in Table 1 it is much larger than the newer employment centres farther from the city centre. Nonetheless, while we find that the attractiveness of larger firms cannot be statistically distinguished from the effect of attractiveness in the CBD neither can the effect be distinguished from zero. Thus, despite the clear advantage for larger firms found for the CBD we find no statistically significant advantage for larger firms from the most important employment sub-centre. Unfortunately, our analysis is unable to discern whether it is because the agglomeration economies are less important, or whether the localisation economies are sufficient throughout the broad area so that no special advantage is conferred by a sub-centre location[11].

The smaller and less centrally located employment sub-centres however show a much more distinct pattern. Like the CBD, these areas demonstrate that large firms apparently differentially benefit from the net agglomeration economies. We find that four out of the five farther-out sub-centres appear to confer a statistically significant advantage to larger firms. Further, for three of the five farther-out sub-centres, a location within three miles of the centroid appears to confer a differential positive effect to larger firms. The clear advantage of a centralised location for larger firms however is not generally as strong as the advantage for larger firms in the CBD in all areas except Webster as shown in the last column which presents a t-statistic for whether the marginal effects of employment in a given employment centre are equal to that for the CBD.

There are two central findings here. First, we find that larger firms appear to benefit from a centralised location more than smaller firm both in the CBD and in outlying areas of employment concentration. We presume this attraction results because larger firms find more benefits from agglomeration net of congestion costs than do smaller firms. The other aspect to our results however is a consequence of the presumed dynamics. Specifically, we find that the newer sub-centres show a less pronounced impact on the

large firms than does the CBD. Even the relatively well developed close-in sub-centre is shown to have rather dispersed benefits that seem to confer no special advantage to larger firms. This dynamic evidence thus suggests that the advantage to larger firms may develop over time and is not in the initial conditions of employment centre formation. It thus suggests that public policy oriented towards attracting new larger firms may be focusing on a consequence of economic development, rather than a cause.

In some sense, these findings can be interpreted in the context of geographic equilibrium, in that the agglomeration benefits net of congestion costs should be about equivalent in all of the alternatives available to firms. As our logit estimates are reduced form and do not separately estimate agglomeration benefits from congestion it may not be surprising if the estimated net benefits to larger firms are about equivalent. By this reasoning in fact only Webster and Greenspoint out of the five identified sub-centres are in equilibrium since they are the only ones with estimated net benefits that cannot be rejected as equal to the net benefits of the CBD. To the extent the other sub-centres are in the process of becoming established, it might not be surprising if the net benefits are smaller than the CBD's. Our simple model here is likely to have some omitted characteristics of firms but taken at face value our model implies the three sub-centres where the estimated net benefits from agglomeration are small are likely to grow or change in character.

5 Summary and conclusions

The research described in this project contributes important new understanding to the role of entrepreneurship and small businesses in economic growth. The objective of the research presented here has been to ascertain the importance of firm size for urban growth and development. We investigate this question using a cross sectional data set from Houston for 2010[12]. Our finding is that large firms are more attracted to employment centres than are smaller firms. This result holds for both the CBD and for the farther-out and presumably newer employment centres. This would seem to indicate that larger firms receive more net benefits from employment agglomerations than smaller firms from being located in the core of any agglomerative area. By itself our findings do not speak to whether firm size affects the generation of agglomeration economies as our findings only pertain to the ability of firms to prosper from the net-of-congestion benefits of agglomeration.

On the other hand, the dynamics implied in our cross-sectional results also suggest that while large firms are differentially attracted to employment centres compared to smaller firms at least part of the finding is because employment sub-centres are associated with firm growth. Specifically, we find that the marginal effect of additional employees on the probability that a firm will locate in an employment centre is significantly larger for the CBD than it is for most of the other centres. Surprisingly and at odds with the other employment centres, the closest-in sub-centre does not show that an additional employee affects the probability of sub-centre location at all. Nonetheless, there seems to be a reasonable likelihood that the large firms we find in employment sub-centres have been made large by the agglomeration process not necessarily because they choose to be there. To us this finding suggests the need for a more extensive research programme to fully explore the dynamic relationship between firm size and creating centres of employment.

Acknowledgements

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Notes

1   We use the term 'employment centre' to refer to all employment centres (concentrations of employment) including the CBD. Sometimes we distinguish the CBD from the other employment centres by referring to the other employment centres as 'sub-centres'.

2   Because we use cross-sectional data to make inferences on growth our analysis is conducted entirely in levels rather than growth rates.

3   For information on the economic impact of the Port of Houston, see their URL at http://www.portofhouston.com/about-us/economic-impact/ (accessed 20 January 2013).

4   It may also be important that the employment centres do not apparently depend on specialisation by industry or occupation. Although energy and production equipment are Houston's main industrial sector we did not find statistically significant evidence that energy firms concentrated in a particular sub-centre.

5   That is, they find the city needs to be a certain size before any employment centres will emerge. They speculate that multiple centres result theoretically from an extension of the original process that created the CBD and thus the newer sub-centres would be farther from the CBD.

6   The criteria that employment centres be economically important is first advocated by Craig and Ng (2001) and is consistent with the objective here because only examining employment concentrations would not answer the question as to the effect of firm size on economic growth.

7   The Bureau of Labor Statistics reports the first quarter 2010 employment for Harris County, Texas was 1,970,800 and the number of establishments was 99,500. See URL http://www.bls.gov/cew/ew09table11.pdf (accessed 20 January 2013).

8   The observations are for establishments, which may be stand-alone firms, subsidiaries or branches. Henceforth for brevity, we will use the term 'firms' interchangeably with 'establishments'. It turns out that year established is missing for many observations, although we find very similar results when this variable is included in the estimation.

9   We experiment with a large number of definitions of 'small' firms. The qualitative results discussed below are preserved for all definitions, with the caveat that the definition of small firm must be small enough to leave a substantial number of observations. For example, defining small firms as up to 500 employees (the largest definition we found in any context) is too small to statistically distinguish differences by firm size.

10   This argument does not necessarily imply that agglomeration economies are all on the cost side, positive revenue externalities are equally possible resulting from other firms or consumers.

11   That is, the Galleria/Greenway sub-centre covers a larger land area than the CBD and it may be that the benefits are rather diffused compared to the concentration found in the CBD.

12   Our data exploits firm size information in a density context, an interesting avenue of future research would be to replicate our work here with land price data were land area available by firm size as well.