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The Plant Size-Place Effect: Agglomeration and Monopsony in Labour Markets

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Abstract

This paper shows, using data from both the US and the UK, that average plant size is larger in denser markets. However, many popular theories of agglomeration – spillovers, cost advantages and improved match quality – predict that establishments should be smaller in cities. The paper proposes a theory based on monopsony in labour markets that can explain the stylized fact – that firms in all labour markets have some market power but that they have less market power in cities. It also presents evidence that the labour supply curve to individual firms is more elastic in larger markets.

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JEL Classification: J21, J42, R23

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Introduction

Economists have long been puzzled by the phenomenon of agglomeration in economic activity. A higher density of economic activity typically means higher land prices for which workers need to be compensated for by higher wages if they are to locate in the agglomerations (see Glaeser and Mare, 2001, for US evidence that the real wages of workers are no higher in agglomerations). For firms to wish to remain in the agglomeration they must derive some advantage to off-set the negative impact of higher land and labour prices on profits. There is much theorizing about what these advantages might be (see Duranton and Puga, 2003, for a recent survey) from something boring like lower transport costs to something sexy like knowledge spill-overs (see Moretti, 2004a). There is good evidence that firm productivity is higher in agglomerations (see, for example, Ciccone and Hall, 1996, Moretti, 2004b, Greenstone, Hornbeck and Moretti, 2007) so that some of the advantages seem to lie on the revenue and not the cost side – though more controversy about the reason for this (see Rosenthal and Strange, 2003, for a recent review of the empirical evidence).

This paper starts by proposing a stylised fact about agglomerations – the average number of workers per establishment is higher in larger markets – this is what I call the plant size place effect. I show the existence of the plant size-place effect using data from both the UK and the US and it is a very robust finding. This paper is not the first to present a correlation between establishment and market size – researchers in economic geography, industrial organization and labour economics have all been interested in the

determinants of and correlates with plant size¹. But I think it a fair summary to say that the plant size- place effect is not centre stage in any of the papers that note it nor is its pervasiveness recognized in the literature. For example, Krugman (1998, p172) wrote “it is, for example, a well-documented empirical regularity that both plants and firms in large cities tend to be *smaller* than those in small cities” (his italics). As we shall see, this is not completely wrong but it is a very long way from being completely right. But it is worthwhile briefly reviewing the other papers that have commented on the plant size place effect.

Among economic geographers, Dinlersoz (2004) remarks on it while Holmes and Stevens (2004) compare small, medium and large cities showing that service sector establishments are bigger in large cities while manufacturing establishments are smaller (a conclusion we will see below though we argue this pattern is very much the exception)². It is perhaps in Industrial Organization that one gets closest to a general statement about the plant size-place effect. In IO there is a widespread belief that product market competition intensifies as market size increases and evidence for this (see, for example, Sutton, 1991, or Bresnahan and Reiss, 1991). The increased competition implies that price-cost margins are lower in large markets and hence firm size must be bigger to cover the fixed cost. This leads to a predicted positive correlation between plant and market size. Market size is generally hard to measure but for non-tradeables one can link market and population size so empirical applications have focused on non-tradeables. For example, Campbell and Hopenhayn (2005) present evidence for 13 retail

¹ Though labour economists do not seem to have noticed the correlation of plant and market size– see Brown, Hamilton and Medoff, (1990) for a summary of the many variables found to be correlated with plant size.

² See also Wheeler (2006) who considers the determinants of plant size, Holmes (2005) who relates the location of sales offices to firm size, a related though slightly different issue.

industries, and Syverson (2004) does the same for ready-mixed concrete. For tradeable goods one would expect the relationship between market size and local population to be much weaker or non-existent. However this paper shows that the plant size –place effect is pervasive across all types of industry (though it may be larger for some industries than others) – this fact guides the choice of theory in the second part of the paper.

The plant size place effect might be thought an exceedingly boring stylized fact but I then go on to show that many popular theories of agglomeration – productivity spillovers and improved match quality predict – if they have any prediction at all – exactly the opposite, namely that establishment sizes should, on average, be smaller in dense labour markets.

I then propose a theory that can explain this finding as well as the other stylized facts about agglomerations – all labour markets are monopsonistic but less so in agglomerations. I show that this means that large, productive employers will have a comparative advantage in locating in agglomerations leading to the correlations of wages, productivity and employer size noted above. This theory has many parallels to the IO models mentioned earlier that emphasize how product market competition rises as market size increases (see, for example, Syverson, 2004). Here, I choose to emphasize labour market competition as the plant size place effect seems present in both tradeable and non-tradeable industries.

The plan of the paper is as follows. In the next section, I document the existence, for both the US and the UK, of a very robust correlation between the average size of establishments and the size of the local labour market. This correlation cannot be explained by differences in industrial composition, nor is it caused by a few very large

firms only locating in large labour markets. The second section then outlines the problem this stylized fact causes for a number of common theories of agglomeration based on the assumption of perfectly competitive labour markets. The third section then shows how monopsony in the labour market combined with employer heterogeneity can explain the plant size place effect. I provide an explanation for why labour markets should be more competitive in denser labour markets and a more formal model of this idea. The fourth section then present further evidence in support of the monopsony hypothesis.

1. The Plant Size-Place Effect

In this section I establish the basic stylised fact that establishments have, on average, more workers in larger markets.

US Evidence

The main US data used here come from the County Business Patterns (CBP) for 1999. This contains information on total employment and total number of establishments as well as the distribution of the number of establishments by size class. To investigate the relationship between average establishment size and agglomeration we need a measure of market size, so we need a definition of a market and a measure of size. We experiment with a variety of definitions and measures and show that the basic stylised fact is robust. For size we primarily use total employment in the labour market however defined though we also experiment with employment density i.e. employment per unit land area.

As a definition of a labour market I first start with the 3109 counties in the contiguous states of the US (i.e. I exclude Hawaii and Alaska). 7 of these counties do not report total employment for confidentiality reasons so the basic sample size is 3102. Some descriptive statistics are presented in Table 1. The average employment level across counties is 35441 with an average number of establishments of 2243. The average across counties of average establishment size is 11.95. Of course, these averages are very different if one weights by employment – the average worker is in a county with total employment of 531074, 29084 establishments and an average establishment size of 16.75. Figure 1 presents the basic relationship between the log of average establishment size and log of total employment in the county. There is a clear positive, concave relationship. Table 2 then presents some simple regressions.

The first row estimates a simple linear relationship between log average establishment size and log total employment. The coefficient on log total employment is 0.171 with a standard error of 0.003 confirming the existence of a significant relationship (something of little surprise given Figure 1). The second row then models the relationship as a quadratic with the quadratic term being very significant. The third column then includes a cubic term, showing this is insignificant.

That the relationship between log average establishment size and log labour market size is well-approximated by a quadratic can be confirmed by estimating a kernel regression. Figure 2 uses data from Figure 1 and shows the fitted regression line from the quadratic specification and the kernel regression line³. One can see that the quadratic is a pretty good fit. Figure 2 suggests that the positive relationship between average employment size and labour market size is weak once total employment in the county reaches 250000 – about half of workers are in smaller counties than this. So the plant size effect documented here is not really a difference between large and small cities (the focus of much research in economic geography and a literal reading of the application of the Krugman quote given in the introduction) but between cities, towns and villages. The next 3 rows of Table 2 do the same analysis but using employment per square mile as the measure of labour market size. The results are very similar, not surprising given that the correlation between the two measures of labour market size is 0.90.

One problem with using US counties as the unit of analysis is that they are political entities without any intrinsic economic meaning. Workers may live in one county and work in another, particularly where counties are geographically small (as they are more likely to be in the eastern states). Accordingly I use data on inter-county

³ This is based on a bandwidth of 0.5, an Epanechnikov kernel and 1000 grid points.

commuting patterns from the 2000 Census to compute measures of the ‘labour pool’ available to an employer in each county.

As I lack any finer geographical information I assume all workers and employers in each county to be located at the population-weighted centroid. For each county I then look at the distances travelled by workers in the county. I compute a median distance, and 75th, 90th and 95th percentiles⁴. These distances are also reported in Table 1⁵. For all but 32 counties the median worker lives in the county so that median distance for the commute is zero. But moving further out one finds larger numbers. Some of the estimates for some counties are crazy - typically these are small counties in which one or more workers reports living a very long way away. Whether these are included or excluded from the analysis that follows does not make very much difference so I include all in the analysis.

Having computed these distances I then compute the total number of workers who live within these distances. So, if the 75th percentile for one particular county includes 3 counties then I use as my measure of the labour pool the total employment in those 3 counties. The average values of the labour pools are reported in Table 1. Because the available data is not very fine, these measures are crude but the British data I use later is much better and the results are very similar.

The bottom half of Table 2 then uses these measures as total labour market size. The results are very similar. Note that these measures of total employment come from a

⁴ One could also compute the maximum though these tend to be very large numbers indeed as most counties have at least one worker reporting traveling hundreds of miles to work.

⁵ These commuting distances are rather low as the assumption that all the population in a county is at its centroid means that commuting distances are measured as zero for those who live and work within the same county.

different data source from the CBP data so allay any concerns that measurement error in total county-level employment in the CBP can explain the correlation observed earlier.

One might also be concerned that this result is driven by the presence of a few large plants that only locate in dense labour market areas because they would be a sizeable fraction of total employment in most counties if they chose to locate there. This is not the case: Figure 3 plots the fraction of plants in different size classes against total employment. One sees a smaller fraction on establishments with 1-5 employees in large labour markets but a positive relationship between the fraction of establishments with 5-9 employees and labour market size each of whom is a negligible fraction of total employment in any county.

There are perhaps other concerns about the source of the relationship shown in Figure 1. One is that it is a spurious relationship driven by the ‘dartboard’ effect discussed by Ellison and Glaeser (1997). One way to understand this would be to consider the case when each region is so small there is only one firm in each region. In this case total employment and average establishment size will be perfectly correlated but this relationship is clearly spurious. However, this is a ‘small numbers’ phenomenon – as the number of firms in a region increases the effect goes away. One way to see this is to compare the true relationship in Figure 1 with what it would look like if plant location was independent of establishment size. To this end I simply keep the number of firms in each county fixed at the true value and then randomly assign firm sizes to them and look at the relationship between average firm size and total market size when we do this. This simulated relationship looks like that shown in the second panel of Figure 4 – it is

nothing like the true relationship which is shown in the first panel⁶. The ‘dartboard’ problem cannot explain our findings because most counties have so many establishments that laws of large numbers can be applied.

One might also be concerned that average plant size varies greatly across industries and the location of industries varies across labour markets. But, the effect is at work within industries. Table 3 reports the results from regressions in which the unit of observation is an industry in a county, with results for different levels of industry disaggregation from 2- to 6-digit being shown. For each level of disaggregation, two results are shown, one without industry dummies and one with. In all cases there remains, within industries, a robust correlation between average plant size and total labour market size. One problem with the US data is that total employment is not reported for many cells for confidentiality reasons – to get around this problem I also report results for the fraction of total establishments with 1-4, 5-9, 10-19 and 20+ employees. The results are qualitatively similar – the fraction of very small plants is higher in smaller markets and the fraction of plants even in the next size category is increasing in market size.

One might also be concerned that the nature of the plant size-place effect differs across industries, especially in the light of the conclusion of Dinlersoz (2004) that average plant size declines in manufacturing as cities grow and the conclusion of Holmes and Stevens (2004, p227) that “big-city establishments in services are larger than the national average, whereas those in manufacturing are smaller” which suggest the plant size-place effect only exists in some sectors and not others. To investigate this Figure 5

⁶ It is not just the slope that demonstrates this but also the range of the two axes. As the number of plants in different areas is being held constant the small areas are predicted to have much more employment than is the case under the ‘dartboard’ model.

shows the plot of average plant size against total employment for the nine 1-digit industries. One notices that, with the exception of the first category (and one would not expect much logging in large cities!), there is a plant size-place effect in all industries. However we do see the Holmes-Stevens conclusion – that, in manufacturing, average plant size in large cities is smaller than in small cities (and the evidence cited in the Krugman quote only applies to manufacturing) – but it remains the case that the average plant size in large cities is bigger than it is in small counties. Manufacturing has a quadratic relationship between log average plant size and market size like other sectors but it does turn down once we reach cities of a reasonably large size. That there is this significant quadratic relationship is confirmed by looking at the regressions in Table 4. However, this negative relationship between plant size and place size does seem unique to manufacturing and only emerges when one restricts the sample to cities – furthermore we will not see it in the UK data.

UK Evidence

The main UK data used in this section comes from the Annual Business Inquiry (ABI) for 1998-2002 inclusive. This is a very similar survey to the CBP data used above. As labour market areas I start by using the UK's Office for National Statistics 'Travel-to-Work Areas' (TTWAs). I use the 1998 classification for which there are 303 in Great Britain (and another 15 in Northern Ireland which are not used here because the ABI data does not exist there). TTWAs are explicitly constructed to be local labour markets as "the fundamental criterion is that, of the resident economically active population, at least 75% actually work in the area, and also, that of everyone working in the area, at least

75% actually live in the area”⁷. This means that UK TTWAs have the advantage over US counties that they are intended to be economically meaningful. Some descriptive statistics are shown in Table 5. The median size across TTWAs is 30000 and the median across workers is 225000.

Figure 6 presents the basic stylized fact for the UK – average plant size is larger in larger labour markets. Each point on this graph represents a single TTWA – the horizontal axis is the log of total employment in the TTWA, the vertical axis the log of average plant size. There is a very clear positive correlation between the two albeit with the largest TTWA (London) appearing to be something of an outlier.

Table 6 then formalizes this relationship by estimating some regressions. The first row estimates a simple linear relationship between log average establishment size and log total employment. The coefficient on log total employment is 0.149 with a standard error of 0.009 confirming the existence of a significant relationship (something of little surprise given Figure 6). The second row then includes a dummy for London – this makes the relationship slightly stronger. The third row then models the relationship as a quadratic with the quadratic term being very significant. The fourth row then shows that London is no longer such an outlier. The fifth row then includes a cubic term, showing this is significant. The sixth row changes the measure of market size to employment density but the results are very similar – the correlation between the two measures of market size is 0.87. Figure 6 also plots the fitted regression line from the quadratic specification (excluding the London dummy) and a kernel regression line⁸. One can see that, as in the US, the quadratic is a pretty good fit.

⁷ In practice this condition remains an unattainable ideal.

⁸ This is based on a bandwidth of 0.5, an Epanechnikov kernel and 1000 grid points.

Although TTWAs are constructed to be economically meaningful, they nevertheless introduce discontinuities across the borders between them that have no foundation in economic reality. Areas close to a TTWA border may well draw more heavily on employment from a neighbouring TTWA than the one in which they are classified. So, we repeat the exercise we did for the US in constructing labour pools from commuting data. But one big advantage of the UK data over the US data is that we have information on average plant size at the level of wards – of which there are approximately 10000 in England and Wales (we cannot use the Scottish ones as we cannot match the ward codes in the separate data sets).

To construct a labour pool I construct, for each ward, a source area. Sometimes this is just the ward itself, sometimes those within 5 or 10km, sometimes excluding the own ward to ensure that there is no spurious correlation between this plant's activities and the measure of the labour pool. Then, using the commuting data from the 1991 Census I compute the median, 75th, 90th, and 95th percentiles of commuting distance for workers in the source area. Then I compute the labour pool as the number of people who live within these distances. The results are reported in Table 7 – the bottom line is that, however the measure of the labour pool is constructed, the correlation is always the same: plants are bigger on average in larger labour markets.

2. The Plant Size-Place Effect and Popular Theories of Agglomeration

The plant size place-effect might seem to be an exceedingly boring stylized fact. But it becomes more interesting when one considers how popular theories of agglomeration fare in explaining it. Any model of agglomeration must be able to write down an

equilibrium profit function for a firm if it chooses different locations. A necessary condition for equilibrium is that the firm's profit-maximizing choices are consistent with the proposed equilibrium. We will use this necessary condition to derive some useful results – note that we do not need to specify complete models to do this exercise and we do not seek to do so⁹.

Let us write the 'reduced-form' revenue function in region r for a firm after all other choice variables have been concentrated out apart from employment as $R(N, A_r)$ where A_r is a measure of 'productivity' in region r which will include all the ways in which agglomeration affects the revenue function (including any effects that work through the costs of non-labour inputs and including any possible externalities). This revenue function can have increasing returns over some region but must be eventually concave for the individual employer's decision to be well-defined. If the labour market is competitive I can then write a 'reduced-form' profit function for the firm in region r as:

$$\pi_r = R(N, A_r) - W_r N \quad (1)$$

where W_r is the wage in region r . If there is an interior solution with some economic activity in all regions, this must be equalized across regions¹⁰. We are interested in restrictions on the form of $R(A_r, N)$ for the model to predict larger establishments in regions with high wages and productivity? To answer this question it is convenient to imagine that there is a continuum of regions indexed by the wage, W , and a function

⁹ Though many worked-out general equilibrium models of agglomeration in the literature do not predict the plant size place effect e.g. the classic model of Krugman (1991) has the prediction that plant size is the same in all areas.

¹⁰ Not all theories of agglomeration have an interior solution – often they have as their equilibrium a corner solution in which some areas have all firms and others none – a good example (because I refer to it extensively later on) is Helsley and Strange (1990) where, in equilibrium, all cities are the same size but not all land is occupied. But it is more realistic to consider an interior solution where some firms choose to locate in cities and others in villages and there is a continuum of intensity of economic activity.

$A(W)$ that gives the corresponding level of productivity that, in equilibrium, must be a positive function of the wage for any region where firms choose to locate because no firm would choose to locate in a region with higher wages and lower productivity than some other region. Denote by $N(W)$ the demand for employment in a region with wage W .

This must satisfy the equation:

$$R_N(N(W), A(W)) = W \quad (2)$$

Note that this cannot, on its own, be used to predict the relationship between plant size and region because the function $A(W)$ is endogenous. But, in equilibrium, profits must be equalized across regions and the following Proposition uses this fact to show when the model can predict the plant size-place effect.

Proposition 1: Average plant size will be greater (smaller) in regions with higher wages if:

$$\frac{\partial \ln R_A}{\partial \ln N} > (<) 1 \quad (3)$$

Proof: Differentiating (2) we have that:

$$N'(W) = \frac{1 - R_{AN} A'(W)}{R_{NN}} \quad (4)$$

From the second-order conditions for maximization the sign of this depends on the sign of the numerator. Profit equalization across regions requires, from the envelope condition that:

$$\pi_W = R_A \cdot A'(W) - N(W) = 0 \quad (5)$$

Using this to eliminate $A'(W)$ in (4) we have that the sign of the numerator depends on:

$$\text{sgn}[N'(W)] = \text{sgn}\left[\frac{NR_{AN}}{R_A} - 1\right] \quad (6)$$

Which gives (3).

Proposition 1 says that models of agglomeration that are capable of explaining the plant size-place effect must have a reduced-form revenue function that satisfies the condition in (3). Put simply (and obviously), the condition in (3) says that it must be the case that large employers have a comparative advantage in cities.

I have derived this result using the assumption that employers are homogeneous so that all regions with some economic activity must offer equal profits. What happens if there is heterogeneity among employers so that some will strictly prefer to locate in the city and some in the village? If there is a marginal employer profits must be equal in the two regions for this employer and Proposition 1 applies for this marginal firm. By continuity the condition must also be satisfied for employers close enough to the margin. It is conceivable that away from the margin there is some effect at work making employers who strictly prefer the city very different in size than those who strictly prefer the village even though this is not true at the margin but any such effect must work against the mechanism described here and overcome it.

Now consider whether some popular models of agglomeration satisfy the condition in (3).

First consider theories that are based on lower costs of some inputs or spill-overs or externalities in which the revenue function can be written as $A_r R(N)$ so that regions differ in terms of a Hicks-neutral productivity shock. Note that this model has:

$$\frac{\partial \ln R_A}{\partial \ln N} = 0 \quad (7)$$

so, by Proposition 1, predicts that plant sizes will be smaller in agglomerations¹¹.

Next, consider a matching model that suggest the quality of the match between worker and employer is better in denser labour markets. In this case one can write the productivity effect of being in a denser market as being labour-augmenting and the revenue function as $R(A, N)$. This revenue function has the feature that:

$$\frac{\partial \ln R_A}{\partial \ln N} = 1 + \frac{ANR''(AN)}{R'(AN)} < 1 \quad (8)$$

As the equilibrium of the firm must be on the concave part of the revenue function we must have $R''(AN) < 0$. So, this model also predicts smaller plant sizes in regions with high wages.

Next suppose there is no productivity effect of locating in a city but the costs of recruiting workers are lower. Write the profit function for this sort of model as:

$$\pi = R(N) - (W + V(A))N \quad (9)$$

where V are expected amortized vacancy costs. One can write

$R(N, A) = R(N) - V(A)N$ which has the feature that $\frac{\partial \ln R_A}{\partial \ln N} = 1$. This model does not

predict smaller establishments in cities but it does not predict larger ones.

Now lets consider a model of agglomeration that does have the potential to explain the plant size-place effect. Suppose that regions differ in the competitiveness of their product

¹¹ One should note that if one has ‘constant returns to scale’ in the revenue function, profit maximization requires profits to be zero. In this case the scale of individual employers is indeterminate in which case the model does not have any prediction at all about average plant sizes. But, it then becomes hard to explain the strong pattern in two countries that can be seen in Figures 1 and 6.

markets with agglomerations being more competitive. To keep things simple assume that output is given by N and that the price of output is given by $P(N, A)$.

To capture the idea that product markets are more competitive in bigger markets assume that the price elasticity of demand is smaller in agglomerations:

$$\frac{\partial}{\partial A} \frac{\partial \ln P(N, A)}{\partial \ln N} = \frac{N}{P^2} [P \cdot P_{NA} - P_N P_A] > 0 \quad (10)$$

In this case we have that the revenue function is given by $R(N, A) = P(N, A)N$ which, after some manipulation leads to:

$$\frac{\partial \ln R_A}{\partial \ln N} = 1 + \frac{\partial \ln P_A}{\partial \ln N} = 1 + \frac{N \cdot P_{NA}}{P_A} \quad (11)$$

In equilibrium it must be the case that $P_A > 0$ so that the implications of (11) for the average plant size depend on the sign of P_{NA} . From (10), this can be positive. Although, a model based on imperfect competition in product markets has the potential to explain the existence of the plant size-place effect, it has a problem to explain the existence of this phenomenon among tradeable sectors of the economy where we would expect product market competition not to be influenced by the size of the local market for the product.

It is for this reason that I turn to imperfect labour markets as a potential explanation for the plant size-place effect. The models described above all assume the labour market is perfectly competitive and any employer in any region can hire any amount of labour at the going wage in that region. The rest of the paper relaxes that assumption.

I am going to argue that a simple explanation of the empirical findings is that labour markets are not perfectly competitive, that they are monopsonistic. In a very

general sense this can be thought of as a version of Marshall's 'labour pools' story for agglomeration (Marshall, 1920). But that story has always fitted uncomfortably with a view that labour markets are perfectly competitive (because the market wage is then a sufficient statistic for the labour supply curve to an individual employer). The story I will tell has affinities with matching models of agglomeration (see Helsley and Strange, 1990, or Amiti and Pissarides, 2005) although they typically mix up monopsony effects with increased quality of matching – the latter effect has the problem discussed above.

3. Monopsony and the Plant Size-Place Effect

This paper argues that the existence of monopsony in labour markets can help to explain the puzzle. Why this might be the case can be explained very simply. If labour markets are competitive then the labour supply curve facing an individual firm will be infinitely elastic at the market wage. Because wage costs are higher in cities, the labour supply curve to individual firms in cities and villages will look something like the curves drawn in Figure 7. Suppose there are two firms who differ in their productivity of labour within them. Both firms would choose to locate in the village unless the marginal product of labour curve itself varied with the location. The search for such variation is at the heart of many theories of agglomeration discussed above.

But now suppose the labour market in both city and village is monopsonistic. The defining feature of this is that the labour supply curve to the individual employer is upward-sloping. One possibility (and a central claim of this paper is that there is evidence for this view) is that the firm level labour supply curves in city and village look like those drawn in Figure 8 with the labour market in the city being more competitive

than that in the village. Now the low-productivity firm will still choose to locate in the village but the high-productivity firm will choose to locate in the city. Wages will still be higher in the city than the village but there is no puzzle about why some firms prefer densely-populated areas – their labour costs are lower than if they recruited elsewhere. Of course this result depends on drawing the firm-level labour supply curve as more elastic in the city than village i.e. the labour market is more competitive in the city than village. But the existence of agglomeration is now driven by differences in desired employer size. Employers who want to be large either because their technology has a large minimum efficient size or because, for given technology, they are particularly productive will choose to locate in cities. One way of summarizing this is that the quality of employers in cities will be higher.

There are a number of questions raised by this simple account that need to be answered. Why should there be monopsony at all, in village or city? Manning (2003a) has argued that employers do have pervasive monopsony power in modern labour markets but his arguments are not based on the classical notion of monopsony in which employers are large in relation to the size of their labour market for the simple reason that they are not (more evidence on this is presented below). Instead, he emphasizes how labour market frictions mean that workers do not instantaneously respond to changes in wages. But, even if one believes in monopsony power in labour markets, one needs to provide a good explanation for why the labour supply curve is more elastic in cities so firms have more monopsony power in villages.

Why Should Larger Labour Markets Be More Competitive?

Here, I present a simple model and some sufficient conditions for the elasticity of the labour supply curve to an individual employer to be higher in denser markets. Assume that the utility u_{if} that worker i gets from firm f that pays log wages w_f is:

$$u_{if} = w_f + \eta_{if} \quad (12)$$

where we assume that η_{if} is distributed independently across workers and firms with density function $f(\eta)$ and distribution function $F(\eta)$. Denote by $\bar{\eta}$ the upper support of this distribution. The unit coefficient on the log wage is simply a normalization. We assume that each worker chooses the firm that offers the highest utility from among the D firms assumed to be in the market. This model has close affinities to the circle model of Helsley and Strange (1990) though which firm is closest to which worker is stochastic here and deterministic in their model. To keep the ideas simple let assume that all other firms pay w and this firm is considering paying wage w_f . Then if a worker gets non-monetary utility of η from employment in this firm, the probability that they work for this firm is the probability that, in all the other $(D-1)$ firms, the non-monetary utility is less than $(w_f - w + \eta)$. The probability of this happening is $F^{D-1}(w_f - w + \eta)$. Of course, η is itself random so, to get total labour supply to the firm one has to integrate over all possible values of η . Hence, expected employment in the firm can be written as:

$$N(w_f, w) = L \int F^{D-1}(w_f - w + \eta) f(\eta) d\eta \quad (13)$$

To work out the elasticity of the labour supply curve facing the firm one simply differentiates (13) with respect to w_f . The following Proposition says something about how this elasticity varies with D, the number of firms in the market.

Proposition 2: If all firms pay the same wage then the elasticity of the labour supply curve facing an individual firm is:

$$\varepsilon(D) = \frac{\partial \ln N}{\partial w} = Df(\bar{\eta}) - \frac{\partial \ln f(\bar{\eta})}{\partial \eta} + \int F^D(\eta) \frac{\partial^2 \ln f(\eta)}{\partial \eta^2} d\eta \quad (14)$$

Sufficient conditions for this to be increasing in the number of firms in the market are:

- $f(\bar{\eta}) > 0$

and - $f(\eta)$ is log-concave

Proof of Proposition 2: See Appendix.

It should be emphasized that the conditions given are sufficient not necessary. In particular, as D gets large, it is only the right-hand tail of the distribution that will get any weight in the final integral in (14) so that one only would need log-concavity in this tail to have the elasticity increasing in D. The intuition for the result is that as the market size increases it becomes more likely that there is a firm in the market with a similar value of η making the choice of the worker a simple comparison of the wage.

Often theoretical papers make very particular assumptions about functional form so it is worthwhile briefly considering what some popular functional forms imply about the elasticity. If η has a uniform distribution then only the first term in (14) is non-zero and the elasticity increases linearly with D. On the other hand if η has an extreme-value distribution (that would lead to a multinomial logit model for the choice of employer)

then one can show the elasticity is $(D-1)/D$, increasing in D but tending to an asymptote. Both of these two assumptions predict an elasticity increasing in D though they have different predictions about how the elasticity is likely to vary with D .

This section has shown that it is simple to construct models in which the intensity of labour market competition is greater in larger markets. The next section shows how a model in which the elasticity of the labor supply curve increases with the number of firms can explain the existence of agglomeration and the plant size-place effect.

4. A Model of Agglomeration with Monopsonistic Markets

In this section we present a simple model with 2 regions to show how monopsony can lead to an agglomeration equilibrium which would not occur if the labour market was perfectly competitive. The model has some ‘reduced-form’ aspects to it but could be derived from a more fundamental model. The different elements of the model are as follows.

The Labour Supply Curve Within A Region

Assume that the log-labour supply to a firm that pays log wage w in region R , denoted by $n^R(w)$ is given by the following ‘Dixt-Stiglitz’ form:

$$n^R(w) = (l^R - d^R) + \varepsilon(d^R)(w - w^R) \quad (15)$$

where l^R is the log of the number of workers in the region, d^R is the log of the number of firms in the region, w^R is some wage index for the log average wages and ε is the elasticity of labour supply with respect to the wage. This labour supply curve says that firm that pays the average wage gets a labour supply equal to the average plant size in the region and this can be influenced by the wage it pays. For this labour supply curve to

‘add up’ across firms it must be the case that the wage index is of a CES form and given by:

$$W^R = \left(\frac{1}{D} \sum W_i^\varepsilon \right)^{1/\varepsilon} \quad (16)$$

In line with the arguments earlier in the paper we assume that the elasticity of the labour demand curve, $\varepsilon(d^R)$ depends positively on the number of firms in the region.

Firms

Suppose that all firms have constant returns to scale but differ in the marginal product of labour. A firm at position f in the productivity distribution is assumed to have marginal product of labour $P(f)$. All firms will choose the wage to maximize profits (P-W)N.

The optimal log wage for a firm at position f in the productivity distribution in region R is:

$$w^R(f) = p(f) + \ln(\varepsilon(d^R)) - \ln(1 + \varepsilon(d^R)) \quad (17)$$

which is the usual marginal product equals marginal cost of labour equation. This then implies that log-profits for a firm at position f in the productivity distribution in region R can be written as:

$$\pi^R(f) = (1 + \varepsilon(d^R))p(f) - \ln(1 + \varepsilon(d^R)) + (l^R - d^R) - \varepsilon(d^R)w^R \quad (18)$$

Firms will choose their location to maximise this. Note that we can write this as:

$$\pi^R(f) = (1 + \varepsilon(d^R))p(f) - \theta^R \quad (19)$$

Note the important point that high-productivity firms are, other things equal, going to have a comparative advantage in locating in labour markets that are more competitive because a higher value of $\varepsilon(d^R)$ enters multiplicatively with the productivity.

The Allocation of Workers Across Regions

Now consider the location of workers across markets. We assume that workers base their decisions on the expected utility – as all workers are assumed identical this will mean that expected utility will be equalized across regions. Expected utility might be influenced by the wage index and the number of firms as this affects the quality of the match (like in the model of the previous section). Because we want to ‘turn off’ the match quality effect and focus purely on the monopsony effect, we will assume the number of firms has no effect on worker utility beyond any effect on the wage.

Assume that the utility to a worker from locating in region r , is $w^r - \xi h^r$ where h^r is the log of housing costs. Assuming that land in a region is not in completely inelastic supply, that housing is a normal good and that households (but not firms¹²) demand land, assume that the log of housing costs in a region is given by:

$$h^r = \chi w^r + \zeta l^r \quad (20)$$

Utility equalization across regions then implies that, in equilibrium:

$$(1 - \xi\chi)w^A - \xi\zeta l^A = (1 - \xi\chi)w^B - \xi\zeta l^B \quad (21)$$

Which, on re-arrangement leads to:

$$(l^A - l^B) = \frac{(1 - \xi\chi)(w^A - w^B)}{\xi\zeta} \quad (22)$$

¹² This is a convenient assumption but nothing of importance depends on it.

So that if $\xi\chi < 1$ (which is reasonable as otherwise an increase in earnings makes people worse off because the effect on house prices is so strong as to reduce utility), relative labour supply to the two regions is a positive function of relative wages in the two regions. This also implies that the share of total labour supply in each region is only a function of relative wages – denote it by:

$$l^A = l + \ln \left[\lambda(w^A - w^B) \right] \quad (23)$$

where l is the log of total population and we assume that $\lambda(0) = 0.5$ so that identical regions each get half the available workers.

Equilibrium

An equilibrium will be an allocation of firms across regions such that no firm prefers to locate in any other region.

There will always be a symmetric equilibrium in which half of workers and half of firms, chosen at random, locate in each of the two regions. In this case the two regions are identical so there is no reason for any firm or worker to prefer one region over the other and this sustains the mixed strategy equilibrium.

But, we are interested in the possibility of an agglomeration equilibrium in which the number of firms in the two regions is unequal. First, we will derive some necessary properties that must be satisfied in any agglomeration equilibrium and then we will provide a sufficient equilibrium for an agglomeration equilibrium to exist. Without loss of generality let us assume that in an agglomeration equilibrium it is region A that has the largest number of firms.

Proposition 3: Any agglomeration equilibrium must have all the highest productivity firms in region A.

Proof: See Appendix.

The reason for this is the comparative advantage point made earlier. An important consequence of this is that firms in the agglomeration will have higher productivity than those outside it but there is nothing causal about this – it is simply a result of employer sorting. The empirical literature on the relationship between market size and productivity does not really establish anything more than a correlation for the simple reason that it is hard to randomly alter plant location¹³.

One can also prove the following result about the constellation of correlations we would observe in the data.

Proposition 4: The agglomeration has:

- a. more firms
- b. higher average productivity
- c. higher average wages
- d. more workers
- e. higher average firm size.

Proof: See Appendix.

The intuition for all these results is straightforward except perhaps the last. The intuition for this is that firms that pay the ‘average’ wage (or lower wages) in the high-wage region

¹³ One notable exception to this is Greenstone, Hornbeck and Moretti (2007) who compare areas which saw the influx of a large plant with those that just missed out – they find evidence of sizeable productivity effects.

do not gain from the fact that the labour market is more competitive there (see (15)), so can only be induced to locate there because of a larger labour pool per firm which translates into a larger average firm size.

Nothing proven so far has established the existence of an agglomeration equilibrium – the following Proposition provides some sufficient conditions.

Proposition 5: A sufficient condition for the existence of an agglomeration equilibrium is:

$$\ln \left[\lambda \left(\left[w^A(0.5) - w^B(0.5) \right] \right) \right] - \left[1 - \lambda \left(\left[w^A(0.5) - w^B(0.5) \right] \right) \right] > \varepsilon(0.5) \left[w^A(0.5) - w^B(0.5) \right]$$

where $w^A(0.5)$ is the average wage in region A if the most productive 50% of firms

locate there and $w^B(0.5)$ is the average wage in region B if the least productive 50% of firms locate there.

Proof: See Appendix

The intuition for this condition can most easily be understood in the following way. For an agglomeration equilibrium to exist it must be the case that if the best 50% of firms are in region A and the worst 50% in region B, the median firm can make more profits by locating in A. The median firm will locate in region A if, for a given wage, labour supply is higher there – this follows from (15) as the elasticity will be the same in the two regions if the number of firms is the same. There are two conflicting factors that affect labour supply for a given wage - both come from the fact that wages will be higher in region A as average employer quality is higher there. First, the higher wages in region A will attract more workers and this increases the supply of labour to all firms located in that region. But the higher wages also tend to reduce labour supply to an individual firm

for a given wage. It is the relative size of these two effects that is important. It is that the regional labour supply effect must dominate the wage competition effect to make it more profitable for the median firm to locate in the high-wage region in this scenario. This is a reasonable condition as wage differentials of the order of 20% seem to be able to support differences in labour market size of several hundred percent and the micro evidence does not suggest a particularly large wage elasticity in labour supply to the individual firm.

So far we have shown that a model of a monopsonistic labor market in which larger markets are more competitive can explain the plant size-place effect and why wages and productivity are higher in agglomerations. But there remains work to be done in arguing that this is a plausible prediction and testing further predictions of the model. This work takes up the rest of the paper.

5. How Much Monopsony Power?

Bunting (1962) studied employer concentration in US labour markets and showed that there were very few markets in which employer concentration was sizeable. He concluded that very few employers were likely to have any monopsony power, a conclusion that, if correct, would mean the failure of the basic hypothesis of this paper. His conclusion about the low levels of employer concentration remains true today but modern theories of monopsony (see Manning, 2003a,b) emphasize that employers do not have to be large in relation to their labour market to have some market power. However, this leaves open the question of how much market power they possess, and whether the elasticity of the labour supply curve needed to explain agglomeration lies in a 'plausible' range.

This section shows how data on labour markets of different sizes can be used to obtain an estimate of the elasticity of the labour supply curve facing an individual employer. It is helpful to think of there being a continuum of labor markets indexed by the average log wage index, w – the high wage regions will be the agglomerations. In each region there will be an average log employer size, denoted by $n(w)$ and an elasticity of the labour supply curve facing the firm, $\varepsilon(w)$. Both $n(w)$ and $\varepsilon(w)$ will be increasing in their arguments. An individual firm f can think that if it locates in labour market with average wage w and pays wage w_f then its labor supply will be given, from a modification of (15), as:

$$n(w_f, w) = n(w) + \varepsilon(w)(w_f - w) \quad (24)$$

When thinking about location, a necessary condition for profit maximization is that, given the wage the firm pays, it chooses the labour market where that wage brings forth the greatest labour supply. So, a necessary condition for profit maximization is:

$$\frac{\partial n(w_f, w)}{\partial w} = n'(w) + \varepsilon'(w)(w_f - w) - \varepsilon(w) = 0 \quad (25)$$

Evaluating this at the average wage for each region i.e. $w_f = w$ leads to the equation:

$$\varepsilon(w) = n'(w) \quad (26)$$

i.e. one can estimate the elasticity of the labour supply curve facing the average firm

within its region using the elasticity of plant size with respect to wages **across** regions.

The latter is observable so one can then ask whether this elasticity matches up with other evidence on the elasticity of the labour supply curve facing individual firms. Of course, this result is derived under the assumption that all of agglomeration can be explained by the monopsony effect which is a claim far stronger than this paper would wish to make.

But the plausibility of the estimate can be used to address its potential importance and to think about what it cannot explain.

Figure 9 plots of log of average wages against the log of average plant size for US counties, together with the regression line. There is a clear positive relationship. Figure 10 does the same for UK TTWAs. Some regressions to summarize the results are shown in Table 8 where a measure of log average wages is regressed against the log of average plant size. For the UK we report estimates using the unadjusted average wage and the average wage after controlling for age, occupation and industry. As the theory predicts there is a positive relationship in both the UK and the US. These estimates suggest the existence of considerable monopsony power – from (26) the coefficients can be interpreted as one over the elasticity of the labour supply curve facing an individual firm.

6. The Elasticity of the Labour Supply Curve Facing Individual Employers

An important component of the idea put forward here is that the elasticity of the labour supply curve facing employers is higher in agglomerations: a direct test of the hypothesis would be to provide evidence of this. Unfortunately it is not clear that we have good evidence on this elasticity for any employers – Manning (2003a, ch.4) reviews the arguments. But a simple-minded approach is to use as a estimate of the inverse of the labour supply elasticity, the employer size wage effect (ESWE), as this measures how much higher are the wages paid by large employers. Manning (2003a, ch4) gives reasons why this is likely to be a downward-biased estimate of the true labour supply elasticity but if this bias is the same in city and village it is perhaps meaningful to compare the employer size wage effect in and out of agglomerations.

Table 9 presents some US evidence on this. The data are taken from the April 1993 Contingent Worker Survey Supplement to the Current Population Survey, the latest main US data source that contains employer size. Also, the CPS contains limited information on the location of workers – here we simply compare workers in and out of MSAs as this seems the most telling comparison given the earlier evidence. The columns headed 1a and 1b simply report the coefficient on log employer size where no other covariates are included – the coefficient is, as the theory would predict, lower in MSAs. The next two columns then include personal characteristics (age, race, gender, education) – the inclusion of these variables reduces the employer-size wage effect (this is well-known) but the ESWE is lower in MSAs. The columns 3a-3c then also include controls for industry and occupation and also includes an equation for large MSAs. Again we see the same pattern – a decline in the ESWE as the size of the labour market increases.

Table 10 then does a similar exercise for British data. The data used here comes from the New Earnings Survey for 1997-2001. It has one advantage over the US CPS data used in the previous data – namely it does contain information on the TTWA the worker is in. However, it also has one disadvantage – it contains information only on firm size and not plant size. This is likely to make it harder to find the effect we want as, for example, small rural bank branches will describe themselves as being part of a very large firm.

The first column reports the result of a regression of log wages on a quadratic in log labour market size, the log of firm size and the log of firm size interacted with the log of labour market size. The coefficient on this interaction term is, as the theory predicts, negative and significantly different from zero. The second column shows that this is

robust to including a full set of dummies for age, occupation and 4-digit industry. The third and fourth columns then repeat the exercise but also including the log of firm size interacted with a quadratic in labour market size – the quadratic term is not significantly different from zero. The final two columns exploit the fact that the NES is a panel which follows the same individuals over time. This means that we can include individual fixed effects and still identify the coefficients of interest off those who change the firm for which they work and change the area in which they work. The last two columns show that the firm size wage effect continues to be estimated to be weaker in large labour markets.

7. Conclusions

This paper has proposed a stylized fact – that, on average, plants are larger in agglomerations. This is the plant size-place effect. This effect is more marked when comparing villages and towns with cities than when comparing small and large cities. It is argued that this stylized fact is something of a problem for many existing theories of agglomeration as many of them actually predict that plant sizes should be smaller in large markets. Hence, there is a need for a theory to explain why large plants have a comparative advantage in locating in large markets.

This paper proposes one explanation for this – that labour markets are monopsonistic but that they are more competitive in large markets where the supply curve is also moved further out. This can be thought of as one form of Marshall's 'labour pools' argument. The wage premium that needs to be paid when locating in city and village is then lower for large plants and this is the source of the comparative advantage

necessary to explain the plant size-place effect. Some evidence was presented to suggest that the labour supply curve facing individual employers is more elastic in large markets.

It should be emphasized that this paper is not claiming that monopsony can explain all of agglomeration – I strongly suspect that the other factors discussed in the literature are also relevant. But, perhaps more attention should be paid to the labour market in trying to explain agglomeration.

Technical Appendix

Proof of Proposition 2:

Take the log of (13) so that we have:

$$\log N(w_f, w) = \log L + \log \int F^{D-1}(w_f - w + \varepsilon) f(\varepsilon) d\varepsilon \quad (27)$$

The elasticity is then the derivative of this with respect to w_f (remember, the wage is already in logs). This yields:

$$\varepsilon = \frac{\partial \log N(w_f, w)}{\partial w_f} = \frac{(D-1) \int F^{D-2}(w_f - w + \eta) f(w_f - w + \eta) f(\eta) d\eta}{\int F^{D-1}(w_f - w + \eta) f(\eta) d\eta} \quad (28)$$

Now let us evaluate this at a symmetric equilibrium in which all firms pay w in which case (28) becomes:

$$\varepsilon = \frac{(D-1) \int F^{D-2}(\eta) f^2(\eta) d\eta}{\int F^{D-1}(\eta) f(\eta) d\eta} \quad (29)$$

The denominator in this case can just be written as $(1/D)$ which is just the share of employment if all firms pay the same wage. Integrating the numerator by parts, we have that:

$$\begin{aligned} \varepsilon &= D(D-1) \left\{ \left[\frac{F^{D-1}(\eta) f(\eta)}{D-1} \right]_{\underline{\eta}}^{\bar{\eta}} - \frac{1}{D-1} \int F^{D-1}(\eta) f'(\eta) d\eta \right\} \\ &= Df(\bar{\eta}) - D \int F^{D-1}(\eta) f(\eta) \frac{\partial \ln f(\eta)}{\partial \eta} d\eta \end{aligned} \quad (30)$$

Integrating the final term in (30) by parts we have that:

$$\varepsilon = Df(\bar{\eta}) - \left\{ \left[F^{D-1}(\eta) \frac{\partial \ln f(\eta)}{\partial \eta} \right]_{\underline{\eta}}^{\bar{\eta}} - \int F^D(\eta) \frac{\partial^2 \ln f(\eta)}{\partial \eta^2} d\eta \right\} \quad (31)$$

which is (14). Differentiating this with respect to D leads to:

$$\frac{\partial \varepsilon}{\partial D} = f(\bar{\eta}) + D \int F^D(\eta) \cdot \ln F(\eta) \cdot \frac{\partial^2 \ln f(\eta)}{\partial \eta^2} d\eta \quad (32)$$

The sufficient conditions given will ensure this is positive.

Proof of Proposition 3:

Suppose that a firm at position f in the productivity distribution chooses to locate in region A. Using (18) this implies that:

$$\begin{aligned} \pi^A(f) - \pi^B(f) &= (1 + \varepsilon(d^A))p(f) - \theta^A - (1 + \varepsilon(d^B))p(f) - \theta^B \\ &= (\varepsilon(d^A) - \varepsilon(d^B))p(f) - (\theta^A - \theta^B) \geq 0 \end{aligned} \quad (33)$$

Now consider a firm with productivity f' where $f' > f$. We have that:

$$\begin{aligned} \pi^A(f') - \pi^B(f') &= (1 + \varepsilon(d^A))p(f') - \theta^A - (1 + \varepsilon(d^B))p(f') - \theta^B \\ &= (\varepsilon(d^A) - \varepsilon(d^B))p(f') - (\theta^A - \theta^B) \\ &= (\varepsilon(d^A) - \varepsilon(d^B))(p(f') - p(f)) + (\pi^A(f) - \pi^B(f)) > 0 \end{aligned} \quad (34)$$

where the last line follows from (33) and the fact that the elasticity of labour supply is higher in region A.

This ‘single-crossing’ property implies that any agglomeration equilibrium must be of the form of a cut-off f^* such that all firms with $f > f^*$ locate in region A and all firms with $f < f^*$ locate in region B. For there to be more firms in region A it obviously must be the case that $f^* < 0.5$.

Proof of Proposition 4:

Part a is the definition of the agglomeration.

Part b follows directly from Proposition 2.

Part c. then follows from (17) as the agglomeration both has more productive firms and is more competitive as it has more firms.

Part d. follows from parts b. and c. and (23).

Part e. Consider a firm that pays a wage $w = w^A$ - in an agglomeration equilibrium this firm must be in region A. This means that a shift to region B while paying the same wage must result in lower employment or else profits would be higher in region B. wage such that $w^A \geq w > w^B$. From (15) this implies that:

$$n^A(w^A) - n^B(w^A) = (l^A - d^A) - (l^B - d^B) - \varepsilon(d^B)(w^A - w^B) \geq 0 \quad (35)$$

As $w^A > w^B$ this implies that:

$$(l^A - d^A) > (l^B - d^B) \quad (36)$$

and part e. follows from the observation that log average firm size is given by $(l - d)$.

Proof of Proposition 5

I will show this using a fixed-point argument. Suppose that the cut-off for the firm location decisions is f^* as Proposition 2 shows must be the case in any agglomeration equilibrium. Using (16), (17) and (23) one can then derive the number of workers and average wages in the two regions as a function of f^* .

Given that this is the case let us consider the optimal location decisions of firms.

Given the single-crossing property of the profit functions, this must also be a cut-off, \hat{f} , such that all firms further up the productivity distribution than this locate in region A and

the others in region B. Obviously an interior solution for \hat{f} must have profits for a firm at that position being equal in the two regions so one has that \hat{f} must satisfy:

$$\begin{aligned} & (1 + \varepsilon(1 - f^*)) p(\hat{f}) - \ln(1 + \varepsilon(1 - f^*)) + (l^A(f^*) - \ln(1 - f^*)) - \varepsilon(1 - f^*) w^A(f^*) \\ & = (1 + \varepsilon(f^*)) p(\hat{f}) - \ln(1 + \varepsilon(f^*)) + (l^B(f^*) - \ln(f^*)) - \varepsilon(f^*) w^B(f^*) \end{aligned} \quad (37)$$

If there is no value such that this is satisfied then we must have a corner solution in which all firms would choose to locate in one region or another. One can think of the (37) as giving a solution $\hat{f}(f^*)$. An equilibrium must be a fixed point of this mapping.

A sufficient condition for an agglomeration equilibrium is that if the firms split equally between the two regions with the most productive locating in region A then the median firm will also locate in region A. Using (37) this leads to the condition in Proposition 4.

Table 1
Descriptive Statistics: US Counties

	Unweighted	Employment –Weighted
Employment	35441 (132557)	531074 (802612)
Establishments	2243 (7465)	29804 (45505)
Average Establishment Size	11.95 (4.74)	16.75 (3.85)
Log (Employment)	8.86 (1.70)	12.11 (1.69)
Log (Establishments)	6.45 (1.44)	9.32 (1.57)
Log (Average Establishment Size)	2.41 (0.40)	2.79 (0.24)
Median Distance Travelled to Work	0.39 (9.19)	0.37 (3.07)
75 th Percentile of Distance Travelled to Work	5.40 (15.09)	6.94 (11.87)
90 th Percentile of Distance Travelled to Work	34.67 (29.84)	29.11 (17.95)
95 th Percentile of Distance Travelled to Work	56.04 (51.11)	47.78 (21.26)
Number of Counties	3102	3102

Table 2
The Relationship Between Log Average Establishment Size and Log Total Employment:US Counties
Dependent Variable: Log Average Establishment Size

Measure of Market Size	Coefficient on Log Market Size	Coefficient on Log Market Size Squared	Coefficient on Log Market Size Cubed	Observations	R-squared
Total Employment	0.171 [0.003]			3102	0.54
Total Employment	0.538 [0.020]	-0.02 [0.001]		3102	0.59
Total Employment	0.542 [0.077]	-0.021 [0.008]	0.000016 [0.000030]	3102	0.59
Employment/ Land Area	0.212 [0.006]	-0.012 [0.001]		3102	0.59
Employment within Median Commute	0.763 [0.039]	-0.03 [0.002]		3102	0.47
Employment within 75 th percentile Commute	0.741 [0.035]	-0.029 [0.002]		3102	0.49
Employment within 90 th percentile Commute	0.585 [0.037]	-0.021 [0.002]		3102	0.38
Employment within 95 th percentile Commute	0.659 [0.050]	-0.023 [0.002]		3102	0.27

Notes: Robust standard errors in brackets.

Table 3
The Relationship Between Log Average Establishment Size
and Log Total Employment within Industries in the US

Level of Aggregation	2-digit	2-digit	3-digit	3-digit	4-digit	4-digit	5-digit	5-digit	6-digit	6-digit
Dependent Variable: Log Average Establishment Size										
Coefficient on Log Market Size	0.344	0.339	0.578	0.474	0.199	0.415	0.042	0.374	-0.066	0.359
	[0.022]	[0.018]	[0.024]	[0.019]	[0.033]	[0.023]	[0.032]	[0.027]	[0.029]	[0.028]
Coefficient on Log Market Size Squared	-0.006	-0.007	-0.015	-0.014	0.002	-0.01	0.007	-0.008	0.011	-0.008
	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]
Observations	44093	44093	92107	92107	161621	161621	208548	208548	213392	213392
Dependent Variable: Fraction of Establishments with 1-4 Employees										
Coefficient on Log Market Size	-10.903	-10.234	-13.357	-11.407	-11.476	-12.929	-9.528	-13.407	-8.031	-13.774
	[0.515]	[0.508]	[0.475]	[0.451]	[0.468]	[0.442]	[0.496]	[0.456]	[0.539]	[0.476]
Coefficient on Log Market Size Squared	0.429	0.412	0.543	0.459	0.416	0.517	0.327	0.517	0.24	0.536
	[0.026]	[0.026]	[0.025]	[0.023]	[0.024]	[0.023]	[0.026]	[0.024]	[0.028]	[0.025]
Dependent Variable: Fraction of Establishments with 5-9 Employees										
Coefficient on Log Market Size	2.479	2.887	1.725	2.515	2.137	2.935	2.443	3.15	2.524	3.005
	[0.417]	[0.414]	[0.322]	[0.317]	[0.254]	[0.243]	[0.235]	[0.221]	[0.228]	[0.212]
Coefficient on Log Market Size Squared	-0.133	-0.152	-0.102	-0.124	-0.121	-0.135	-0.131	-0.14	-0.136	-0.13
	[0.021]	[0.021]	[0.016]	[0.016]	[0.012]	[0.012]	[0.011]	[0.011]	[0.011]	[0.010]
Dependent Variable: Fraction of Establishments with 10-19 Employees										
Coefficient on Log Market Size	4.121	4.005	3.346	3.442	3.077	3.776	2.793	3.964	2.541	3.932
	[0.257]	[0.256]	[0.219]	[0.218]	[0.182]	[0.180]	[0.176]	[0.172]	[0.168]	[0.164]
Coefficient on Log Market Size Squared	-0.182	-0.181	-0.14	-0.14	-0.121	-0.15	-0.104	-0.149	-0.09	-0.147
	[0.013]	[0.013]	[0.011]	[0.011]	[0.009]	[0.009]	[0.009]	[0.008]	[0.008]	[0.008]
Dependent Variable: Fraction of Establishments with 20+ Employees										
Coefficient on Log Market Size	4.304	3.342	8.287	5.45	6.263	6.218	4.292	6.293	2.966	6.836
	[0.290]	[0.283]	[0.310]	[0.283]	[0.337]	[0.297]	[0.350]	[0.302]	[0.417]	[0.342]
Coefficient on Log Market Size Squared	-0.114	-0.079	-0.301	-0.195	-0.175	-0.232	-0.091	-0.228	-0.014	-0.259
	[0.015]	[0.015]	[0.016]	[0.015]	[0.018]	[0.016]	[0.018]	[0.016]	[0.022]	[0.018]
Observations	59846	59846	178177	178177	429716	429716	686116	686116	792896	792896
Industry Controls	no	Yes	no	Yes	no	yes	no	yes	no	yes

Notes.

1. standard errors reported in parentheses and computed clustering on the county.

Table 4
The Relationship Between Log Average Establishment Size
and Log Total Employment within Industries in the US by 1-digit industry

	Forestry, Fishing, Hunting	Mining, Utilities, Construction	Manu- facturing	Wholesale, Retail, Transport	Finance, Real Estate etc	Health and Education	Food, Accomm- odation, Leisure	Other Services
Coefficient on Log Market Size	0.028 [0.124]	0.491 [0.046]	1.839 [0.087]	0.517 [0.020]	0.781 [0.040]	0.217 [0.041]	0.894 [0.035]	0.372 [0.025]
Coefficient on Log Market Size Squared	-0.001 [0.006]	-0.015 [0.002]	-0.087 [0.004]	-0.018 [0.001]	-0.024 [0.002]	-0.007 [0.002]	-0.035 [0.002]	-0.009 [0.001]
Constant	1.31 [0.596]	-1.484 [0.214]	-5.646 [0.415]	-0.977 [0.093]	-3.319 [0.184]	1.532 [0.190]	-2.709 [0.163]	-1.141 [0.113]
Observations	1200	2930	2693	3066	2988	2933	2955	2992
R-squared	0	0.34	0.2	0.65	0.64	0.1	0.53	0.61

Table 5
Descriptive Statistics: UK Travel-to-Work Areas

	Unweighted	Employment –Weighted
Employment	83883 (256925)	868171 (1408017)
Establishments	7207 (23423)	78346 (133549)
Average Establishment Size	10.23 (2.64)	12.00 (2.03)
Log (Employment)	10.31 (1.37)	12.46 (1.59)
Log (Establishments)	8.02 (1.18)	9.99 (1.59)
Log (Average Establishment Size)	2.29 (0.27)	2.47 (0.18)
Number of TTWAs	297	297

Table 6
The Relationship Between Log Average Establishment Size
and Log Total Employment:UK Travel-to-Work Areas
 Dependent Variable: Log Average Establishment Size

Measure of Market Size	Coefficient on Log Market Size	Coefficient on Log Market Size Squared	Coefficient on Log Market Size Cubed	Coefficient on London Dummy	Observations	R-squared
Total Employment	0.147 [0.009]				297	0.56
Total Employment	0.153 [0.008]			-0.681 [0.039]	297	0.58
Total Employment	0.726 [0.075]	-0.028 [0.004]			297	0.62
Total Employment	0.696 [0.093]	-0.026 [0.004]		-0.119 [0.093]	297	0.62
Total Employment	0.252 [0.513]	0.017 [0.046]	-0.001 [0.001]		297	0.62
Employment/ Land Area	0.133 [0.011]	-0.002 [0.004]			297	0.54

Notes: Robust standard errors in brackets.

Table 7
The Relationship Between Log Establishment Size and Labour Pools:
UK Ward Data

Measure of Labour Pool Based On	Percentile	Coefficient on Log Labour Pool		Coefficient on Log Labour Pool Squared		Number of Observations	R2
		[standard error]	[standard error]	[standard error]	[standard error]		
Own Ward	50	0.335	[0.019]	-0.014	[0.001]	9524	0.2
Own Ward	75	0.268	[0.021]	-0.009	[0.001]	9524	0.13
Own Ward	90	0.29	[0.022]	-0.01	[0.001]	9524	0.1
Own Ward	95	0.281	[0.022]	-0.01	[0.001]	9524	0.1
Wards within 5km (including own ward)	50	0.351	[0.019]	-0.017	[0.001]	9524	0.13
Wards within 5km (including own ward)	75	0.337	[0.024]	-0.015	[0.001]	9524	0.07
Wards within 5km (including own ward)	90	0.382	[0.027]	-0.016	[0.001]	9525	0.05
Wards within 5km (including own ward)	95	0.418	[0.028]	-0.018	[0.001]	9525	0.05
Wards within 5km (excluding own ward)	50	0.338	[0.023]	-0.016	[0.002]	8869	0.08
Wards within 5km (excluding own ward)	75	0.345	[0.030]	-0.016	[0.002]	8869	0.04
Wards within 5km (excluding own ward)	90	0.424	[0.034]	-0.019	[0.002]	8870	0.03
Wards within 5km (excluding own ward)	95	0.462	[0.035]	-0.021	[0.002]	8870	0.03
Wards within 10km (including own ward)	50	0.344	[0.025]	-0.016	[0.002]	9524	0.07
Wards within 10km (including own ward)	75	0.39	[0.030]	-0.018	[0.002]	9525	0.05
Wards within 10km (including own ward)	90	0.445	[0.037]	-0.02	[0.002]	9525	0.03
Wards within 10km (including own ward)	95	0.563	[0.044]	-0.025	[0.002]	9525	0.03
Wards within 10km (excluding own ward)	50	0.367	[0.026]	-0.017	[0.002]	9513	0.07
Wards within 10km (excluding own ward)	75	0.4	[0.031]	-0.018	[0.002]	9514	0.05
Wards within 10km (excluding own ward)	90	0.47	[0.038]	-0.021	[0.002]	9514	0.03
Wards within 10km (excluding own ward)	95	0.538	[0.043]	-0.024	[0.002]	9514	0.03

Table 8
The Plant-Size Wage Effect Across Markets

Dependent variable	US	UK	UK
	Log	Average	Adjusted
	average	log	Average
	earnings	hourly	log
		wage	hourly
			wage
log average plant size	0.385	0.113	0.045
	[0.012]	[0.018]	[0.008]
Constant	0.709	1.702	-0.147
	[0.028]	[0.042]	[0.019]
Observations	3102	297	297
R-squared	0.4	0.11	0.09

Notes.

1. The US estimates are for counties, the UK estimates are for TTWAs
2. US data on average establishment size and average earnings are from County Business Patterns
3. UK data on average establishment size from ABI and on average earnings from NES. Adjusted wages are residuals are from earnings function controlling for a full set of age, industry and occupation dummies.
4. Robust standard errors in parentheses

Table 9
The Employer Size-Wage Effect In and Out of Cities: US Evidence

	1a	1b	2a	2b	3a	3b	3c
MSA Status	Non-MSA	MSA	Non-MSA	MSA	Non-MSA	MSA	Large MSA
Log Employer Size	0.1201 [0.0083]**	0.1071 [0.0047]**	0.0759 [0.0079]**	0.0598 [0.0043]**	0.0671 [0.0078]**	0.0567 [0.0044]**	0.0495 [0.0049]**
Personal Characteristics Included	No	No	Yes	Yes	Yes	Yes	Yes
Industry/Occupation Included	No	No	No	No	Yes	Yes	Yes
Other Sample Restrictions	No	No	No	No	No	No	No
Observations	1708	5003	1684	4939	1684	4939	3978
R-squared	0.12	0.1	0.39	0.36	0.48	0.43	0.42

Notes: Data come from April 1993 Contingent Worker
 Dependent variables is log hourly wage
 Sample is restricted to non-union.
 Robust standard errors in brackets
 Log employer size is computed using mid-points of size class with...

Table 10
The Variation in the Employer Size-Wage Effect With Labour Market Size: UK Evidence

	1	2	3	4	5	6
Log labour market size	-0.273 [0.197]	-0.592 [0.094]	-0.771 [0.387]	-0.303 [0.208]	0.151 [0.055]	0.152 [0.055]
Log labour market size Squared	0.879 [0.127]	0.731 [0.057]	1.209 [0.287]	0.539 [0.151]	0.025 [0.034]	0.025 [0.034]
Log firm Size	0.46 [0.080]	0.528 [0.042]	0.137 [0.200]	0.716 [0.105]	0.217 [0.022]	0.217 [0.022]
Log firm Size * Log labour market size	-0.545 [0.121]	-0.211 [0.060]	0.348 [0.621]	-0.73 [0.323]	-0.086 [0.028]	-0.086 [0.028]
Log firm Size * Log labour market size squared			-0.591 [0.470]	0.344 [0.240]		
Other Controls	No	Yes	No	Yes	No	yes
Fixed Effects	No	No	No	No	Yes	Yes
Observations	422440	422283	422440	422283	422440	380594
R-squared	0.05	0.65	0.05	0.65	0.18	0.18

Notes: Data come from New Earnings Survet for 1997-2001
 Dependent variables is log hourly wage excluding overtime
 Sample is restricted to private sector
 standard errors clustered on TTWA in brackets
 Log firm size is computed using mid-points of size class with...

Figure 1
The Relationship Between Average Establishment Size and Log Total Employment:
US Counties

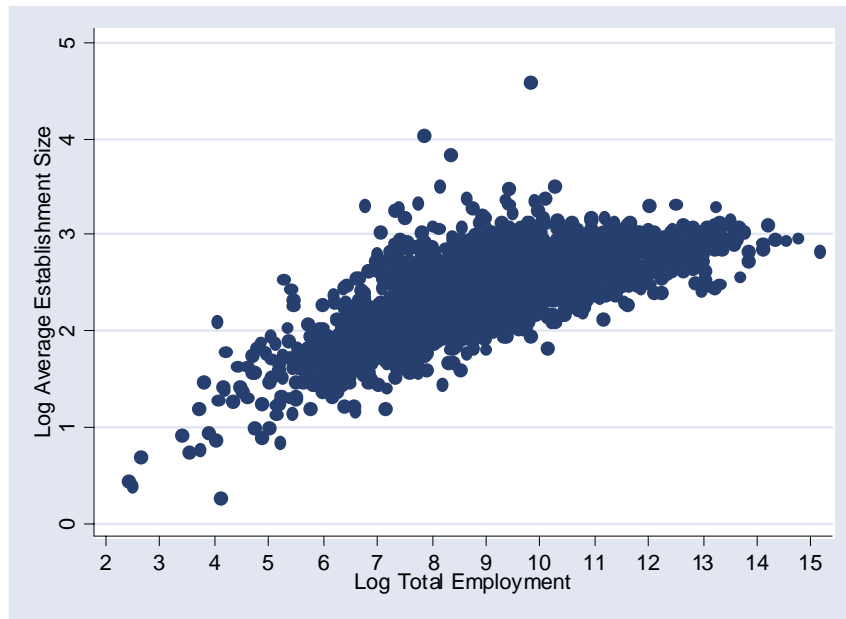


Figure 2
The Quadratic and Kernel Regression for the
Relationship Between Average Establishment Size and Log Total Employment:
US Counties

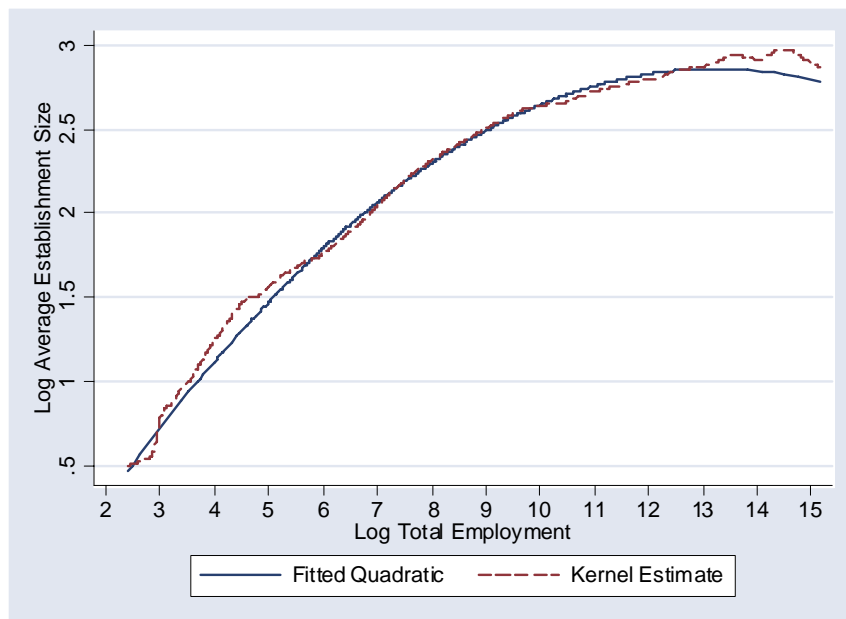


Figure 3
The Fraction of Total Establishments by Size Class:
US Counties

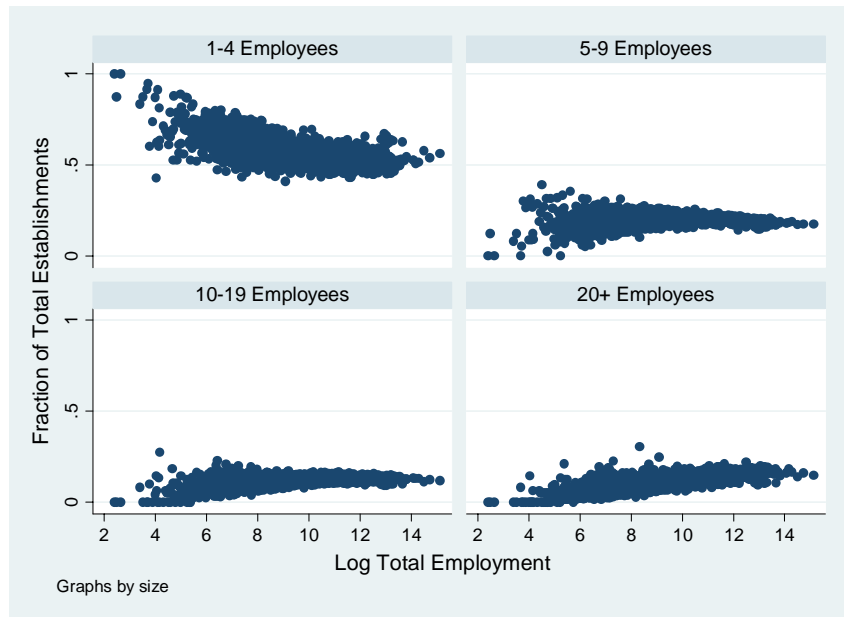


Figure 4
The Plant Size- Place Effect and the Dartboard Effect

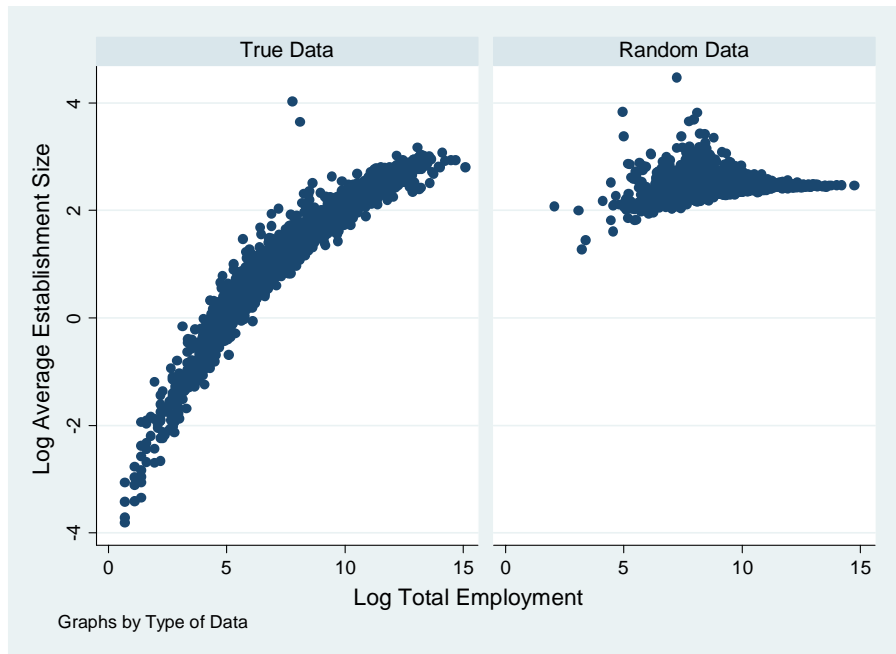


Figure 5

**The Relationship Between Average Establishment Size and Log Total Employment within 1-digit industries:
US Counties**

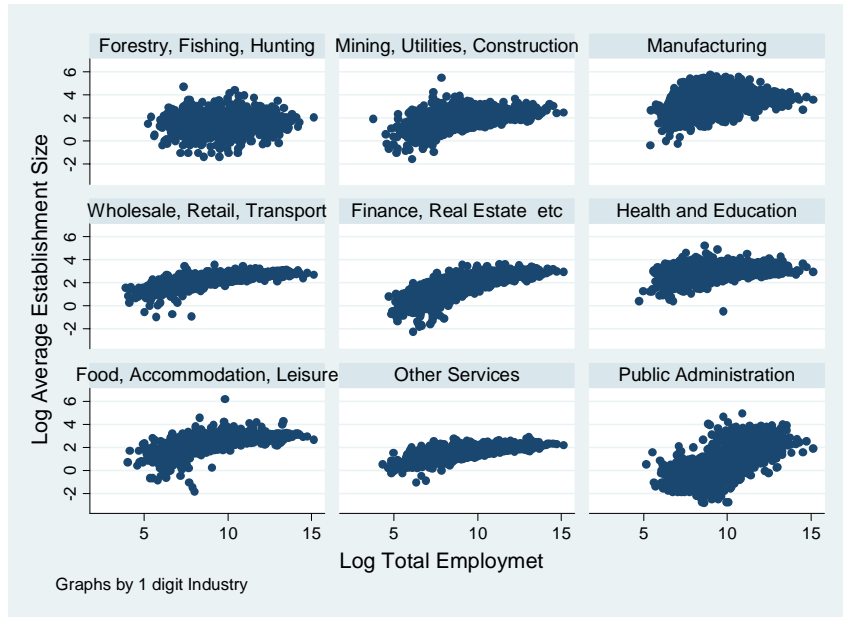


Figure 6

**The Relationship Between Average Establishment Size and Log Total Employment: UK Travel-to-Work
Areas
(with quadratic and kernel regression lines)**

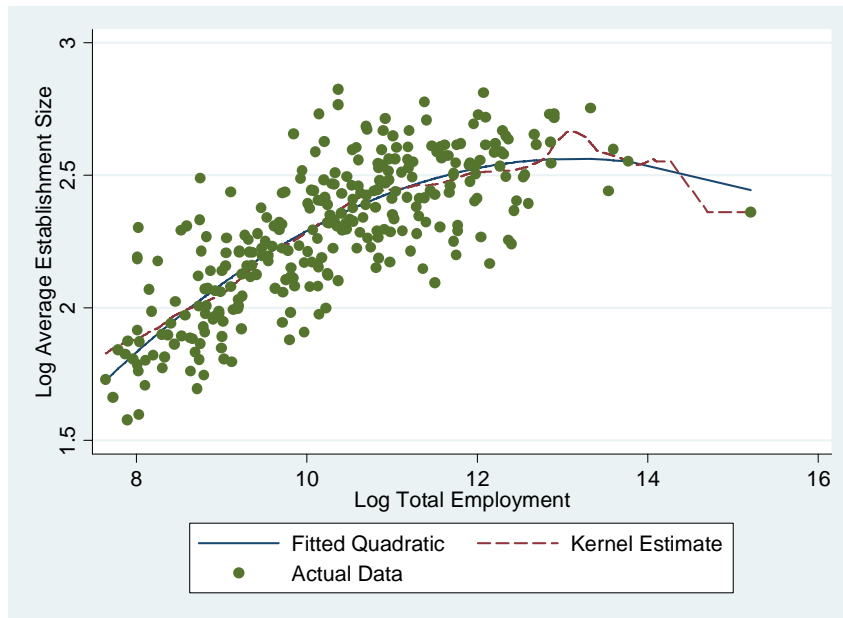


Figure 7
City and Village with A Competitive Labour Market

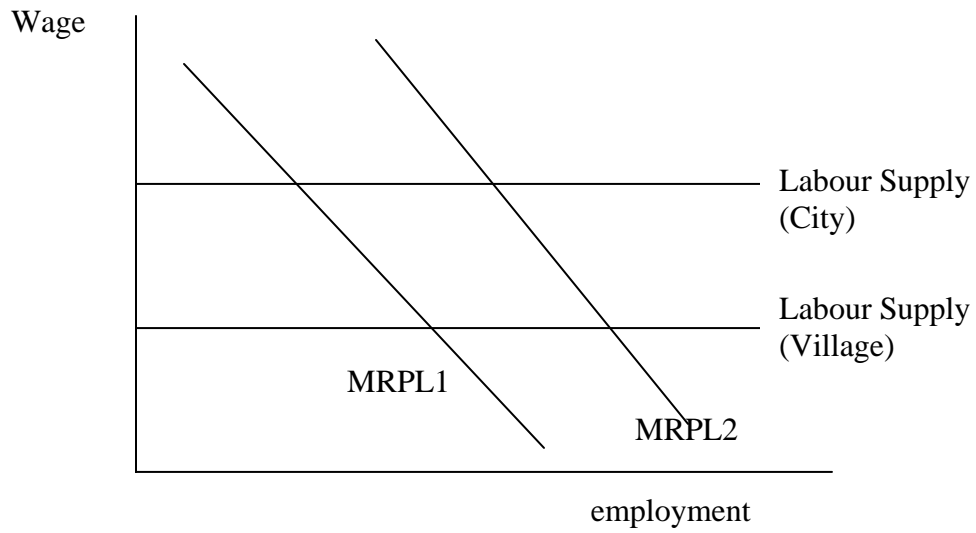


Figure 8
City and Village with A Monopsonistic Labour Market

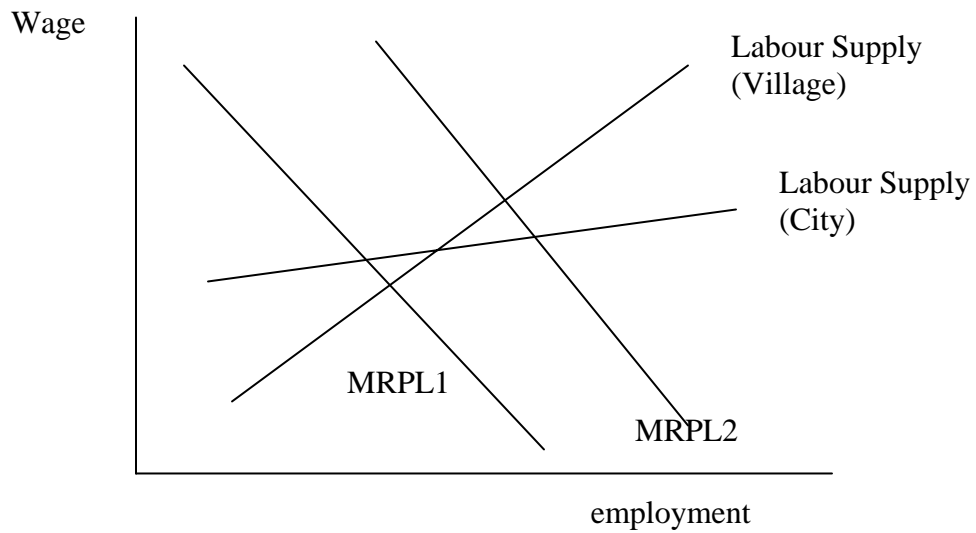


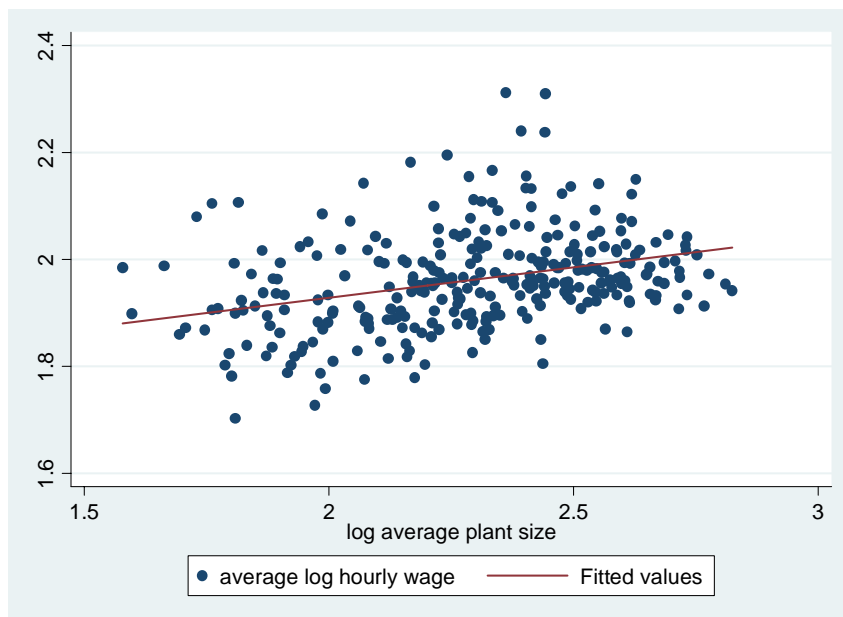
Figure 9

The Relationship between Log Average Wages and Log Average Plant Size Across US Counties



Figure 10

The Relationship between Log Average Wages and Log Average Plant Size Across UK TTWAs



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