OFFICE OF FAIR TRADING

Competition in local homebuilding markets

A report for the OFT by Catherine Ball

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CONTENTS

This paper was funded by the Office of Fair Trading (OFT) from Catherine Ball. She was asked to prepare a paper which used the analytical techniques developed by Bresnahan and Reiss to examine competitive relationships in the homebuilding industry. The views of this paper are those of Catherine Ball and do not necessarily reflect the views of the OFT nor the legal position under existing competition or consumer law which the OFT applies in exercise of its enforcement functions.

1 EXECUTIVE SUMMARY

Introduction

1.1 This research was commissioned to look at the level of competition in the market for homebuilding. The analysis focuses on the relationship between market size and number of firms in the market to draw inferences on competitive conduct in the market.

1.2 Using a method developed by Bresnahan and Reiss (1990, 1991), it is possible to surmise the effect the entry of another firm has upon the competitive pressures firms face. For example, if a monopolist requires a market of size S to break even, we would expect a market size of more than 2S would be required to support two firms as the entry of the second firm would be expected to increase competition and thus reduce the firms' margins. Extending this framework to n firms enables the researcher to use the relationship between number of firms and market size to evaluate how many firms are required in the market for it to become competitive (competitive pressure is assumed to be increasing in the number of firms in the market until perfect competition is reached). The main advantage of this methodology is that it requires very little information. In particular, no price data is required as price-cost margins are inferred indirectly.

1.3 This approach allows the researcher to estimate demand entry thresholds for homebuilders. These show the size of market required to support a given number of firms. When the market size required to support each firm in a market of n firms is the same as the market size required to support each firms in a market of $n+1$ firms, it can be assumed that the entry of the $n+1$th firm did not increase competitive pressure and the market is perfectly competitive.

Data

1.4 For the purposes of this research, Local Authority districts were assumed to represent geographical markets for homebuilding. Whilst more sophisticated methods of compiling geographical markets are

available, these have data requirements that are unobtainable and often lead to market regions that are empirically intractable. Local Authority districts are an appropriate measure of market size in this study because the planning process firms face is conducted at the Local Authority level, thus, on the supply-side, any constraints the firms face are likely to be consistent.

1.5 The data on the number of firms in each Local Authority district was collected from EMAP data on the number of successful planning applications in each Local Authority. Planning applications made by Housing Authorities and other public bodies were not counted. Due to limitations in the data , only data from the year 2004 was used.

1.6 The data on number of firms was counted in three different ways.

- The number of all private firms granted planning permission in each Local Authority in 2004.
- The number of firms, who had in any Local Authority, built more than *m* housing units, granted planning permission in each Local Authority in 2004.
- The number of firms, who had built houses in any Local Authority, granted planning permission in each Local Authority in 2004

  -or-

- The number of firms, who had built flats/apartments in any Local Authority, granted planning permission in each Local Authority in 2004.

1.7 The latter two counts extend the analysis to look at differences in the relationship between market size and number of firms for both different size of builds and different types of build.

1.8 Several different definitions of market size have been used in this research. These include, population, the number of jobs, the number of house sales (both of the existing housing stock and new housing) and

the number of households. Typically some measure of population is used when calculating demand entry thresholds but in the case of homebuilding this might not be an appropriate measure because population is likely to depend upon the supply of housing, of which new homebuilding is a part.

1.9 Other variables were used to predict the profitability of firms in a market, these include, on the supply side, wage costs, access to developable land and affordable housing requirements imposed by the Local Authority, and on the demand side, residents' income, access to and the provision of existing housing and the availability of affordable housing which may be seen as a substitute to private housing.

Results

1.10 Factors that impact negatively on the number of homebuilders in a market (holding other factors constant):

- the average wages paid to construction workers and,
- the level of Section 106 requirements faced by the firms

1.11 Therefore, the affordable housing requirements imposed upon firms by Local Authority planners either reduce firms' profits or act as a barrier to entry.

1.12 When the market is defined as all private firms in a local authority, it appears that it is the entry of a fifth firm into a market that significantly increases competition.

1.13 When the market is defined as containing only firms capable of building sites with at least 125 housing units, competitive pressure increases with the entry of the second and then successive firms. As this implies competition at higher levels of concentration than in the case when the market is defined as all homebuilders it suggests evidence that firms capable of building less than 125 units act as a competitive fringe and their entry does not significantly effect competitive conduct.

1.14 When the market is defined as only private firms that are capable of building flats, it is the entry of the seventh/eighth firm that induces competitive pressure. When the market is defined as only private firms that are capable of building houses, competitive pressures start increasing with the entry of the second firm. Thus competition can be sustained at higher levels of concentration among firms that are capable of building houses than among firms that are capable of building flats.

1.15 The proportion of land in a local authority that is brownfield land suitable for housing negatively affects the profits of firms capable of building houses. This may be because this land is costly to build upon per square foot and houses are significantly more land-intensive to build than flats.

Concluding remarks

1.16 The econometric results described above are robust across several different model specifications. However, the entry thresholds ratios (which provide evidence for the number of firms required in a market in order for that market to break even are sensitive to the econometric specification used. Some evidence has been provided that the results above are obtained from the specification that is most appropriate.

1.17 The main limitation of these results is that they rely upon strong assumptions about geographical and product market definition. In addition to this, the main data source used may not give an accurate representation of the number of firms operating in each market and if this count is incorrect, the results will be unreliable.

1.18 Nevertheless, despite these difficulties, certain conclusions are robust and can be treated with confidence. First, there is an inverse relationship between section 106 affordable housing requirements and the number of homebuilders in a local market, as the proportion of affordable housing required under section 106 rises the number of homebuilders falls. Second, competition only increases once a significant number of homebuilders enter the market, although the exact entry thresholds found by this paper must be regarded as indicative rather than conclusive.

2 INTRODUCTION

2.1 This study relies heavily upon the seminal work by Bresnahan and Reiss (1990, 1991) in developing a model that relates the structure of a market to the size of that market in a static setting, in order to draw inferences about competitive conduct in that market. This approach differs from the traditional market power literature because the structure of each market is determined endogenously (the entry decisions of the firm are explicitly modelled). In addition to this, this type of model also has the advantage that it does not require the researcher to have information about prices and quantities. In their paper, 'Entry and Competition in Concentrated Markets', the authors investigate competition in five industries, doctors, dentists, druggists, plumbers and tire dealers. They find that in all the industries examined, a change in competitive conduct occurs with the entry of the second or third firm, after that, entry of successive firms does not cause variation in competitive conduct. Their methodology comprises the estimation of demand entry thresholds, that is, the amount of demand (proxied by market size) required for a given number of firms to break even. The amount of extra demand each firm requires to break even is expected to increase as concentration decreases.

2.2 Models of firm entry and issues arising from the estimation of these models are discussed in great detail by Berry and Reiss in their chapter in the third volume of the Handbook of Industrial Organization (2007). In particular, models are separated into those that deal with homogeneous firms and those where firms are allowed to be heterogeneous. In the case of heterogeneous firms, problems of multiplicity in equilibria are discussed. Here a problem occurs because, when firms are non-identical, it can be difficult to obtain a unique equilibrium concerning the number of firms in the market (for example, in the extreme case, two smaller firms could find it profitable to enter in a market that would only be big enough to support one large firm). In this case, it may be necessary to impose further assumptions on the model, such as sequence of entry. Efficient entry models would assume that the firm with the largest potential profits would enter first (be the incumbent), thus solving the multiplicity problem. If the sequence of entry is not known to the

researcher, then the probability of each equilibrium occurring may be estimated alongside the other parameters of the model, however, this can lead to a large number of parameters to be estimated if the number of potential entrants is large.

2.3 As Berry and Reiss (2007) describe the methodological issues involved in estimating entry models, in this section, I shall concentrate on summarizing some of the papers that apply Bresnahan and Reiss type entry models to a variety of different industries.

2.4 Asplund/Sandin (1999) estimate an entry model investigating competition between driving schools in Sweden. They calculate both demand entry thresholds and capacity unit entry thresholds. They hypothesise that if per-firm demand entry thresholds are increasing in the number of competitors and capacity unit thresholds are decreasing in number of capacity units, then competition increases with market size.

2.5 Capacity unit thresholds may decrease in market size due to two effects:-

- If competition is increased in larger markets then price will be lower and demand will be higher and the number of driving lessons per capita will be greater so each car will be used to satisfy fewer individual consumers, and

- Firms will compete by offering greater accessibility during periods of temporarily high market demand, requiring a larger car fleet and therefore sustaining higher fixed costs again with each car satisfying fewer consumers.

2.6 In order to obtain demand and capacity unit thresholds Asplund and Sandin estimate Tobit and Poisson models alongside the ordered Probit model favoured by Bresnahan and Reiss (1991).

2.7 The Tobit model uses more of the information in the dependent variable because it recognises that it will be non-negative. In any given market the number of firms in the market will be zero or positive. However, the Poission model goes further than this by recognising that the number of

firms in the market is a count, that is, the dependent variable will be an integer variable. This also accounts for the fact that unlike with a rank variable, in this case, for example, two firms will not just be more firms than one firm it will be twice as many. A problem with the Poisson model is that the conditional variance is assumed to be equal to the conditional mean. Asplund and Sandin find that mean variance equality tests suggest that their data on the number of Swedish driving schools in regional markets is under-dispersed, and therefore, although their estimated coefficients are consistent, their standard errors are not. This means that they are unable to display standard errors for their calculated entry thresholds and hence it is impossible to test whether these entry thresholds are significantly different to one. This means that it is difficult for the researcher to know whether competitive pressures are truly increasing with the number of firms in the market. The ordered Probit model has the advantage over the Poisson and the Tobit in that it allows the functional form that represents the relationship between number of firms and market size to change as the size of the market changes.

2.8 Asplund and Sandin find, similarly to Bresnahan and Reiss that the largest increase in competitive conduct comes as the market moves from monopoly to duopoly. They also found that in their case the choice between different econometric models was unimportant as all gave very similar results.

2.9 Another paper that investigates the importance of functional form in calculating entry thresholds is Sjoberg (2007) which investigates the degree of competition in the Swedish rural retail banking sector using a standard Bresnahan and Reiss model using both an ordered Probit and Poisson econometric specification. The standard Bresnahan and Reiss framework is extended to include, as an explanatory variable, a dummy variable reflecting whether the market share of multi-market banks (banks that operate across many geographical markets as opposed to smaller scale local banks) is greater than the median value. This allowed the author to test the further hypothesis that markets containing multi-market banks would be more competitive, ceteris paribus. Sjoberg finds that, contrary to the standard Bresnahan and Reiss results (and what we would expect as a prediction from the Cournot model) there is not a

monotonically decreasing relationship between the per-firm entry threshold ratios and the number of firms with the ordered Probit specification. Other than this the results are similar to those estimated with the Poisson model. Competitive pressure seems to increase with the entry of each individual firm and the biggest increase in competitive pressure comes with either the entry of the third firm (ordered Probit specification) or the entry of the second firm (Poisson specification). These are similar to results from the US local banking market (Cetorelli, 2002) and do not contradict those found by Bresnahan and Reiss (1991) in the industries that they investigated.

2.10 The allowance of different types of firm is also examined in Olczak (2006), an investigation into the effect of market liberalisation in the market for opticians' services. Here the distinction is made between firms that use national pricing strategies and those that price locally. The author finds that chain stores' use of national pricing strategies protects independents from the intense price competition that might occur if all firms in the market adopted local pricing that depended upon the number of firms in the market.

2.11 Collard-Wexler (2006) extends the standard Bresnahan and Reiss framework to a panel data model with fixed effects to investigate competition in the US ready-mix concrete industry. Collard-Wexler believes that the assumption of the standard Bresnahan and Reiss model, that unobserved profitability in the error term is not correlated with any of the explanatory variables (for example, demand and the number of firms in the market), is 'heroic'. Whilst such profitability might be unobserved by the researcher, if the firms can observe it then there will be greater entry into markets with higher unobserved profitability and hence there will be correlation between the error term and the number of firms in the market. Also, unobserved profitability may be correlated with demographic variables used to measure differences in observed profitability across markets, for example, in the case of the ready-mix concrete industry if large markets are more likely to require the building of multi-storey buildings that are more concrete intensive. Thus there can be correlation between the error term and both of the main components of observed profitability. Collard-Wexler shows how this

can lead to bias in the demand entry thresholds calculated using the standard Bresnahan and Reiss model. In particular, the relationship between market size demographics and profitability can be biased upwards and the competitive effects of entry (the relationship between the number of firms in a given market and the level of firm profitability) can be biased downwards. This can lead to the researcher overestimating per-firm demand entry thresholds. In a simple example using data from the ready-mix concrete industry, Collard-Wexler shows that the standard Bresnahan and Reiss model would suggest that most of the increase in competitive conduct comes with the entry of the fourth firm in the ready-mix concrete industry, whereas a model that accounts for this bias would suggest it was at least the entry of the sixth firm. Collard-Wexler's solution to the problem of bias in entry models is to use a panel data model with both market specific and year-specific fixed effects to pick up unobserved differences in firm profitability. In that some of the unobserved profitability may not be picked up by either of these fixed effects there is the possibility of some bias remaining but it is likely to be much smaller. Obviously panel data models have higher data requirements, as it is not sufficient for the researcher to know the number of firms operating in each market at any given point in time but also across several time periods. In addition to this, the number of parameters-to-be-estimated is increased significantly as the market-specific fixed effects require a dummy variable to be included for each market in the sample. This can be computationally difficult.

2.12 Abraham et al (2003) estimate a Bresnahan and Reiss style entry model using data from the US hospital industry. They extend the framework by also looking at how quantity increases as the size of the market increases. If entry leads to increased quantity being supplied then either lower prices or increased quality are increasing the number of 'consumers' being served and hence increasing social welfare. They find (similarly to Bresnahan and Reiss, 1991) that it is the entry of the second firm that causes the biggest increase in 'toughness of competition' and give the policy implication that mergers in the industry should be prohibited if they are mergers to monopoly but mergers to duopoly or triopoly are likely to have little impact on competition. They

also find that entry of the second firm causes a significant increase in quantity consumed and hence an increase in consumer welfare.

2.13 Another paper that looks at the effect of entry on social welfare is that of Hseih and Moretti (2003) investigating whether free entry is socially efficient in the real estate agent industry in the US. They find that, assuming percentage commission rates paid to agents are fixed, increasing house prices lead to excessive entry that is socially inefficient from a social welfare viewpoint as firms compete harder to attract the same number of consumers, that is, entry does not appear to expand the market due to the commission rate remaining fixed, hence increased competition merely raises firms costs (such as costs of advertising) and reduces broker profitability.

2.14 Cleeren et al (2006) estimate a Bresnahan and Reiss entry model on data from the Belgian video-rental market. They extend the basic framework by including a variable to represent the presence of substitutes in each market (in this case the substitutes are premium cable and movie theatres. They find that the greatest variation in competitive conduct occurs with the entry of the third firm in the market. The authors posit that whilst this contradicts the predictions from Cournot, differentiated Bertand and contestable market theories, it is consistent with the predictions from imperfectly sustainable collusion theories where collusion is sustainable when markets are very concentrated (that is, duopoly) but as the number of firms increases, collusion breaks down. They also find that whilst there is cannibalisation from movie theatres, the existence of premium cable in a market does not lower video store profits.

Econometric specification

2.15 For baseline results I estimate a standard Bresnahan and Reiss entry model. In this sense I treat homebuilding firms as homogeneous. In order to deal with potential heterogeneity between firms I then re-estimate the models on various sub-samples of firms, accounting for the type of properties and the different sizes of site firms build. Hence firms are assumed to be homogeneous within a market definition but I have tested

the assumption that the homebuilding industry may contain several heterogeneous sub-markets.

2.16 I investigate the way in which competition changes with entry. As entry increases in a market area we would expect competition to intensify and the viability of collusion either tacit or explicit to decrease. This leads to firms making lower price-cost margins and therefore requiring a higher level of market demand to break even (variable profits high enough to cover fixed costs).

2.17 For example, as the number of firms in a market increases from monopoly to duopoly the market size required to support each firm increases as competitive pressures increase. Once perfect competition is reached, the entry of an extra firm no longer lowers margins and therefore as the market grows each extra firm requires the same market demand to break-even as the one preceding it.

2.18 However, this implies the same relationship between number of firms and market size under both perfect competition and perfect collusion. Therefore, a further assumption is required in order to distinguish between the two. That is, that competition is increasing with the number of firms in the market. This relationship can be used to infer the level of competition in the market. By estimating demand entry thresholds for differently sized markets we can identify the level of market demand required for N firms to break even and hence determine the change in concentration caused by firm entry.

2.19 Cournot and differentiated Bertrand competition models suggest that the largest increase in competitive pressure should occur with the entry of the second firm and the entry of subsequent firms should also increase competitive pressure but to a lesser degree until the market becomes perfectly competitive and no further reductions in margins can be achieved. Additionally, if the market is contestable, potential entry should reduce even an incumbent monopolist's profits to a competitive level and therefore if this is the case we should not expect competitive pressures to increase as the number of firms increases. Thus it can be seen that entry thresholds need to be interpreted with care.

2.20 By means of the econometric framework used by Bresnahan and Reiss (1991), Asplund and Sandin (1999) and Cleeren et al (2006) a firm's profits are assumed represented by the latent profit function:

$$\Pi_i^n = \pi_i^n + \varepsilon_i \quad \textbf{(1)}$$

2.21 Where π_i^n is non-stochastic and dependent upon the number of firms in the market and ε_i is an error that varies across markets but not across firms and that is unobserved by the researcher but is observed by the firm. Hence firms are treated as homogeneous.

2.22 When Π_i^1 is less than zero, even a monopolist would not enter the market, when $\Pi_i^1 \geq 0$ but $\Pi_i^2 < 0$ we observe a monopoly, when $\Pi_i^2 \geq 0$ but $\Pi_i^3 < 0$ we observe duopoly, and so forth.

2.23 If the market specific errors, ε_i, are standard normally distributed then, the following represent the probability of observing a given number of firms in the market:

$$P(N = 0) = 1 - \Phi(\pi_i^1) \quad \textbf{(2)}$$

$$P(N = n) = \Phi(\pi_i^n) - \Phi(\pi_i^{n+1}) \text{ for } \forall n \geq 1$$

Where $\Phi(\cdot)$ is the cumulative standard normal distribution.

2.24 Hence the likelihood function for a sample with I markets and a maximum observed number of firms in a market of K is (from Cleeren et al 2006):

$$L = \prod_{i=1}^{I} \prod_{n=0}^{K} P(N_i = n)^{z_{in}} \quad \textbf{(3)}$$

2.25 And this corresponds to the likelihood function of an ordered Probit model. Obviously the assumption that the errors from this model are normally distributed needs to be checked using sensitivity testing. In particular, I check that the results from this model are robust to different

functional forms. Whilst the ordered Probit model is used to obtain the baseline results, for the purposes of sensitivity testing, a Negative Binomial and a Tobit model specification have also been estimated.

2.26 In the case of homebuilding the factors that might be expected to explain a firm's profitability in a given market could be the following: Size of the market, costs, number of firms in the market, other factors affecting demand.

2.27 A firm's latent profit function is assumed to be:

$$\Pi_i^n = \pi_i^n + \varepsilon_i$$

$$\pi_i^n = \alpha \ln(S_i) + \beta \mathbf{DEM}_i - \lambda^n \mathbf{D}_i^n \quad \textbf{(4)}$$

2.28 Where S is the measure of market size[1], **DEM** is a vector of demographic variables to explain variation in profitability across markets and **D** is a vector of n dummy variables that report 1 when the number of firms in that market is equal to n.

2.29 This reduced-form specification is used as opposed to the more specific profit function from the Bresnahan and Reiss (1991) model as it can be difficult to separately identify the variable profit and fixed cost parameters.

2.30 Entry thresholds are then derived as (from Cleeren et al 2006):

$$S^n = \exp\left(-\frac{\hat{\beta}\overline{\mathbf{DEM}} - \hat{\lambda}^n}{\hat{\alpha}}\right) \quad \textbf{(5)}$$

2.31 And the per-firm entry threshold ratios are:

[1] The natural logarithm of the market size is taken to ensure that the entry thresholds estimated are non-negative.

$$s^n / s^{n-1} = \frac{S^n}{n} / \frac{S^{n-1}}{n-1} = \exp\left(\frac{\hat{\lambda}^n - \hat{\lambda}^{n-1}}{\hat{\alpha}}\right) \times \left(\frac{n-1}{n}\right) \quad \textbf{(6)}$$

2.32 If this ratio is equal to one then the entry of an nth firm into the market has not changed competitive conduct. If the ratio is greater than one, the entry of the nth firm has increased competitive pressure in the market. Cournot and differentiated Bertrand models predict that the ratio will be greatest when n is equal to two (that is, the change from monopoly to duopoly will induce the largest increase in competitive pressure) and then decline smoothly to one with successive entry. Contestable market theories will predict that the value of the ratio will be one for all n as the mere threat of entry will reduce incumbents profits to the competitive level (even in the monopoly case). Perfectly sustainable collusion would also require each successive ratio to be one if new entrants were to join the collusive group. Where we observe ratios equal to one for large n it might be more realistic to assume that the reason for the lack of change in competitive conduct is that the industry has become perfectly competitive and no further decreases in price-cost margins are attainable.

3 DATA

3.1 In this section I shall describe and give some justification for the variables used in the various specifications. A further discussion of the suitability and limitations of these specifications is included in section x.

Geographical market definition

3.2 One factor of some importance is the geographical definition of the market. If the markets are not properly defined the relationship between number of firms and size of the market will be meaningless.

3.3 The market power literature takes several different approaches to this. In certain countries and for certain goods/services it is possible to find a sample of sufficiently isolated local markets for the researcher to be confident of their definition of market size. However, in using this approach there is a risk that the markets included in the sample may not be representative of the country as a whole being, by definition, rural areas. Even in these areas it may be necessary to include some measure of nearby population that could potentially increase demand. The definition of nearby population will nearly always have some arbitrary component unless population is uniformly distributed around some central point.

3.4 Another approach is to use a broader definition of market size that allows for some leakages of demand and/or supply across geographical markets. An example of this would be including variables such as population growth and commuter data when investigating a service market such as dentists or beauticians (Bresnahan and Reiss 1991). The inclusion of such variables will be discussed further in section 3.3 below.

3.5 The market for new houses in the UK is such that a satisfactory measure of geographical market definition is hard to find. On the one hand, supply of developable land is heavily controlled at the LA level and thus this would seem a reasonable definition, on the demand side, however, the geographical boundaries of each market are much harder to identify.

In this study, the geographical definition of the market chosen is the LA for the reason mentioned above and due to the availability of data.

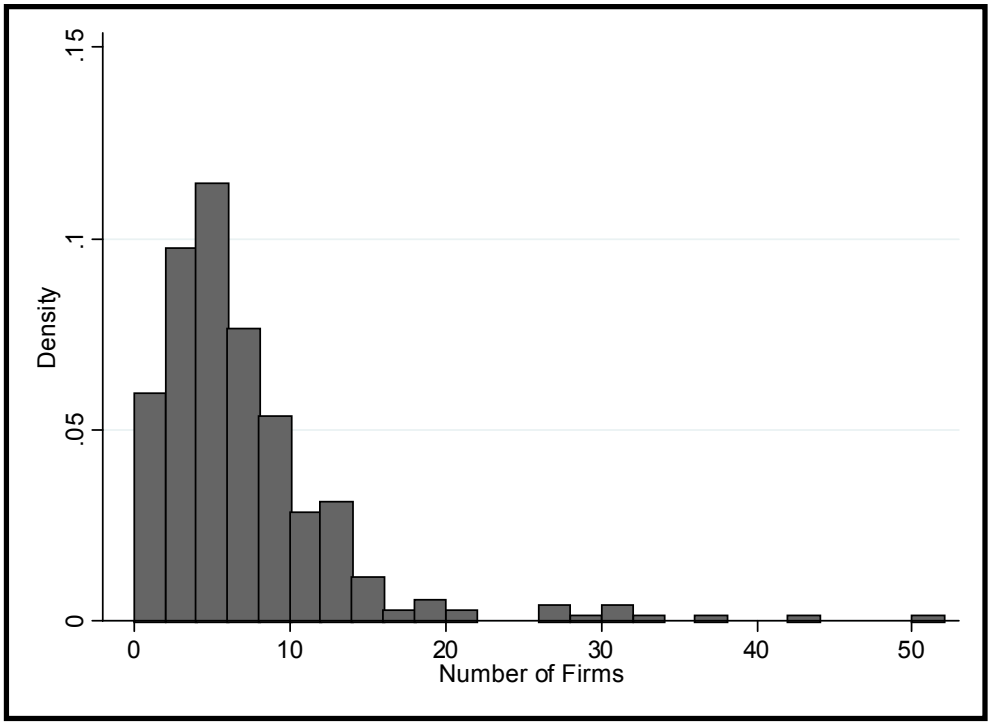
3.6 An optimal method of determining geographical market boundaries would be based more firmly on preferences from the consumer side of the market. DCLG (2007) suggests a method for defining geographical markets for housing using house price data. They suggest that houses in close proximity and with similar rates of house price inflation should be considered to be located within the same market. These observations on individual houses (or arbitrarily small groups of houses) can be combined to identify submarkets in housing based upon areas for which data is easily available. They identify these submarkets for Kent and East Sussex but as yet, these submarkets have not been identified for the whole of England. This method would yield geographical market areas that more closely correspond with the heterogeneity in consumers' preferences over various locations. However, the market areas determined by this approach may be so geographically complex that policy outcomes might be difficult to implement.

Number of firms (N)

3.7 Three measures of the number of firms in the market have been used in this study.

3.8 The first measure of number of firms in the market is a count of all the firms granted planning approval for home builds containing 10 or more units. It was collected from EMAP data on successful planning applications.

Figure 1: Histogram of number of firms



3.9 I have not counted builds completed by housing associations[2] and other public bodies such as universities and charities, or sheltered housing, however the number of these units granted planning permission is included in the model as a control, as obviously the existence of these builds might affect a private homebuilder's profitability in a given market. This might be caused by increased construction in a local authority market increasing a private firm's costs, or that these non-private or specialist units may be weak substitutes for the units built by private firms (for more detail see section on demographic variables).

[2] Non-profit housing associations were identified using the list maintained by the Housing Corporation under the Housing Act 1996.

3.10 As a first look at considering now concentrated the market is, the ratio of number of firms in a market to the number of planning applications granted is of some interest. In the case of N being identified as all private homebuilding firms granted planning permission in a Local Authority, the ratio of applications to clients has a mean value of 1.097 with a minimum of 1 and a maximum of 3. If the ratio takes a value of one it corresponds to the situation where every planning application granted in that Local Authority is granted to a different firm. As the ratio increases above one, it implies that some firms in the Local Authority have been granted planning permission more than once in 2004.

3.11 A further step in the analysis uses as a count of number of firms, the number of firms in a market obtaining planning permission for builds where the greatest number of units those firms received planning permission for in 2004 is above a particular threshold. By comparing differences in the relationship between number of firms and market size for each of these groupings it is possible to examine whether or not they form different sub-markets.

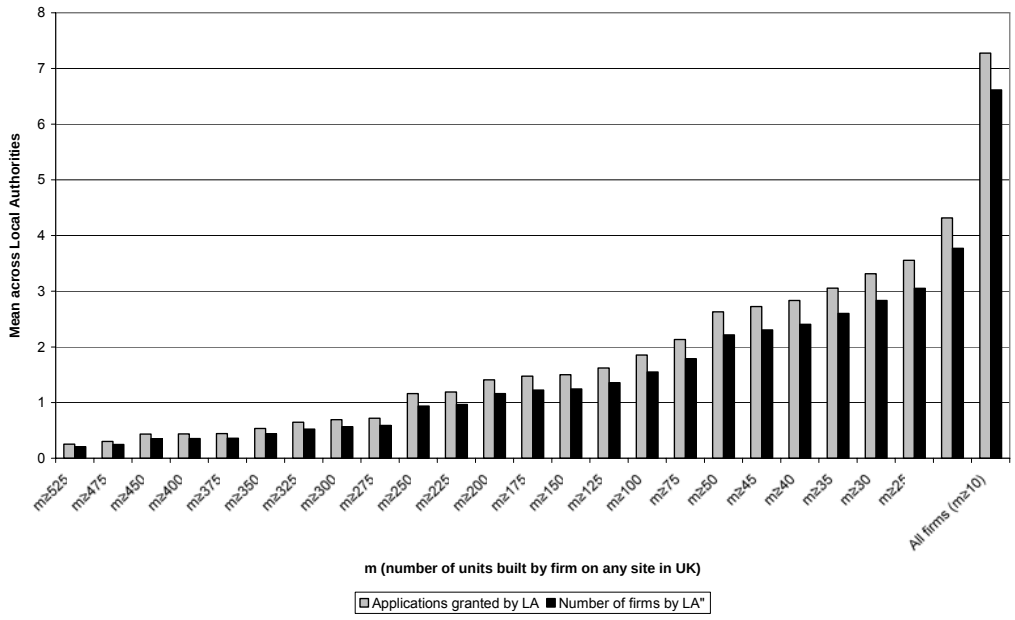
3.12 The groupings were compiled by firstly identifying the firms who, in 2004, were granted planning permission for sites with more than m units in any local authority district. For each local authority district, a count was then taken of the number of these firms with planning permission approved. Therefore, for each value of *m*, a firm would be 'counted' in a local authority district even if the site it was developing in that district was comprised of fewer than *m* units provided that it had received planning approval for a site comprised of *m* or more units in a different local authority district in 2004. For example, suppose that, in 2004, ten firms had received planning permission for builds with 300 or more units in any local authority district in England. Then the number out of these ten firms that appear in each local authority would be recorded (even if, in some of the local authorities the builds that they received planning permission for were less than 300 units).

3.13 Therefore, this is a measure of the number of firms capable of developing a site of *m* or more units in a particular location rather than

the number of firms that actually were developing a site of *m* or more units in that location.

3.14 As *m* decreases the number of firms capable of building *m* units increases. Figure 2 below shows the mean number of planning applications granted to m-capable firms in a local authority and the mean number of firms that are m-capable receiving planning permission in a local authority, as *m* increases.

Figure 2 (Number of planning applications granted to m-capable firms and the number of m-capable firms they were granted to):[3]

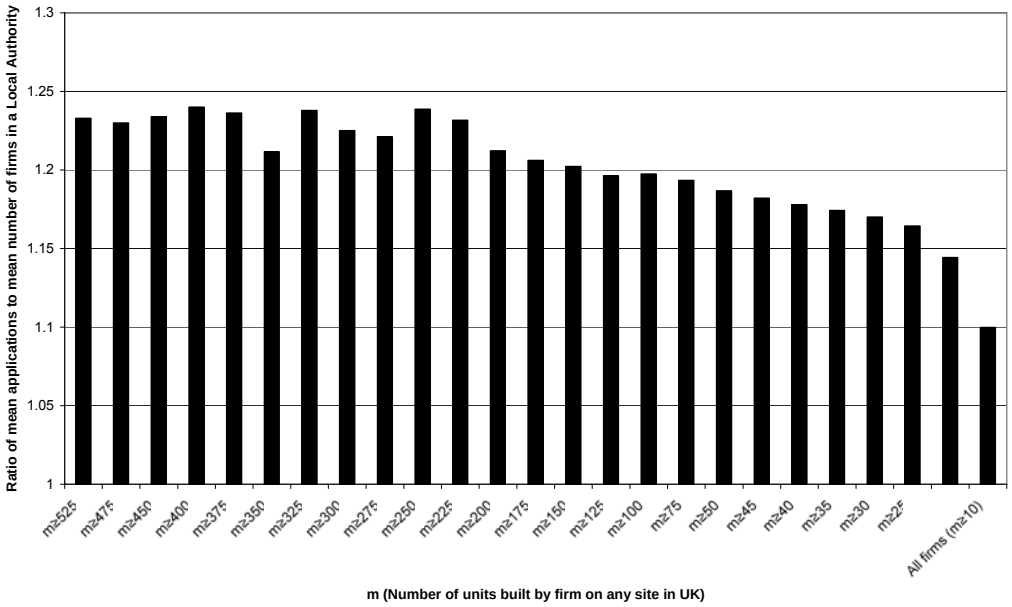


[3] m is a filter applied to the dependent variable (number of firms). For each application of the filter only those firms that built a site of greater than m units somewhere in England and Wales in 2004 were included.

3.15 The height of each light grey column represents the average number of planning applications granted by each local authority to firms capable of producing *m* or more units. The height of each black column shows the number of firms being granted planning permission for these applications. Thus the difference in height of the different coloured column for each value of *m* gives some indication of how concentration changes as the definition of the market changes. If the grey column is large relative to the black column then on average, given that particular definition of the market, concentration is high. If the grey column is small relative to the black column then on average, given that particular definition of the market, concentration is lower as the successful planning applications are spread across more firms.

3.16 Figure 3 below illustrates this effect more clearly. Here the ratio between the average number of successful planning applications and the average number of firms granted those planning permissions is shown. Again, m gives a measure of firms' ability to achieve planning permission for large sites. When m is large, only firms and applications made by firms capable of building large sites are included in the count. When m is small, both large and small firms are included in the count.

Figure 3 (mean ratio of number of applications granted to the number of firms they were granted to for different definitions of the market):



3.17 The ratios displayed are bounded below at one, which corresponds to a situation where within each Local Authority every application granted was made by a different firm. As the ratio increases above one it implies that some firms had more than one application granted within a local authority.

3.18 As we increase the market definition to include small-capacity firms and their applications, the ratio of applications to firms falls suggesting that the market becomes relatively less concentrated given its definition. This suggests that there is more diversity (even within individual local authority districts) amongst smaller firms than larger firms.

3.19 The relationship shown in figure 3 would suggest that, within LA markets, competition for sites is more vigorous amongst firms that are only capable of building small sites than those that are capable of building large sites. Importantly, it highlights that competition may be different across different definitions of the scope of the market.

3.20 A further area of interest may be the delineation between homebuilders that mainly concentrate in flats/apartments and those that concentrate in houses. On the demand side a large flat and a small house may be fairly close substitutes but their means of manufacture may be quite different. The firms in the sample were divided into two groups. Those who had built flats in 2004 and those that had built houses in 2004. There was a large overlap between the two groups with a significant majority of the firms building both flats and houses. Again, when counting the number of firms in any given Local Authority, a firm was counted towards the 'houses' sample if it had built houses in any Local Authority in 2004, regardless of whether it had built houses or only flats in that particular Local Authority. Therefore, in the 'houses' case, N is a count of the firms in each Local Authority capable of building houses and in the 'flats' case, N is the count of the firms in a Local Authority capable of building flats. The average ratio of applications to clients for the houses sub-sample is 1.127, and for the flats sub-sample it is 1.116. This means that for both sub-samples, on average, each firm operating in each local authority received just over one successful planning application. Thus there were some firms that were granted more than one planning application in a given local authority in 2004, although the number of these firms (and/or the number of additional planning applications granted to each firm) is small.

Market size (S)

3.21 In the case of homebuilding, along with the usual difficulties of market definition, it is problematic to find a variable that truly represents market size.

3.22 Possible measures of market size that I have estimated are, population (**POP**), the number of houses sold in a particular market year (**HOUSESALES**), the number of households (**HOUSES**) and the number of jobs in the area (**JOBS**). I have estimated demand entry thresholds for each of these measures of market size for comparison.

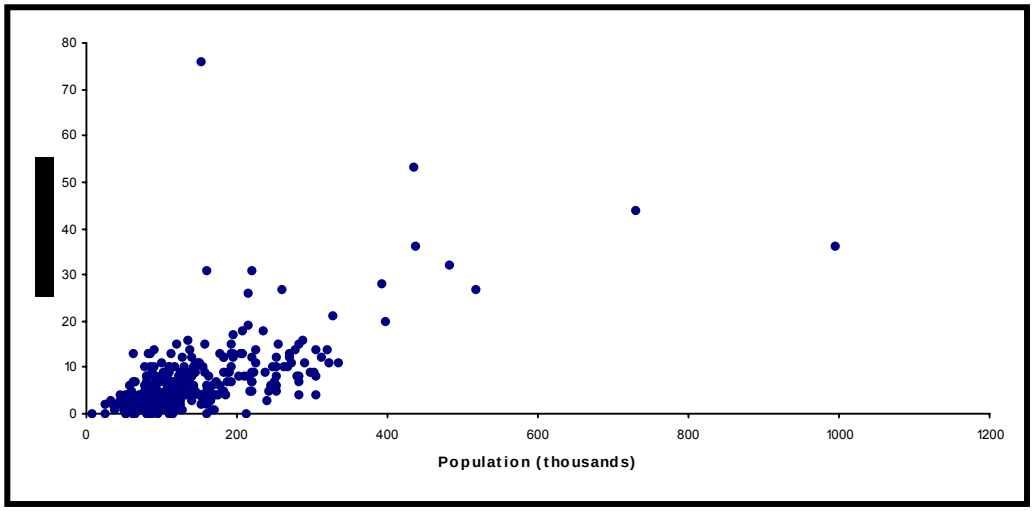
Table 1: Some summary statistics for these market size (S) variables:

VARIABLE	UNITS	MEAN	STANDARD DEVIATION	MIN.	MAX.	n
POP	(1000s)	141.952	95.060	7.6	995.5	353
HOUSESALES	(1000s)	33.136	20.947	3	190	353
HOUSES	(1000s)	61.535	40.791	5.512	410.75	353
JOBS	(1000s)	73.768	64.193	10	597	353

Population (POP):

3.23 Whilst in similar entry models of retailers/service-sector markets the measure of market size is obviously population, in the homebuilding sector this is perhaps not the case. Population (**POP**) measures the number of people already successfully living in an area but is not necessarily a good indicator of demand for new housing within an area. In the case of homebuilding, population partly measures the number of people already 'consuming' the product, not the potential demand for the product.

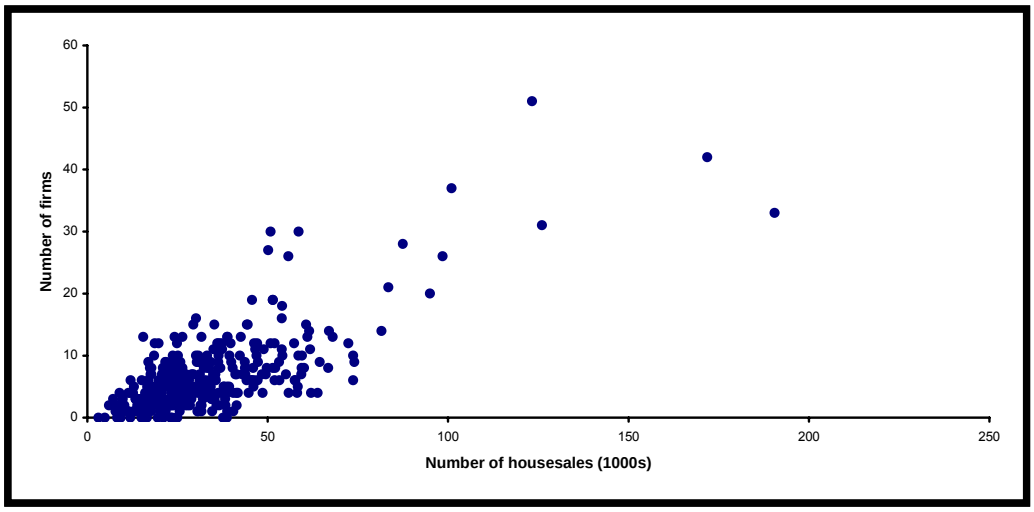
Figure 4: Scatter plot of number of firms against population.



Number of houses sold (HOUSESALES):

3.24 The number of houses sold in a particular locality gives a direct measure of the realised demand for new housing in that locality. A concern with this measure of market size, however, is that it may be endogenous to the model. The number of house sales in an area could be dependent upon the number of home building firms operating in that area. This will be problematic if there are Local Authority districts in which a large proportion of the housing for sale is new build, that is, in Local Authorities that have seen a large amount of development relative to the original stock of housing. The data for this variable was derived from the Land Registry.

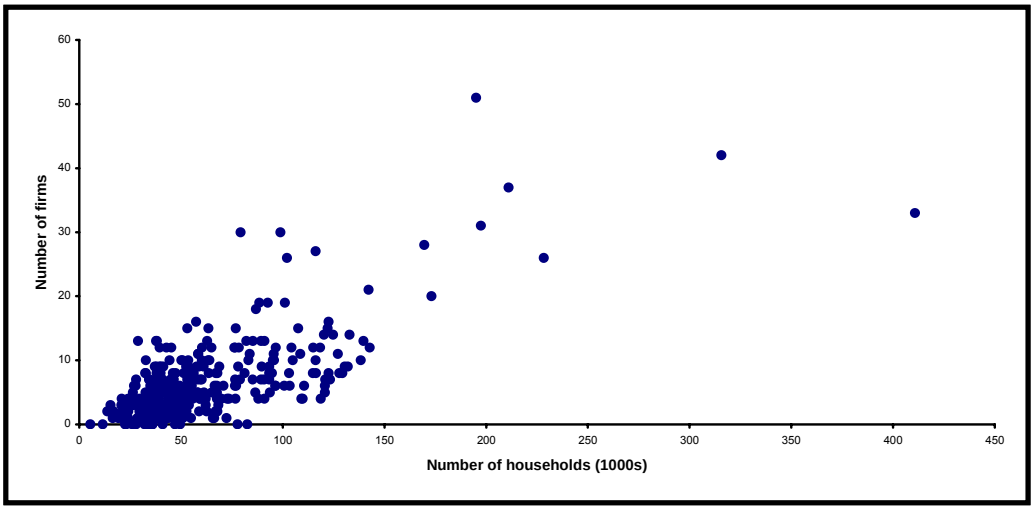
Figure 5: Scatter plot of number of firms against number of housesales (2004).



Number of households (HOUSEHOLDS):

3.25 This measure of market size (S) is the number of households in a Local Authority district. The more households a Local Authority district has, the greater the demand for housing. This variable however, suffers from the same shortcoming as **POP**, in that this variable is a proxy for the number of people already living in the area and is therefore partly composed of people who already own homes in that area. This makes the relationship between market size and number of homebuilders less direct than it would potentially be for other types of firm. The data for this variable comes from the Office for National Statistics.

Figure 6: Scatter plot of number of firms against number of households.



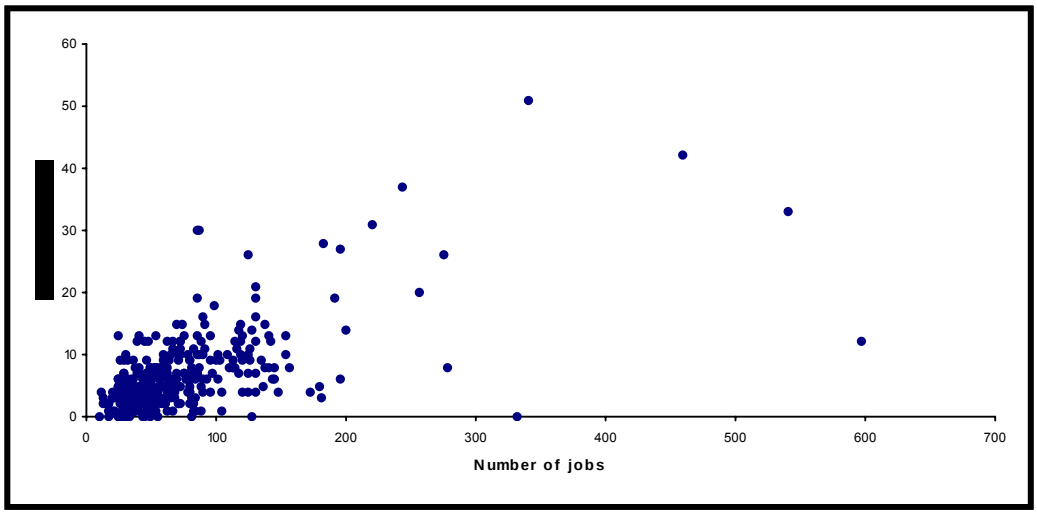
Number of people employed in the Local Authority (JOBS):

3.26 Under the assumption that, all other factors held constant, people would prefer to live near to the area in which they work, the number of people employed in an area could be seen as a proxy for the size of the housing market in that area. This variable is not subject to the problems of **POP** and **HOUSEHOLDS**, in that it is a measure of potential demand for housing, not the number of people successfully 'consuming' housing in that area. The data for this variable was taken from the 2004 Annual Survey of Hours and Earnings (ASHE).

3.27 In general, across the various model specifications, population and house-sales are better at predicting the number of firms in a market than the number of dwellings or the number of jobs.

3.28 However, none of these measures alone is particularly good at predicting the number of firms in a particular market. Therefore, other variables need to be included in the model to control for other differences in cross-market profitability.

Figure 7: Scatter plot of number of firms against number of jobs.



3.29 The decision to include a variable in the model as a market size variable (represented in S) rather than a demographic control variable (represented in the vector X) depends upon whether the variable affects the number of consumers demanding the good/service or whether it affects the quantity of the good/service each individual consumer demands. Variables included in S should represent the number of potential consumers in each market whereas variables in X should represent differences in consumers' preferences across the markets as well as other factors that affect firms' profitability in those markets.

Control variables (X)

3.30 These controls include on the cost side, wage costs, access to developable land and planning authority requirements. On the demand side they include opportunity of access to housing, income, level of commuting and house prices. These variables are included to control for differences in homebuilders' profitability across markets.

Cost-side variables

Wage costs (MEANCONSTRUCTWAGE):

3.31 The average wage of construction workers varies across geographical region and therefore might also be expected to cause variation in homebuilders' profits across markets. The mean weekly wage of full-time construction workers has been included in the model. This data is from the 2004 Annual Survey of Hours and Earnings (ASHE). The data is available at 2 digit SOC code by industry (in this case the classification is construction) and at the geographical area of Government Office Region. Whilst it would obviously be preferable to have this data at Local Authority level, regional data will capture some of the variation in wage costs across different geographical markets.

Access to developable land (**PBROWNFIELD** and **PGREENBELT**):

3.32 Two variables have been included in the analysis to capture differences in the availability of developable land across markets. The first of these is the proportion of the Local Authority that is brownfield and suitable for re-development into housing. The second is the proportion that is greenbelt. The data for both of these variables were obtained from DCLG. It might be expected that geographical markets with more land available for development will be more profitable for homebuilding firms as the cost of that land is likely to be lower. It might be expected that the amount of brownfield land in an area will have a stronger effect on firms' profitability than the amount of greenbelt land as local planning authorities may have different attitudes to the use of greenbelt land for homebuilding. It may, in fact, be the case that a Local Authority has a large amount of greenbelt land because it rejects more proposals for building on such land. In this case the overall effect on profitability of an area having a higher proportion of greenbelt land is ambiguous.

Section 106 requirements (**S106PROP**):

3.33 Another variable with potential importance is the requirements that individual councils put on homebuilders to provide a proportion of 'social' or 'affordable' housing. Under Section 106 of the Town and Country Planning Act (1990) a local planning authority may place obligations upon a developer, requiring them to minimise the effect their development will have upon the local community. This may include the provision (and maintenance) of affordable housing, transport infrastructure and green-space. The use of these agreements varies by local authority and is likely to affect an individual homebuilder's expected profitability from developing in that local area. DCLG have collected data on the number of affordable housing units build by developers under section 106 requirements. I have included this in the model as the proportion of units built by private firms in 2004 that were affordable. Some Local Authorities have not reported figures for 2004 for the number of units that were built under section 106. In this case I have taken an average of the number of units built in 2002, 2003 and 2005 where this data is available. Where there is data missing for all of these years I have taken an average of the proportion of affordable housing units across the Government Office Region in which that particular Local Authority was located. In the case where the data was aggregated across the four year time period there might be some concern that these observations might be serially correlated. A Local Authority might, for example, follow a year in which the build rates of affordable housing were low with a year in which the section 106 requirements were much higher. A more sophisticated method would be to estimate the missing values using an auxiliary regression. In this case, however, this would be impracticable due to the complexity of characteristics that could be thought to affect a particular local authority's use of section 106.

Demand-side variables

Number of public (affordable housing) units built (**PUBLICUNITS**):

3.34 To some extent the affordable housing built by housing associations and councils can be seen as a substitute for the housing units built by private (for-profit) homebuilders. Because of this, a market where a large number of affordable housing units have been granted planning permission is likely to be able to support fewer private homebuilders. This variable was computed from EMAP data. Housing associations were identified using lists maintained by the Housing Corporation under the Housing Act 1996.

Difficulty of access to home ownership (**OWNERSHIP**):

3.35 This variable measures the difficulty potential homeowners face in affording housing in the area in which they work. It is an indicator of the percentage of households in an area unable to afford to enter owner-occupation. It is based upon the ratio of house prices to average earnings for households where the head of household is less than thirty-five years old. The variable is increasing in difficulty of access to home ownership. This variable can have various interpretations. It might be expected that demand for new houses in areas where access to home ownership is more difficult is lower because wages in these areas are lower and a higher proportion of people cannot afford homes. However, it may be that home ownership is low in an area because house prices are too high as the supply of new housing in that area is not meeting demand. Hence areas where there is difficulty of access to home ownership may be more or less profitable to homebuilders than those where access is easier. The data for this variable comes from the Index of Deprivation collated by DCLG.

Average wage of residents (**RESIDENTSWAGE)**:

3.36 Supposing that housing is a normal good we would expect markets where the average income is higher to have a higher demand for housing

units. The data for this variable comes from the Annual Survey of Hours and Earnings (ASHE).

Insufficient supply of existing housing (**JOBDENSITY**):

3.37 The variable job density is a ratio of the number of working age residents in an area to the number of filled jobs in that area. When the variable takes a value greater than one it implies that there are more people working in that area than living in it and net commuting is positive. It might be expected that in areas where net commuting is positive, there is an under-supply of housing and thus the area is more profitable for homebuilders. Such an under-supply might also be brought about through homebuilders facing barriers to entry, for example a lack of land suitable for residential development in the area. As the geographical areas used in this research are quite large, it is unlikely that they will be solely non-residential (the exception to this possibly being certain London boroughs). Also the availability of brownfield land suitable for residential development is included as a control in this model. The variable could also be seen as a proxy for desirability of the area for home buyers. In this case an area with positive net commuting may indicate that the area is seen as undesirable by potential home buyers as a possible residential area. Therefore the relationship between job density and number of homebuilding firms in the area might be negative. The data was derived from Census data.

Demand for private housing (**OWNOCCRENTED**):

3.38 This variable measures the proportion of households in which the residents either own the property or rent it privately (as opposed to it being rented through a housing association or registered social landlord). The relationship between this variable and homebuilders' profitability is ambiguous. On one hand a low proportion of privately owned homes might imply that the Local Authority district has a lower average income, which would likely mean less demand for new homes. On the other hand, such a situation might exist because the area has an under-supply of private housing and thus demand for new homes might be higher. The data for this variable comes from the Office for National Statistics.

3.39 Table 2 displays some summary statistics for these variables:

Table 2: summary statistics for the demographic control variables (X)

VARIABLE	UNITS	MEAN	STANDARD DEVIATION	MIN.	MAX.	n
MEANCONSTRUCTWAGE	£ per week	488.775	51.668	433	611	353
PBROWNFIELD	Proportion of total	0.005	0.010	0	0.090	353
PGREENBELT	Proportion of total	0.0002	0.0003	0	0.001	353
S106PROP	Proportion of housing units	0.261	0.233	0.004	1	353
PUBLICUNITS	Number of housing units	87.567	254.631	0	3300	353
OWNERSHIP	Percentage of households	56.665	13.077	30.54	94.49	353
RESIDENTSWAGE	£ per week	427.673	71.633	286.3	858.9	353
JOBDENSITY	Ratio	0.970	3.035	0.38	57.67	353
OWNOCCRENTED	Proportion of households	0.828	0.074	0.470	0.945	353

4 RESULTS

Baseline specification – estimated coefficients

4.1 Table 3 displays the results from treatment 1. The dependent variable, N, is the number of all private (non-housing association) homebuilders that were granted planning permission to build more than 10 homes in a Local Authority district in 2004. In this treatment four different measures of market size (S) are used. Treatment 1a uses population of a measure of market size, 1b uses house sales, 1c uses the number of households and 1d the number of jobs in a Local Authority district.

4.2 In all four treatments the natural logarithm of the market size variable is positive and significant and does not vary a great deal with the different variables. The variable **S106PROP**[4] is also significant in all four models. It suggests that whatever the measure of market size, as the section 106 requirements in a Local Authority district increase, the number of homebuilders operating in that market decreases. This implies that either Section 106 requirements reduce the profitability of homebuilders or that they act as a barrier to entry. Interestingly, in none of the models is the variable **PUBLICUNITS** significantly different to zero. Therefore, whilst the cost of section 106 requirements affects firms' profitability, on the demand side the availability of affordable housing does not.

4.3 Difficulty of access to owner-occupation, **OWNERSHIP**, is also positive and significant in all the models estimated in treatment one. This suggests that in areas where home ownership is currently too expensive for a large proportion of the population, homebuilders are able to realise greater profits. This would suggest that supply is not adjusting- to meet the excess demand.

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[4] The variable S106PROP is the proportion of units built in 2004 that were affordable housing built by homebuilders at the request of that Local Authority under Section 106 of the Town and Country Planning Act (1990).

4.4 The variable **MEANCONSTRUCTWAGE** is negative and significant in all the models except where the market size variable (**S**) is the natural logarithm of the number of jobs in the local authority district. This is as expected, as homebuilders' wage costs increase, their profitability falls.

Table 3: All private firms are included in the dependent variable.

Treatment	**1a**	**1b**	**1c**	**1d**
	Coef.	Coef.	Coef.	Coef.
	(robust s.e.)	(robust s.e.)	(robust s.e.)	(robust s.e.)
	1.696***			
lnpop	(0.144)			
		1.707***		
lnhousesales		(0.139)		
			1.679***	
lnhouseholds			(0.143)	
				1.517***
lnjobs				(0.144)
	0.0002	0.0003	0.0002	0.0002
publicunits	(0.0003)	(0.0003)	(0.0003)	(0.0003)
	0.023***	0.025***	0.021***	0.021***
ownership	(0.000)	(0.005)	(0.005)	(0.005)
	-0.004**	-0.004***	-0.004**	-0.002
meanconstructionwage	(0.002)	(0.002)	(0.002)	(0.002)
	-7.665	-9.733	-6.571	-7.105
pbrownfield	(6.243)	(5.374)	(5.845)	(5.545)
pgreenbelt	-145.068	4.986	-96.641	-20.628

	(233.991)	(236.660)	(236.247)	(231.496)
	-0.001	-0.001	-0.0004	-0.002**
residentswage	(0.001)	(0.001)	(0.001)	(0.001)
	-0.008	-0.031	-0.023*	-1.208
jobdensity	(0.016)	0.019	(0.017)	(0.313)
	-1.378	-2.663***	-1.236	-0.904
ownoccrented	(0.897)	(0.868)	(0.910)	(0.927)
	-4.199***	-4.285***	-4.169***	-4.179***
S106prop	(0.320)	(0.321)	(0.320)	(0.323)
	1.749	-1.805	0.623	-0.592
Lamda(1)	(1.235)	(0.137)	(1.174)	(1.197)
	2.813	-0.689	1.687	0.521
Lamda(2)	(1.225)	(1.050)	(1.161)	(1.188)
	3.553	0.073	2.425	1.239
Lamda(3)	(1.230)	(1.053)	(1.166)	(1.189)
	4.180	0.713	3.050	1.846
Lamda(4)	(1.233)	(1.051)	(1.168)	(1.186)
	4.785	1.335	3.651	2.437
Lamda(5)	(1.245)	(1.061)	(1.179)	(1.198)
	5.120	1.758	4.061	2.828
Lamda(6)	(1.252)	(1.067)	(1.186)	(1.205)
	5.548	2.110	4.407	3.195
Lamda(7)	(1.254)	(1.067)	(1.187)	(1.206)
Lamda(8)	5.856	2.419	4.712	3.501

	(1.259)	(1.071)	(1.191)	(1.209)
	6.128	2.694	4.983	3.772
Lamda(9)	(1.264)	(1.076)	(1.196)	(1.216)
	6.380	2.947	5.232	4.021
Lamda(10)	(1.257)	(1.069)	(1.188)	(1.209)
	6.628	3.196	5.480	4.265
Lamda(11)	(1.263)	(1.073)	(1.192)	(1.214)
	6.746	3.315	5.598	4.381
Lamda(12)	(1.268)	(1.077)	(1.198)	(1.218)
	7.034	3.610	5.888	4.667
Lamda(13)	(1.275)	(1.080)	(1.203)	(1.226)
	7.299	3.883	6.154	4.930
Lamda(14)	(1.261)	(1.067)	(1.189)	(1.214)
	7.406	3.991	6.260	5.036
Lamda(15)	(1.267)	(1.073)	(1.195)	(1.219)
	7.609	4.199	6.463	5.235
Lamda(16)	(1.274)	(1.079)	(1.201)	(1.227)
	7.705	4.299	6.559	5.328
Lamda(17)	(1.275)	(1.079)	(1.202)	(1.228)
	7.756	4.354	6.611	5.378
Lamda(18)	(1.276)	(1.080)	(1.203)	(1.229)
	7.930	4.536	6.786	5.545
Lamda(19)	(1.276)	(1.080)	(1.202)	(1.228)
	7.997	4.606	6.854	5.610
Lamda(20)	(1.281)	(1.081)	(1.205)	(1.230)

	8.071	4.685	6.929	5.682
Lamda(21)	(1.291)	(1.089)	(1.215)	(1.238)
	8.236	4.861	7.096	5.845
Lamda(22)	(1.284)	(1.084)	(1.209)	(1.234)
	8.328	4.959	7.188	5.934
Lamda(23)	(1.287)	(1.088)	(1.212)	(1.240)
	8.426	5.066	7.287	6.030
Lamda(24)	(1.299)	(1.099)	(1.223)	(1.250)
	8.706	5.367	7.566	6.299
Lamda(25)	(1.302)	(1.106)	(1.228)	(1.252)
	8.922	5.588	7.779	6.502
Lamda(26)	(1.341)	(1.141)	(1.264)	(1.284)
	9.136	5.811	7.996	6.711
Lamda(27)	(1.377)	(1.185)	(1.302)	(1.322)
	9.367	6.085	8.247	6.963
Lamda(28)	(1.376)	(1.166)	(1.307)	(1.316)
	9.740	6.484	8.596	7.321
Lamda(29)	(1.478)	(1.276)	(1.411)	(1.415)
Pseudo Rsqu	0.197	0.205	0.195	0.192
log likelihood	-792.609	-784.900	-794.033	-797.933
N	353	353	353	393

*, **, *** indicate significant effects at the 1, 5 and 10% significance levels respectively.

Baseline specification - demand entry thresholds

4.5 Table x below shows the per-firm demand entry threshold ratios for the models estimated with each of the four different market size variables. The ratios are remarkably similar across the four different treatments suggesting that in this case the choice of market size variable is not massively important. In all four cases, the second firm requires slightly less demand than the first firm to enter. Each additional firm after the second requires more demand than the firm preceding it to enter the market. However, these effects are not significant.

Table 4: Per-firm demand entry threshold ratios[+].

Treatment	1a	1b	1c	1d
s2/s1	0.937 (0.31)	0.962 (0.10)	0.942 (0.25)	0.999 (0.00)
s3/s2	1.031 (0.16)	1.041 (0.27)	1.035 (0.19)	1.071 (0.60)
s4/s3	1.086 (1.79)	1.091 (2.00)	1.088 (1.88)	1.119 (2.50)
s5/s4	1.143** (5.39)	1.152** (5.87)	1.144** (5.41)	1.181** (6.33)
s6/s5	1.064 (2.12)	1.067 (2.35)	1.064 (2.12)	1.093* (3.32)
s7/s6	1.053 (1.72)	1.054 (1.80)	1.053 (1.74)	1.077* (2.74)
s8/s7	1.049 (1.66)	1.049 (1.67)	1.049 (1.67)	1.071 (2.63)
Tests that $s_n/s_{n-1}=s_{n+1}/s_n$[++]				
$s_2/s_1=s_3/s_2$	0.48	0.30	0.45	0.21
$s_3/s_2=s_4/s_3$	0.30	0.24	0.29	0.19
$s_4/s_3=s_5/s_4$	0.46	0.49	0.44	0.41
$s_5/s_4=s_6/s_5$	1.13	1.23	1.15	1.08
$s_6/s_5=s_7/s_6$	0.04	0.05	0.04	0.06
$s_7/s_6=s_8/s_7$	0.00	0.01	0.00	0.01

[+] Values in parenthesis are the Wald test statistics, where the null hypothesis is that the ratio is equal to 1. *, **, *** indicate significant effects at the 1, 5 and 10% significance levels respectively.

[++] Values reported are the Wald test statistics. *, **, *** indicate significant differences at the 1, 5 and 10% significance levels respectively (in this case none of the tests show significant differences at these levels).

4.6 It is the entry of the fifth firm that causes a significant increase in the level of competition in the market. This suggests that markets with five or more firms are sufficiently unconcentrated to encourage competition between firms and lower price-cost margins. This contradicts the results found by Bresnahan and Reiss on a sample of retail markets where entry of the second firm causes the largest increase in competitive pressure.

Results from different econometric specifications:

4.7 Table 5 compares the estimated coefficients from several different model specifications, the ordered Probit, the negative binomial and the Tobit. The market size variable (S) in all three specifications is population. The Tobit model (see Greene, 1993) takes advantage of the fact that N is non-negative as it assumes N is censored at 0. The negative binomial also uses the additional information that N is a count.[5] The advantage of the latter two models over the ordered Probit model is that they do not attempt to estimate the profit function directly and therefore do not suffer from the possibility that this may be misspecified. They also better capture the fact that the number of firms is a count rather than a ranking. The ordered probit, however, has the advantage that it does not assume that the same functional form can explain the relationship between number of firms and market size across all market sizes (see Asplund and Sandin, 1999).

[5] The negative binomial is used as a generalisation of the more commonly used Poisson model for analysing count data. The advantage of the negative binomial model is that, unlike the Poisson, it does not require the conditional mean to be equal to the conditional variance. In this case the data is over-dispersed relative to the mean and hence the negative binomial model is more appropriate (see Cameron and Trivedi, 1990).

Table 5: Estimated coefficients from different model specifications (S = population).

Treatment	1a	2a	2b
	Ordered Probit	Negative Binomial	Tobit
	Coef.	Coef.	Coef.
	(robust s.e.)	(robust s.e.)	(robust s.e.)
lnpop	1.696***	0.825***	6.987***
	(0.144)	(0.071)	(0.874)
publicunits	0.0002	0.0001	0.001
	(0.0003)	(0.0002)	(0.001)
ownership	0.023***	0.011***	0.082***
	(0.000)	(0.003)	(0.025)
meanconstructionwage	-0.004**	-0.002***	-0.029***
	(0.002)	(0.001)	(0.008)
pbrownfield	-7.665	-2.388	-22.487
	(6.243)	(3.907)	(27.969)
pgreenbelt	-145.068	-7.452	336.640
	(233.991)	(124.269)	(914.089)
residentswage	-0.001	-0.0004	-0.002
	(0.001)	(0.0005)	(0.004)
jobdensity	-0.008	-0.023	0.118*
	(0.016)	(0.021)	(0.070)
ownoccrented	-1.378	-1.005**	-10.959*
	(0.897)	0.465	(5.061)

	-4.199***	-1.968***	-10.105***
S106prop	(0.320)	(0.158)	(0.954)
		-0.187	-5.219
constant		(0.619)	(5.219)
	1.749		
Lamda(1)	(1.235)		
	2.813		
Lamda(2)	(1.225)		
	3.553		
Lamda(3)	(1.230)		
	4.180		
Lamda(4)	(1.233)		
	4.785		
Lamda(5)	(1.245)		
	5.120		
Lamda(6)	(1.252)		
	5.548		
Lamda(7)	(1.254)		
	5.856		
Lamda(8)	(1.259)		
	6.128		
Lamda(9)	(1.264)		
	6.380		
Lamda(10)	(1.257)		

	6.628
Lamda(11)	(1.263)
	6.746
Lamda(12)	(1.268)
	7.034
Lamda(13)	(1.275)
	7.299
Lamda(14)	(1.261)
	7.406
Lamda(15)	(1.267)
	7.609
Lamda(16)	(1.274)
	7.705
Lamda(17)	(1.275)
	7.756
Lamda(18)	(1.276)
	7.930
Lamda(19)	(1.276)
	7.997
Lamda(20)	(1.281)
	8.071
Lamda(21)	(1.291)
	8.236
Lamda(22)	(1.284)
Lamda(23)	8.328

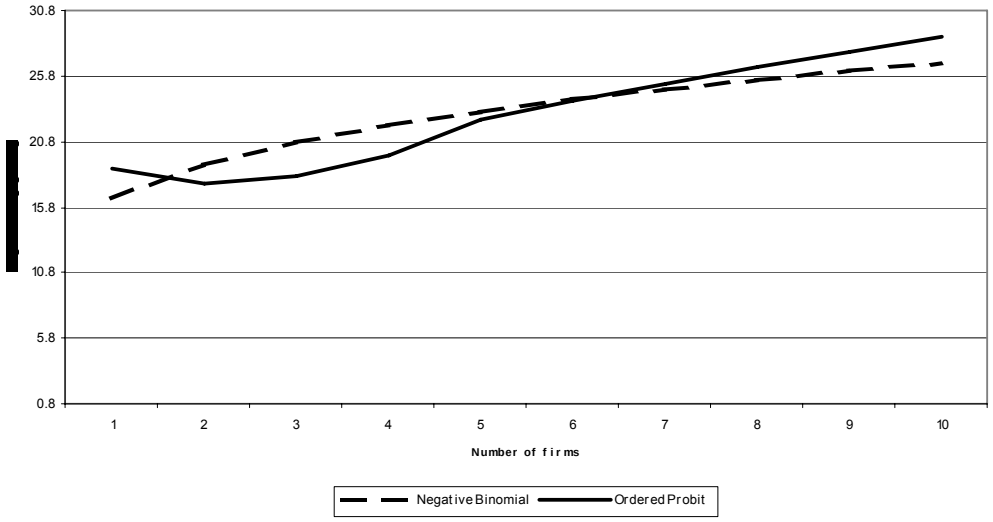
	(1.287)		
	8.426		
Lamda(24)	(1.299)		
	8.706		
Lamda(25)	(1.302)		
	8.922		
Lamda(26)	(1.341)		
	9.136		
Lamda(27)	(1.377)		
	9.367		
Lamda(28)	(1.376)		
	9.740		
Lamda(29)	(1.478)		
		0.102	
Alpha		(0.019)	
		-2.283	
Ln(alpha)		(0.191)	
			4.445
Sigma			(0.434)
Wald (chi-sq)/F statistic		493.82***	23.52***
Pseudo Rsqu	0.197		0.124
log likelihood	-792.609		
N	353	353	353

*, **, *** indicate significant effects at the 1, 5 and 10% significance levels respectively.

4.8 The results from the three specifications are fairly similar. Importantly, the factors that have a significant impact on firms' profitability are the same across all three specifications.

4.9 Given that the Negative Binomial and the Tobit model imply that the relationship between market structure and market size be explained by the same functional form for all n, the entry thresholds are not readily compared with those from the Ordered Probit model. Figure x and x illustrate this. The per-firm entry thresholds from the Negative Binomial model decline smoothly, implying that the largest variation in competitive conduct occurs with the entry of the second firm. Because the Ordered Probit model allows the functional form to change as the number of firms in the market increases, the entry thresholds do not necessarily decline smoothly and it can be seen that the largest variation in competitive conduct actually occurs with the entry of the fifth firm.

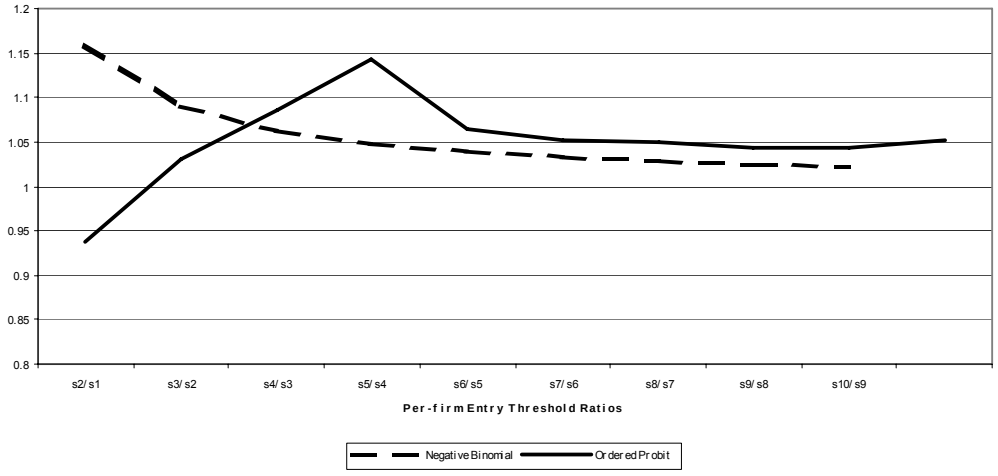
Figure 8: Comparison of per-firm entry thresholds[6] from the Ordered Probit and Negative Binomial[7] specifications.



[6] That is, the level of demand required per-firm for each firm to break even in a market containing N firms.

[7] The entry thresholds for the negative binomial model are calculated by setting $N = \lambda = \exp(\alpha \ln(S_N) + \bar{x}\beta)$ and solving for S.

Figure 9: Comparison of per-firm entry threshold ratios from the Ordered Probit and Negative Binomial specifications.



4.10 The curvature in the entry thresholds can be further investigated using ordinary least squares regressions[8] and including terms for the square of population and the cube of population.

Table 6: Results from the ordinary least squares regression:

$$N = \alpha_1 S + \alpha_2 S^2 + \alpha_3 S^3 + x\beta + u$$

	Coefficients **(Robust standard errors)**

[8] Obviously the dependent variable, N, is a count but due to the fact that the range of N is quite large, it is not necessarily inappropriate to estimate it using OLS.

POP	-0.013 (0.017)
POP^2	0.0002*** (0.00006)
POP^3	-1.64x10^7*** (4.96x10^8)
PUPUNITS	0.00008 (0.001)
OWNERSHIP	0.0578** (0.025)
MEANCONSTRUCTWAGE	-0.016** (0.006)
PBROWNFIELD	-11.641 (27.585)
PGREENBELT	283.555 (781.534)
RESIDENTSWAGE	-0.002 (0.003)
JOBDENSITY	-0.043 (0.034)
OWNOCCRENTED	-8.469* (4.394)

S106PROP	-7.725*** (0.707)
CONSTANT	18.362*** (4.936)
Rsq	0.62
Obs.	353

*, **, *** indicate significant effects at the 1, 5 and 10% significance levels respectively.

4.11 As can be seen from table 6 above, the coefficients on the square and cube of population are significant, with the coefficient on **POP^2** significantly positive and the coefficient on **POP^3** significantly negative. Therefore we should not expect to see monotonically decreasing entry thresholds.[9]

[9] In addition to this it should be noted that the estimated coefficients on the demographic control variables have the same sign as in the other specifications.

5 CONCLUDING REMARKS AND LIMITATIONS

Summary of results

5.1 The main purpose of this research was to investigate the relationship between concentration and competition in the homebuilding industry. It appears that competition does not occur in the homebuilding industry until fairly low levels of concentration are reached. Contrary to studies of other industries, competitive conduct changes most with the entry of the fifth firm (compare this to the retail and professional industries investigated by Bresnahan and Reiss (1991) where the largest variation in competitive conduct occurred when the markets moved from monopoly to duopoly). The implications of this are not clear. On the one hand this could be evidence of collusion (either tacit or explicit) at high levels of concentration, on the other it could be due to the fact that the homebuilding market is actually differentiated into several sub-markets and by operating in different sub-markets firms are able to avoid strong price competition.

5.2 To investigate this further I disaggregated my sample into several sub-samples. The first group of these were based upon the size of site firms were capable of building, the second groupings depended upon the type of property firms were capable of building.

5.3 No strong pattern was detectable in terms of the relationship between market size and market structure in terms of the size of site that firms were capable of building. The entry thresholds for firms capable of building very large sites were not significantly different to one, suggesting that competitive conduct did not increase with entry at any level. In addition to this, the number of units built by other firms (that is, firms not capable of building such large sites) did not impact on these firm's profits. It is likely these results suffer from the fact that the number of markets in which no firms (or only a very small number of firms) capable of building these large sites existed was very high.

5.4 There do appear to be differences in entry thresholds for firms capable of building different size sites. This suggests that it is right to consider that

the entry decisions of these firms affect competitive conduct in the market in different ways. The variation in competitive conduct between small and large site capable firms is, however, ambiguous. It appears that when the market considered is firms capable of building sites of more than around 100 units, competition occurs at lower levels of concentration than when the market is considered to be firms capable of building at least 10 units on a given site. There is weak evidence to suggest that firms capable of building only very small sites should be considered a competitive fringe and it is not until several of this type of firm have entered that competitive conduct changes.

5.5 When the market being considered is narrowly defined to only homebuilding firms capable of building flats, competitive pressure only increases with the entry of the seventh and eighth firm whereas when the market is defined as only homebuilders capable of building houses, competitive pressures increase with the entry of the second and every successive firm. This suggests that the market containing firms capable of building houses may be competitive at higher levels of concentration. Again, it does seem that different types of firms face slightly different entry decisions in these markets.

Certain factors explain firm profitability in nearly all the specifications. These are:

- Wages – the higher the wages the lower firm profits.
- Difficulty of access to ownership – the harder it is for consumers to afford housing within an area, the more profitable firms entering that market will be.
- S106 requirements – the higher the affordable housing requirements placed on firms by Local Authorities the less profitable those firms will be.

5.6 In addition to this, the proportion of land in a Local Authority that is brownfield land available for development into housing negatively affects

the profits of firms capable of building houses and positively affects the profits of firms capable of building sites with large numbers of units.

Strength of assumptions

5.7 Whilst this research has returned some interesting results, there are some caveats that need to be reported as to the reliability of these results. Where possible, sensitivity testing has been carried out to check the robustness of the results to different assumptions. The following section discusses the limitations of this research as well as some possible solutions to the problems incurred.

Geographical market definition

5.8 The majority of Bresnahan and Reiss type entry models have been conducted on data from US industries. The advantage of this is that the scale of that particular country allows estimates to be made from a sample of isolated markets. Due to this, it is possible for the researcher to feel confident that they have identified the correct measure of market size as well as a reliable figure for the number of competitors. In particular, Bresnahan and Reiss (1991) explain the stringent criteria for a market to be considered in their sample. Specifically, they located towns and small cities that are at least 20 miles from cities with a population of 1,000 people or more and at least 100 miles from cities with 100,000 people or more. Unfortunately in analysing data from the UK this would cause problems for two reasons:

- The number of markets included in the sample would be very small. The researcher may be left trying to estimate too many parameters from too few observations and this might result in imprecise estimates of those parameters.

- Eliminating metropolitan areas would involve a large amount of information loss. If the policy implications of the results are to be considered it is important that the results are relevant across the whole of the UK. A sample containing only rural, isolated markets might not return estimates that satisfactorily explained the

relationship between market size and structure in urban locations and thus would be of limited policy use.

5.9 The geographical definition used in this research, Local Authority districts, clearly does not lead to markets that are geographically isolated. In order to account for the leakages in demand that might occur between Local Authority district market areas, the variable **JOBDENSITY** has been included. This variable (the ratio between number of filled jobs in an area and the resident population of that area) gives a measure of peoples willingness to commute into an area for work in that such commuting may be evidence of desire to live in a particular area. This is an imperfect proxy for the number of people outside the area looking to purchase property in that Local Authority district as it assumes that people desire to live in the area in which they work and there may be other exogenous reasons why an area is better suited to commercial rather than residential development. For example, there may be a lack of facilities for residents, or traffic noise may be too great. However, it does give some indication of the level of demand for housing coming from outside the market and therefore not included in the measure of market size. In all the specifications considered in this research, this variable is insignificant. One conclusion from this might be that the geographical definition of markets used here is satisfactory.

Product market definition:

5.10 The product market considered in this research is the homebuilding market. Whilst the majority of the firms counted in the dependent variable are solely homebuilders some may also be general building contractors and there are a small number that are involved in other types of business (for example, supermarkets developing the space above their stores). It may not be entirely appropriate to include these firms in the sample because their entry decisions may be different to firms whose profits depend entirely on homebuilding. In particular, it may be that demand between these firms' different products might be interdependent. If this is the case equation (2) might not hold.

5.11 Due to the large number of firms considered and a lack of information about those firms' other operations it is difficult to isolate them in the sample. In addition to this, it is arbitrary to consider the difference between these types of homebuilders and firms that are solely homebuilders without also considering that a large number of the homebuilders in the sample may be more 'casual', one-time developers (for example somebody building a small block of flats in their back garden). These small developers may be more opportunistic and their entry decisions might be different to large developers whose sole business is homebuilding. In order to control for some of this heterogeneity, the sample of firms has been separated along certain characteristics, such as capability of developing large sites. There is evidence of differences in the entry demand thresholds estimate for the different sub-samples and hence this could be considered evidence that they operate in slightly different markets and/or make different entry decisions.

5.12 Even when considering the baseline model, there may be some concerns about the accuracy of the count of number of firms. Firstly, in this research a firm is considered as entering a market if it successfully applied for planning permission in 2004. The reason for only using information on the number of firms in 2004 was made for several reasons:

- The data for years other than 2004 appeared unreliable. In particular, years much earlier and much later than 2004 appeared to suffer from missing data as the number of reported planning applications dropped off more sharply than might be expected from the prevailing economic conditions. It is more likely that accurate records on the number of planning applications pre-2001 and post-2005 have either not been reported or have been poorly collated.

- Given that only a few years displayed reliable data and the number of market areas was large, the panel was too 'short and wide' for market fixed effects to be estimated.

- There was some concern that including more than one year in the analysis (that is, moving from a cross-sectional model to a panel data model) would lead to inaccuracies due to duplications in the planning process. For example, there were cases in the data where a single firm repeatedly applied for and was granted planning permission for the same site across more than one year. In a static model this is not an issue because the variable of concern would be the number of firms in an area not the number of planning applications. However, in a dynamic model this firm would appear to be 'surviving' in the market across both years when in actual fact it clearly had not yet brought a product to the market.

5.13 The third issue with this definition of whether a firm is active in a market is also concerning for the reason that achieving planning permission itself may not be a good indication of whether that firm actually built any homes. It may be that the firm granted planning permission was doing so speculatively with the aim of reselling the land at a higher price. This means that they should not be included in the count of homebuilders (and hence the dependent variable, n). It is impossible to fully eradicate these firms from the sample without the risk of also removing 'legitimate' homebuilders and therefore it is possible that the sample overestimates the number of homebuilders in any given market. This would mean that the market size required to support n firms may be underestimated.

Market size definition:

5.14 Finding a satisfactory definition for the 'size' of a market is difficult for the homebuilding industry. Whilst the traditional measure of market size in Bresnahan and Reiss (1990,1991) type entry models is some function of an area's population, in the case of homebuilding this might be considered as endogenous to the model as the type of competitive conduct in that market might affect the quantity of new homes produced and hence affect the supply of housing and therefore the size of population an area is able to support. The size of this endogeneity bias is likely to vary across markets according to each market's characteristics and if this is not properly controlled for in the model then the entry

thresholds calculated may be biased. In this research, several definitions of market size have been used to estimate entry thresholds and the results are robust across all of these different specifications.

Sensitivity testing

5.15 The results are robust across different econometric specifications. Models estimated include the Ordered Probit, the Negative Binomial and the Tobit model. The same variables were estimated to significantly effect firms' profits in all these specifications. The entry thresholds estimated from the Negative Binomial and Tobit models are not directly comparable to those from the Ordered Probit model as the latter does not impose the same functional form on the thresholds for different levels of market concentration. Thus the entry thresholds ratios from the Ordered Probit may not be monotonically decreasing as n increases. A further ordinary least squares regression shows that the relationship between market concentration and market size may indeed be non-monotonic, and hence the Ordered Probit model may be more suitable than the Negative Binomial or the Tobit.

5.16 That reasonable results have been achieved and that these results seem robust to the different specifications should suggest that, despite the limitations discussed above, the results should be considered with some confidence. This research should highlight how much can be achieved with limited data.

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A ALLOWING FOR HETEROGENEITY IN FIRM CAPACITY

A.1 This appendix reports the results from the regressions estimated for different counts of the number of firms in each Local Authority district depending upon how many units the firms were capable of building. The reason for segregating the sample in this way was to determine if the relationship between the number of firms in a market and the size of the market was different for firms capable of building large builds to those only capable of building smaller sites.

A.2 A firm was included in the count for m≥*m* if in any Local Authority district in 2004 it successfully received planning permission for a site of over *m* units. Thus this is a measure of capability to build sites of this size and does not imply that the firm actually built a site of this size in every Local Authority in which in was counted.

A.3 Tables A1.1-3 give some summary statistics of the number of firms, the number of successful applications they received and the number of units these applications were for, for each of the different values of m.

Table A1/1: Summary statistics of number of applications received in each local authority districts from firms that in 2004 were successful in achieving planning permission for sites of m or more units in any local authority.

m	Mean	Median	Standard Deviation	Minimum	Maximum	Count
m≥525apps	0.254958	0	0.566724	0	3	353
m≥475apps	0.303116	0	0.604356	0	3	353
m≥450apps	0.433428	0	0.79538	0	5	353
m≥400apps	0.439093	0	0.834178	0	7	353
m≥375apps	0.444759	0	0.837971	0	7	353

m≥350apps	0.535411	0	0.953176	0	8	353
m≥325apps	0.648725	0	1.061252	0	8	353
m≥300apps	0.694051	0	1.151774	0	11	353
m≥275apps	0.719547	0	1.16438	0	11	353
m≥250apps	1.161473	1	1.649549	0	15	353
m≥225apps	1.189802	1	1.697494	0	16	353
m≥200apps	1.407932	1	1.894413	0	19	353
m≥175apps	1.475921	1	1.956955	0	19	353
m≥150apps	1.498584	1	1.975884	0	19	353
m≥125apps	1.623229	1	2.009134	0	19	353
m≥100apps	1.855524	1	2.300958	0	26	353
m≥75apps	2.133144	2	2.682404	0	30	353
m≥50apps	2.628895	2	3.114476	0	32	353
m≥45apps	2.72238	2	3.201914	0	32	353
m≥40apps	2.832861	2	3.311112	0	33	353
m≥35apps	3.053824	2	3.5307	0	36	353
m≥30apps	3.314448	2	3.802697	0	38	353
m≥25apps	3.552408	3	4.114581	0	43	353
m≥20apps	4.314448	3	4.911749	0	50	353
All apps (m≥10)	7.274788	5	7.223373	0	62	353

Table A1/2: Summary statistics of number of firms granted planning permission in any local authority. *m* is the measure of the firms capacity to build large sites. For each value of *m* a firm was included in the count if, in any local authority in 2004, the firm had successfully received planning permission for a site of *m* or more units.

m	Mean	Median	Standard Deviation	Minimum	Maximum	Count
m≥525clients	0.206799	0	0.42608	0	2	353
m≥475clients	0.246459	0	0.457134	0	2	353
m≥450clients	0.351275	0	0.604063	0	3	353
m≥400clients	0.354108	0	0.614079	0	3	353
m≥375clients	0.359773	0	0.62	0	3	353
m≥350clients	0.441926	0	0.736738	0	4	353
m≥325clients	0.524079	0	0.815415	0	5	353
m≥300clients	0.566572	0	0.889787	0	7	353
m≥275clients	0.589235	0	0.903653	0	7	353
m≥250clients	0.937677	1	1.194957	0	9	353
m≥225clients	0.966006	1	1.247261	0	10	353
m≥200clients	1.161473	1	1.420023	0	12	353
m≥175clients	1.223796	1	1.491758	0	12	353
m≥150clients	1.246459	1	1.512785	0	12	353
m≥125clients	1.356941	1	1.542048	0	12	353
m≥100clients	1.549575	1	1.706757	0	15	353

m≥75clients	1.787535	1	2.038734	0	19	353
m≥50clients	2.215297	2	2.470069	0	21	353
m≥45clients	2.303116	2	2.562052	0	21	353
m≥40clients	2.405099	2	2.674092	0	22	353
m≥35clients	2.600567	2	2.860725	0	25	353
m≥30clients	2.832861	2	3.079966	0	27	353
m≥25clients	3.050992	2	3.35456	0	32	353
m≥20clients	3.770538	3	4.114972	0	38	353
All clients (m≥10)	6.614731	5	6.325365	0	51	353

Table A1/3: Summary statistics of number of units planned by firms granted planning permission in any local authority. *m* is the measure of the firms capacity to build large sites. For each value of *m* a firm's units were included in the count if, in any local authority in 2004, the firm had successfully received planning permission for a site of *m* or more units.

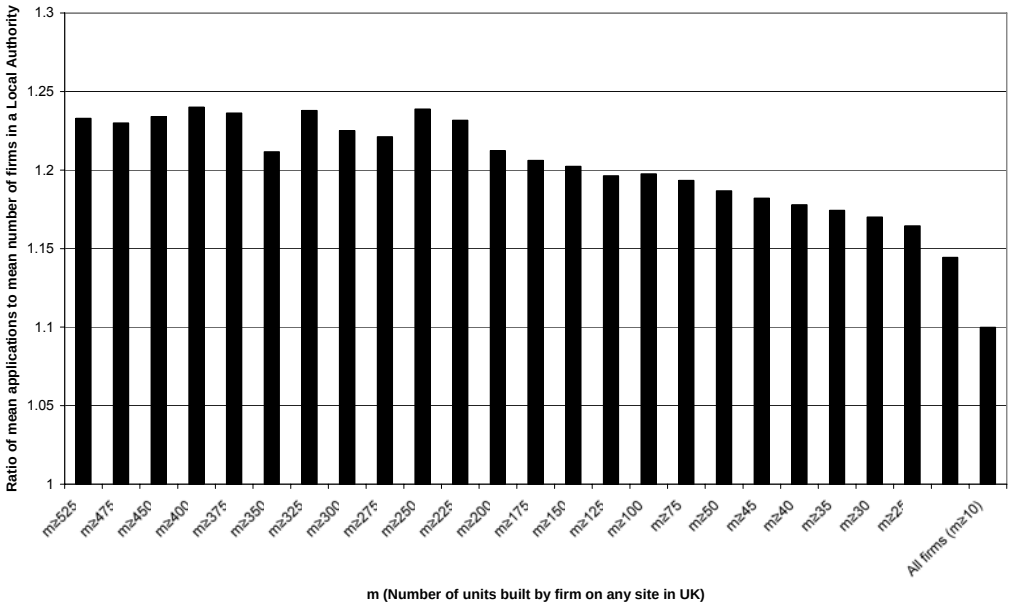
m	Mean	Median	Standard Deviation	Minimum	Maximum	Count
m≥525units	26.52408	0	97.88424	0	1248	353
m≥475units	34.26062	0	117.7499	0	1248	353
m≥450units	46.99717	0	137.374	0	1325	353
m≥400units	48.49575	0	142.8628	0	1325	353
m≥375units	50.62606	0	146.0752	0	1325	353

m≥350units	62.84986	0	160.6773	0	1325	353
m≥325units	72.37677	0	169.4398	0	1325	353
m≥300units	79.5779	0	190.0991	0	1804	353
m≥275units	81.90652	0	191.8747	0	1804	353
m≥250units	113.9547	17	232.1817	0	2432	353
m≥225units	118.4448	17	250.2946	0	2680	353
m≥200units	138.4136	35	272.6154	0	2861	353
m≥175units	141.9405	36	270.3716	0	2861	353
m≥150units	145.5382	39	275.0505	0	2861	353
m≥125units	167.9887	50	406.5842	0	5777	353
m≥100units	171.8102	63	306.3794	0	3397	353
m≥75units	187.8612	85	328.4148	0	3728	353
m≥50units	211.3513	105	347.1615	0	3814	353
m≥45units	214.6402	107	349.0352	0	3814	353
m≥40units	218.6629	111	352.2995	0	3854	353
m≥35units	225.8669	113	359.0655	0	3966	353
m≥30units	233.0425	124	365.3334	0	4021	353
m≥25units	238.83	124	372.3821	0	4150	353
m≥20units	254.6487	137	385.0908	0	4290	353
All units (m≥10)	293.5949	169	408.255	0	4466	353

A.4 Figure A1/1 below (figure 3 in main body of report) shows the ratio of mean successful applications to the mean number of firms that applied

for them across all Local Authority districts for different values of *m*. These ratios are bounded below by one and this corresponds to a situation whereby all applications in each Local Authority are made by different firms. As the ratio increases above one, holding the level of applications constant, successful applications are being received by a smaller number of firms. As can be seen from figure A1/1 as we widen the definition of the market to include firms that are only capable of building small numbers of units, we see that the ratio decreases towards one. This could be weak evidence that suggests firms capable of building large sites may not face strong competition from smaller homebuilders to build on these large sites, further suggesting that small homebuilders may be capacity constrained to developing small sites.

Figure A1/1 (mean ratio of number of applications granted to the number of firms they were granted to for different definitions of the market):



A.5 The econometric specification used to estimate firm profitability is the same as in treatment 1a in the main report. An ordered probit is used with number of firms as the dependent variable. Explanatory variables used include, the natural logarithm of some measure of the market size (S) – in this case population, dummy variables for the number of firms in the market and some demographic variables to control for differences in profitability across markets. In addition to the demographic control variables used in the baseline specification (treatment 1a) in the main report, a further variable is added to control for the effect on firm profitability of the units built by firms not included in each sample. For example, for the sample of firms capable of building sites greater than 125 units, the number of units built in each Local Authority by firms not capable of building sites greater than 125 units was included as a control.

Table A1/4: The dependent variable is a count of all private firms in a Local Authority district capable of building over *m* units on a single build. A selection of the models estimated are reported here.

Treatment	**All Homebuilders**	***m*** **≥25units**	***m*** **≥40units**	***m*** **≥125units**	***m*** **≥200units**	***m*** **≥300units**
	Coef. (robust s.e.)	Coef. (robust s.e.)	Coef. (robust s.e.)	Coef. (robust s.e.)	Coef. (robust s.e.)	Coef. (robust s.e.)
LNPOP	1.696*** (0.144)	0.625*** (0.156)	0.579*** (0.153)	0.765*** (0.151)	0.491*** (0.161)	0.690*** (0.174)
publicunits	0.0002 (0.0003)	0.0002 (0.0003)	0.0002 (0.0003)	0.0004 (0.0003)	0.0002 (0.0002)	0.0001 (0.0003)
ownership	0.023***	0.004	0.005	0.005	0.0001	0.003

	(0.000)	(0.006)	(0.005)	(0.006)	(0.006)	(0.007)
meanconstructionwage	-0.004** (0.002)	-0.005*** (0.002)	-0.006*** (0.002)	-0.005*** (0.002)	-0.003* (0.002)	-0.004* (0.002)
pbrownfield	-7.665 (6.243)	-2.015 (4.793)	-2.336 (4.601)	9.615* (5.368)	10.374** (5.102)	9.484 (7.063)
pgreenbelt	-145.068 (233.991)	21.765 (210.276)	48.460 (208.204)	51.881 (208.355)	88.130 (211.557)	232.736 (250.975)
residentswage	-0.001 (0.001)	0.002* (0.001)	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.001)	0.004*** (0.001)
jobdensity	-0.008 (0.016)	-0.023 (0.015)	-0.029* (0.015)	-0.024 (0.029)	-0.069 (0.266)	-0.208 (0.333)
ownoccrented	-1.378 (0.897)	-4.761*** (0.000)	-4.449*** (0.982)	-2.179** (1.087)	-1.870* (1.094)	-2.319* (1.199)
S106prop	-4.199*** (0.320)	-3.368*** (0.315)	-3.131*** (0.332)	-3.193*** (0.367)	-2.348*** (0.350)	-2.725*** 0.407
otherunits		0.006*** (0.001)	0.004*** (0.001)	-0.0001 (0.0003)	0.001*** (0.000)	0.0004 (0.0003)
Lamda(1)	1.749 (1.235)	-4.150 (1.397)	-3.801 (1.439)	-0.479 (1.484)	-0.001 (1.478)	1.173 (1.577)
Lamda(2)	2.813 (1.225)	-3.173 (1.391)	-2.944 (1.443)	0.530 (1.483)	0.967 (1.483)	2.337 (1.595)
Lamda(3)	3.553	-2.520	-2.168	1.316	1.753	3.219

	(1.230)	(1.390)	(1.441)	(1.489)	(1.499)	(1.613)
Lamda(4)	4.180 (1.233)	-1.996 (1.391)	-1.508 (1.444)	1.879 (1.497)	2.381 (1.515)	4.015 (1.698)
Lamda(5)	4.785 (1.245)	-1.568 (1.395)	-1.129 (1.450)	2.424 (1.505)	2.906 (1.538)	4.015 (1.698)
Lamda(6)	5.120 (1.252)	-1.149 (1.398)	-0.732 (1.456)	2.785 (1.495)	3.200 (1.510)	4.333 (1.604)
Lamda(7)	5.548 (1.254)	-0.785 (1.401)	-0.373 (1.466)	3.006 (1.493)	3.591 (1.483)	
Lamda(8)	5.856 (1.259)	-0.469 (1.405)	0.024 (1.487)	3.162 (1.480)	4.364 (1.562)	
Lamda(9)	6.128 (1.264)	-0.131 (1.419)	0.347 (1.474)	3.684 (1.553)		
Lamda(10)	6.380 (1.257)	0.062 (1.395)	0.681 (1.481)			
Lamda(11)	6.628 (1.263)	0.232 (1.393)	0.944 (1.480)			
Lamda(12)	6.746 (1.268)	0.527 (1.407)	1.352 (1.477)			
Lamda(13)	7.034 (1.275)	0.740 (1.421)	2.224 (1.543)			
Lamda(14)	7.299 (1.261)	0.866 (1.409)				
Lamda(15)	7.406	1.008				

	(1.267)	(1.415)				
Lamda(16)	7.609 (1.274)	1.410 (1.415)				
Lamda(17)	7.705 (1.275)	2.151 (1.514)				
Lamda(18)	7.756 (1.276)					
Lamda(19)	7.930 (1.276)					
Lamda(20)	7.997 (1.281)					
Lamda(21)	8.071 (1.291)					
Lamda(22)	8.236 (1.284)					
Lamda(23)	8.328 (1.287)					
Lamda(24)	8.426 (1.299)					
Lamda(25)	8.706 (1.302)					
Lamda(26)	8.922 (1.341)					
Lamda(27)	9.136 (1.377)					

Lamda(28)	9.367 (1.376)					
Lamda(29)	9.740 (1.478)					
Pseudo Rsqu	0.197	0.189	0.192	0.165	0.156	0.192
log likelihood	-792.609	-631.298	-569.441	-463.152	-435.729	-288.945
Obs.	353	353	353	353	353	353

*, **, *** indicate significant effects at the 1, 5 and 10% significance levels respectively.

A.6 One counter-intuitive result is that the coefficient on the variable **OTHERUNITS** is positive and significant in several of the specifications. It would be expected that the number of housing units built by other homebuilders (those not included in n) would have a negative effect on firm profitability as they would be substitutes for the homes built by firms in the sample. It is likely, therefore, that this variable is also accounting for some of the variation in the intrinsic profitability of developing within a particular area.

A.7 Interestingly, the profits of firms capable of building larger sites are less (negatively) affected by S106 requirements. This may be due to an imperfectly proportional relationship between the size of a development and the numbers of affordable housing units Local Authorities require firms to build.

A.8 Firms capable of building larger sites also have profits that are less determined by wage costs (**MEANCONSTRUCTWAGE**) and more determined by the availability of brownfield land suitable for housing development (**PBROWNFIELD**). In the latter case, as *m* increases the variable becomes positive and significant. This could be because larger site sizes are more land-intensive and so firms rely more heavily on

developing brownfield land that might be too costly for smaller scale builders to consider developing.

Table A1/5: Per-firm demand entry threshold ratios[+].

Treatment	All Homebuilders	*m* ≥25units	*m* ≥40units	*m* ≥125units	*m* ≥200units	*m* ≥300units
		2.386	2.196	1.872*	3.599	2.701
s2/s1		(1.90)	(1.70)	(2.84)	(1.22)	(2.24)
		1.896*	2.546	1.863**	3.308	2.394
s3/s2		(2.98)	(2.66)	(4.35)	(1.74)	(2.41)
		1.732*	2.348*	1.565**	2.703	1.586
s4/s3		(3.48)	(3.36)	(4.06)	(2.00)	(1.31)
		1.586**	1.538*	1.632*	2.329	1.201
s5/s4		(3.93)	(3.12)	(3.66)	(1.65)	(0.35)
		1.631**	1.656*	1.336	1.519	1.322
s6/s5		(4.01)	(3.06)	(1.35)	(0.90)	(0.38)
		1.534*	1.593	1.144	1.902	
s7/s6		(3.19)	(2.67)	(0.45)	(0.67)	
		1.449	1.735	1.073	4.228	
s8/s7		(2.61)	(2.40)	(0.11)	(0.52)	
Tests that $s_n/s_{n-1}=s_{n+1}/s_n$[++]						
$s_2/s_1=s_3/s_2$		0.54	0.45	0.00	0.07	0.16
$s_3/s_2=s_4/s_3$		0.24	0.13	0.78	0.31	0.91

$s_4/s_3=s_5/s_4$	0.24	1.92	0.04	0.13	0.39
$s_5/s_4=s_6/s_5$	0.03	0.12	0.59	0.61	0.03
$s_6/s_5=s_7/s_6$	0.10	0.03	0.32	0.11	
$s_7/s_6=s_8/s_7$	0.08	0.08	0.05	0.27	

[+] Values in parenthesis are the Wald test statistics, where the null hypothesis is that the ratio is equal to 1. *, **, *** indicate significant effects at the 1, 5 and 10% significance levels respectively.

[++] Values reported are the Wald test statistics. *, **, *** indicate significant differences at the 1, 5 and 10% significance levels respectively (in this case none of the tests show significant differences at these levels).

A.9 In interpreting the above demand entry thresholds it is important to realise that, for very large values of *m*, there are very few markets in the sample less concentrated than duopoly and hence it is important not to put too much significance on the threshold ratios for n greater than this. For $m \geq 200$ and $m \geq 300$ it appears that at no point does the entry of a successive firm affect competitive conduct in the market. One interpretation of this is that this sub-market is such a small part of the overall market that the entry of another firm into this sub-market is not sufficient to influence the price of new housing. However, contrary to this reasoning is the fact that, for example in the case where $m \geq 200$, the number of houses built by other homebuilders (that is, those not capable of building sites greater than 200 units) significantly affects firm's profits in a positive way.

A.10 Importantly, there do appear to be differences in entry thresholds for firms capable of building different size sites. This suggests that it is right to consider that the entry decisions of these firms affect competitive conduct in the market in different ways. The variation in competitive conduct between small and large site capable firms is, however, ambiguous. It appears that when the market considered is firms capable of building sites of more than around 100 units, competition occurs at lower levels of concentration than when the market is considered to be firms capable of building at least 10 units on a given site. This suggests weak evidence for the hypothesis that firms capable of building only very small sites should be considered a competitive fringe and it is not

until several of this type of firm have entered that competitive conduct changes.

B HETEROGENEITY IN TYPE OF PROPERTY

B.1 The data on number of firms was also separated into two further sub-samples. The first of these was a count of the number of homebuilders in each local authority whom had built flats anywhere in England in 2004. The second sub-sample was a count of the number of firms in each local authority whom had built houses anywhere in England in 2004. As with the capacity sub-samples (see Appendix 1), these are counts of the number of homebuilding firms in a Local Authority capable of building either flats or houses, not a count of the number that actually did build houses or flats in that Local Authority in 2004. That is, even if a homebuilding firm only built houses in Local Authority X in 2004, provided that it had built flats in at least one other Local Authority in 2004 it would be included in the flats sub-sample.

Figure A2/1: Histogram of number of firms (flats sub-sample)

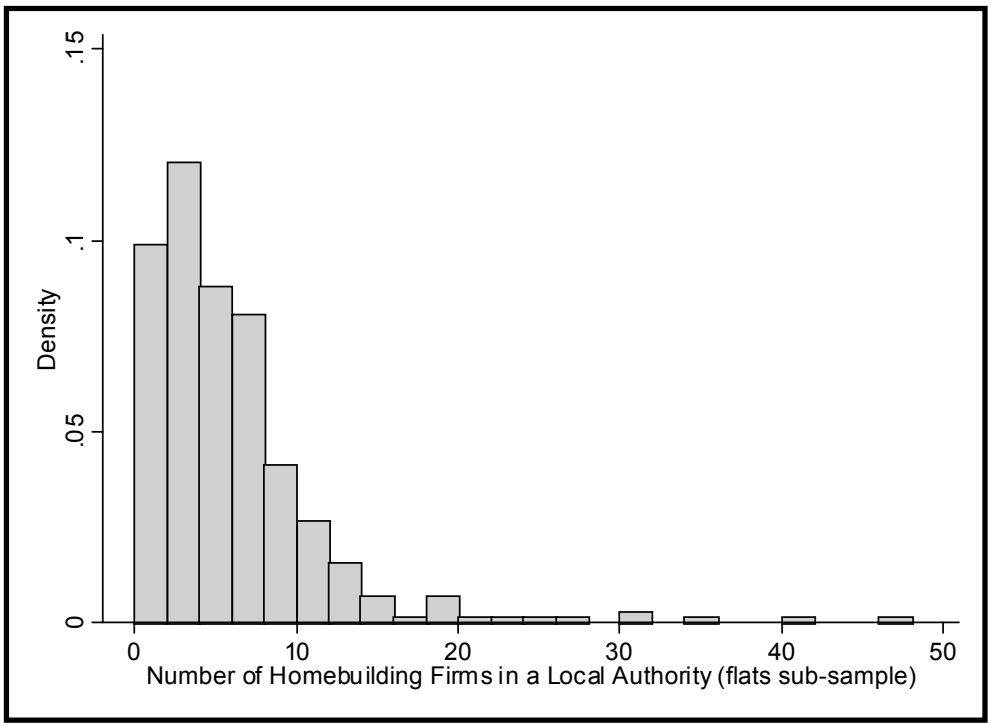
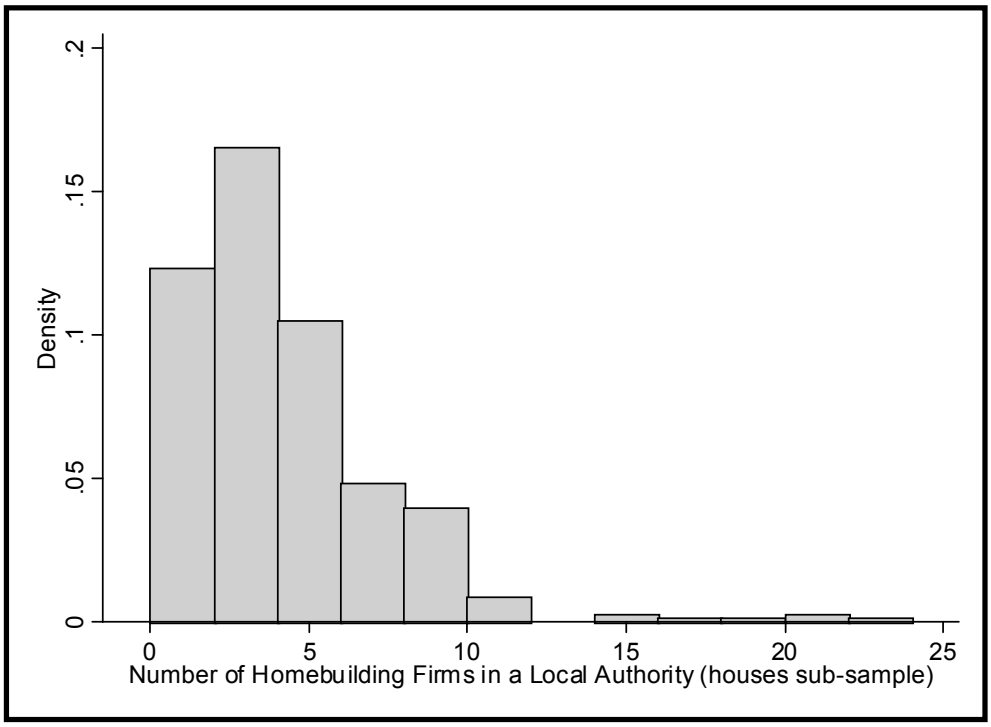


Figure A2.2: Histogram of number of firms (houses sub-sample)



B.2 The two sub-samples were used as the dependent variable to estimate two ordered Probit models (results reported in Table A2.1). As with the baseline results in section 4.1, the number of firms is regressed on the natural logarithm of a variable to measure market size and other demographic variables to control for differences in firm profitability across different markets (**X**).

B.3 In this case, the market size (S) variable used is the natural logarithm of population. The demographic variables used are the same as those used for the baseline models. A further variable (**OTHERUNITS**) is added to control for the number of units built by firms not included in the sub-sample. That is, in the flats case, the number of units built in a Local Authority by solely house builders is included. This is to control for the

effect these units will have on the supply of new homes in the area given that properties built by the other 'type' will be substitutes.

Table A2/1: The dependent variables in each of the three models reported below are a count of all private firms in a Local Authority district (All Homebuilders), all private firms in a Local Authority district capable of building flats (Flats sub-sample) and all private firms in a Local Authority district capable of building houses (Houses sub-sample).

Treatment	**All Homebuilders**	***Flats* sub-sample**	***Houses* sub-sample**
	Coef. (robust s.e.)	Coef. (robust s.e.)	Coef. (robust s.e.)
LNPOP	1.696*** (0.144)	1.699*** (0.141)	0.892*** (0.140)
publicunits	0.0002 (0.0003)	0.0001 (0.0003)	0.0004* (0.0002)
ownership	0.023*** (0.000)	0.027*** (0.006)	0.001 (0.005)
meanconstructionwage	-0.004** (0.002)	-0.005*** (0.002)	-0.005*** (0.001)
pbrownfield	-7.665 (6.243)	2.995 (7.042)	-14.293** (6.195)
pgreenbelt	-145.068	162.90	-185.299

	(233.991)	(229.525)	(231.082)
residentswage	-0.001 (0.001)	0.0004 (0.001)	0.0003 (0.001)
jobdensity	-0.008 (0.016)	0.005 (0.014)	-0.162 (0.259)
ownoccrented	-1.378 (0.897)	-1.714* (0.920)	-0.473 (0.986)
S106prop	-4.199*** (0.320)	-3.599*** (0.299)	-3.632*** (0.287)
otherunits		-0.001 (0.001)	0.0003 (0.0003)
Lamda(1)	1.749 (1.235)	2.830 (1.220)	-1.823 (1.294)
Lamda(2)	2.813 (1.225)	3.855 (1.223)	-0.630 (1.282)
Lamda(3)	3.553 (1.230)	4.525 (1.234)	-0.016 (1.276)
Lamda(4)	4.180 (1.233)	5.064 (1.237)	0.652 (1.275)
Lamda(5)	4.785 (1.245)	5.485 (1.246)	1.134 (1.276)
Lamda(6)	5.120	5.819	1.440

	(1.252)	(1.254)	(1.278)
Lamda(7)	5.548 (1.254)	6.228 (1.258)	1.754 (1.283)
Lamda(8)	5.856 (1.259)	6.583 (1.264)	1.968 (1.286)
Lamda(9)	6.128 (1.264)	6.810 (1.268)	2.234 (1.292)
Lamda(10)	6.380 (1.257)	7.083 (1.273)	2.782 (1.274)
Lamda(11)	6.628 (1.263)	7.251 (1.279)	3.093 (1.285)
Lamda(12)	6.746 (1.268)	7.532 (1.272)	3.181 (1.282)
Lamda(13)	7.034 (1.275)	7.659 (1.271)	3.286 (1.286)
Lamda(14)	7.299 (1.261)	7.193 (1.270)	3.396 (1.294)
Lamda(15)	7.406 (1.267)	8.091 (1.272)	3.510 (1.310)
Lamda(16)	7.609 (1.274)	8.145 (1.281)	3.648 (1.326)
Lamda(17)	7.705 (1.275)	8.203 (1.281)	4.152 (1.300)
Lamda(18)	7.756	8.563	

	(1.276)	(1.285)	
Lamda(19)	7.930 (1.276)	8.660 (1.291)	
Lamda(20)	7.997 (1.281)	8.766 (1.301)	
Lamda(21)	8.071 (1.291)	8.888 (1.281)	
Lamda(22)	8.236 (1.284)	9.035 (1.286)	
Lamda(23)	8.328 (1.287)	9.223 (1.304)	
Lamda(24)	8.426 (1.299)	9.445 (1.341)	
Lamda(25)	8.706 (1.302)	9.714 (1.347)	
Lamda(26)	8.922 (1.341)	10.090 (1.454)	
Lamda(27)	9.136 (1.377)		
Lamda(28)	9.367 (1.376)		
Lamda(29)	9.740 (1.478)		

Pseudo Rsqu	0.197	0.193	0.156
log likelihood	-792.609	-761.746	-682.130
N	353	353	353

*, **, *** indicate significant effects at the 1, 5 and 10% significance levels respectively.

B.4 The estimates from these two sub-samples are, for the most part, similar to each other and to the results from the baseline specification.

B.5 One interesting difference is that the coefficient on **PBROWNFIELD** is negative and significant in the case of houses and not flats. This may be due to the fact that brownfield land may be more expensive to develop than other land types and hence, will be less suitable for the more land-intensive housing developments. This further supports the finding in appendix one that the profits of firm capable of building large (in terms of number of units) sites depend positively on the availability of brownfield land as the sites they build are more likely to be flats than houses.

Table A2/2: Per-firm demand entry threshold ratios[+].

Treatment	All homebuilders	*Flats* sub-sample	*Houses* sub-sample
s2/s1	0.937 (0.31)	0.914 (1.00)	1.906* (3.18)
s3/s2	1.031 (0.16)	0.989 (0.03)	1.326* (3.05)
s4/s3	1.086 (1.79)	1.030 (0.34)	1.587*** (7.34)
s5/s4	1.143** (5.39)	1.014 (0.35)	1.374*** (6.73)
s6/s5	1.064 (2.12)	1.091(0.15)	1.174* (3.41)
s7/s6	1.053 (1.72)	1.078* (3.74)	1.220** (4.38)
s8/s7	1.049 (1.66)	1.061* (3.08)	1.112 (1.86)

Tests that $s_n/s_{n-1}=s_{n+1}/s_n$ [++]			
$s_2/s_1=s_3/s_2$	0.48	0.56	1.84
$s_3/s_2=s_4/s_3$	0.30	0.30	1.91
$s_4/s_3=s_5/s_4$	0.46	0.00	1.29
$s_5/s_4=s_6/s_5$	1.13	0.04	2.06
$s_6/s_5=s_7/s_6$	0.04	1.64	0.15
$s_7/s_6=s_8/s_7$	0.00	0.04	0.77

[+] Values in parenthesis are the Wald test statistics, where the null hypothesis is that the ratio is equal to 1. *, **, *** indicate significant effects at the 1, 5 and 10% significance levels respectively.

[++] Values reported are the Wald test statistics. *, **, *** indicate significant differences at the 1, 5 and 10% significance levels respectively (in this case none of the tests show significant differences at these levels).

B.6 As can be seen in table A2/2, for the flats sub-sample, the market becomes more competitive with the entry of the seventh and eighth firm. This sub-market requires a lower level of concentration to become competitive than when we considered the market composed of all private firms (where the largest increase in competition occurred with the entry of the fifth firm). This suggests that competition is less vigorous between firms capable of building flats.

B.7 For the houses sub-sample, competitive pressure increases with the entry of the first firm (although the largest increases in competition occur with the entry of the fourth and fifth firms). Therefore, in this sub-market, competition starts to increase at much higher levels of concentration.

B.8 The relationship between market size and number of firms varies greatly depending upon the definition of the market used. This suggests that firms that are capable of building flats may not be operating in the same

market as those capable of building houses (although obviously there are firms capable of building both).

B.9