DISCUSSION PAPER SERIES

No. 6713

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INDUSTRIAL ORGANIZATION

Centre for Economic Policy Research

www.cepr.org

ISSN 0265-8003

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Discussion Paper No. 6713
February 2008

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CEPR Discussion Paper No. 6713

February 2008

ABSTRACT

Supermarkets and Planning Regulation*

We are interested in evaluating the impact of restrictive planning regulation on entry into the UK grocery retail industry. We estimate a model similar to Bresnahan and Reiss (1991) where we allow for multiple store formats. We find that more restrictive planning regulation reduces the number of large format supermarkets in equilibrium. However, the impact is overstated if variation in demographic characteristics across markets is not also controlled for. Our estimates suggest that restrictive planning regulation leads to a loss to consumers of up to £10m per annum. This cost must be offset against any benefits that arise, e.g. due to reduced congestion.

JEL Classification: L11, L52 and L81
Keywords: entry, land use regulation and retail

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* The analysis contained in this paper was funded by the ESRC/EPSRC Advanced Institute of Management Research (AIM) and the ESRC Centre for the Microeconomic Analysis of Public Policy at the IFS. We would like to thank Bronwyn Hall, Rupert Harrison, Jonathan Haskel, Mari Sako, Raffaela Sadun, Helen Simpson and John Van Reenen for helpful comments and discussions.

Submitted 11 February 2008

1 Introduction

The UK retail sector has been the focus of academic interest and policy concern because of its relatively low productivity growth, high prices and concentrated market structure.[1] Attention has focused on land use regulation as one of the root causes of this poor performance, and in particular the regulations introduced in the mid-1990s which severely restricted the ability of firms to build new large-scale out-of-town supermarkets. An influential report by McKinsey (1998) highlighted planning regulations as one of the major policy issues affecting productivity in this sector, and in his recent Pre-Budget Report, on 5 December 2005, the Chancellor and Deputy Prime Minister announced a review of the land use planning system in England, with particular focus on the impact on productivity. [2]

Yet there is relatively little empirical evidence on the impact or cost of land use regulation.[3] Work commissioned by the Office of the Deputy Prime Minister (ODPM) has suggested that land use regulation has had a large impact on entry of new large stores,[4] by comparing entry rates before and after the reform of 1996, as shown in Figure 1. Before this major reform approximately similar numbers of small and large

[1] The wholesale and retail sector account for around one-fifth of the UK's productivity gap, with the US and supermarkets accounting for the single biggest component of this sector. See, for example, Griffith, Harrison, Haskel and Sako (2003), Figure 3, Griffith and Harmgart (2005), Inklaar, Timmer and van Ark (2006) and Haskel and Sadun (2007). The supermarket industry has been repeatedly investigated by the UK competition authorities.

[2] See also McKinsey (1996), Haskel and Khawaja (2003), Competition Commission (2000).

[3] A notable exception is a paper by Bertrand and Kramarz (2002) who show that planning regulation in France created an important barrier to entry for large supermarkets. A recent paper by Schaumans and Verboven (2006) considers regulations in the pharmacy industry in Belgium. Djankov et al (2002) also cite land use regulation as an important barrier to entry.

[4] See, for example, ODPM (2005), para 1.5, *".. emerging evidence suggests that since the mid-1990s national planning policy has had a significant impact in terms of increasing the proportion of retail development locating in town centres..."*

stores were opened, after the reforms there was a rapid rise in the number of smaller format stores opened.

[Figure 1 here]

However, the problem with a before and after comparisons is that it does not account for other factors have also affected the shift towards smaller store formats. For example, a report by CB Hillier Parker to the ODPM notes that *"... food retailers are changing their store formats and focusing more on town centre and edge of centre sites, this has been as much due to commercial considerations as to [planning regulations] ..."*

Our contribution in this paper is to consider the impact that planning regulation has had on market structure in the UK supermarket industry *taking into account these other factors*, and thus be able to say something about the direct cost of this regulation. We show that when we do not take these other factors into account we incorrectly attribute other contemporaneous changes to the regulatory reforms. We use variation in the way that the regulations were implemented across local authorities, and argue that it is largely idiosyncratic so that we can identify the effect of regulation on market outcomes. We compare the impact of regulation across store types that were and were not affected by the regulation.

We take the model of Bresnahan and Reiss (1991) as a starting point and extend it in a simple way to allow for two types of stores.[5] This is motivated by the dominant model of consumer behaviour in the grocery market which considers consumers as demanding the bulk of groceries in "one-stop" and the residual in a "top-up" shop. We assume that firms make decisions about entry into the large store format independently of the number of small stores, whereas the decision to enter into the small

[5] Other papers that also do this include Berry (1992), Mazzeo (2002) and Toivanen and Waterson (2001).

store format takes the number of large stores as given. We think this is a realistic assumption, motivated by the one-stop vs top-up model of shopping behaviour. We use information on the geographic concentration of economic activity in town centres in the UK to define local markets.

Our findings suggest that failing to control for variation in demographic factors and observable fixed cost drivers implies that the effect of planning regulations is over twice as large as when we condition on these factors. We find that planning regulation did have a statistically significant impact on market equilibrium outcomes and that it has represented an entry barrier. When we control for demographics, we find that a percentage increase in the approval rate of planning applications has a similar magnitude of effect (but opposite sign) to a percentage increase in the unemployment rate. To further quantify the economic impact of the reform we use additional data to look at the price of groceries vary with the planning regime. We find that restrictive planning regimes are associated with a small but significantly higher food prices.

The structure of the paper is as follows: Section 2 describes the planning and land use regulations as they apply to grocery stores in England. Section 3 describes a model of supermarket entry and equilibrium market structure and our estimation strategy. Section 4 discusses the data. Our results are shown in Section 5 and a final section concludes.

2 Land use regulation

The use of land for certain purposes is regulated in England. Food can only be sold on sites that have been designated as suitable for that use. There are two "use classes" that apply to food: A1 which includes shops that sell packaged foods, and A3 which includes shops selling hot food (restaurants, pubs, cafés, wine bars, etc.). In order to open a grocery store a firm must either purchase a site that already has A1 (or A3) approval, or apply for approval for a new site. When opening a new large out-of-town stores this usually involves making a new application.

Rapid growth in the number of out-of-town supermarkets in the UK over the late 1980s and early 1990s (see Figure 1) led to policy concern about out-of-centre development and the impact they were having on the vibrancy of city centres. Reforms to land use regulation sought to encourage retail development in town centres with the introduction of Planning Policy Guideline 6 (PPG6) in 1996. PPG6 instituted the sequential approach, which states that locations for new developments (in particular retail developments) should be considered sequentially - first in-town sites should be considered, if they are not viable then edge-of-town sites should be considered, with out-of-town centres only considered as a last resort, if there is no viable city centre alternative. PPG6 stated that Local Planning Authorities (LPAs) should take a 'plan-led' approach. LPAs are required to have a development plan, which should set out the need for additional facilities and the authority's policies for the development and use of land in its area. The plan should also identify the town centres in which growth should be concentrated in and identify sites for specific types of development, where a need for additional provision has been identified. Under this regime variation in proportion of applications approved arises due to variation in the LPAs plan (for example, due to differences in the political composition or efficiency of the LPA), along with other reasons.

The process for applying for planning permission involves submitting details about the development of the site (plans, drawings etc.), and for out of town sites also involves submitting information justifying why there is need for additional retail space and why is should be located out of town (and not at a town centre site).[6] We model this as a fixed cost. In order to apply the firm has to invest in the application.

[6]See ODPM (2005) for a description of the process.

The more the firm spends on the application the more it can improve its chances of getting approval. In addition, the firm can spend resources lobbying local officials when the plan is drawn up.

We assume that the process by which firms choose to apply does not differ across local authorities, so that the approval rate is a good indicator of the actual constraint that the regulation imposed. The implementation of the planning approval process - in other words the difficulty of getting an application approved - varies significantly between different local authorities. We assume that this variation is largely unpredictable by the firm. A recent survey of the competition commission[7] shows that local authorities differ in their retail need assessment, their consideration of applications and appeals, and even whether they encourage existing retailers to extend their space rather than to apply afresh. Reasons for these difference range from capacity constraints at the local authority level, e.g. some local authorities name insufficient resources as the main constraint on commissioning an independent assessment in addition to the one provided by the retail applicant, to differences in policy on what the criteria are used to assess the need for retail. Also, the importance given to concerns over existing levels of competition differs widely between the local authorities from having no importance during the reviewing process of a new application to being the most important ingredient for the decision. Another indicator of variation in the approval process is the different density and level of activism by local groups campaigning against large supermarket openings.[8]

3 A model of supermarket entry and equilibrium

We take Bresnahan and Reiss (1991), henceforth B&R, as our starting point with N symmetric firms entering into a Cournot competition. We extend the baseline model

[7] For more details see Competition Commission (2007).

[8] See for example Friends of the Earth (2005).

by allowing for two types of stores - in-town (small) and out-of-town (big). This is an important characteristics of the UK supermarket industry, where there are two distinct types of stores - small city centre stores like Tesco Metro and Sainsbury Local and big often out-of-town supermarkets. These stores were differentially affected by land use regulation.

We assume that demand for groceries takes the following form: consumers demand the bulk of their groceries in a one-stop shopping trip in big stores; they subsequently top-up with additional items that were forgotten or unexpectedly needed in small stores.[9] Adding two product types to the simultaneous-move entry game of B&R introduces multiple equilibria (some of which might be mixed strategy equilibria).[10] In order to obtain a unique pure-strategy equilibrium we need some additional assumptions. Mazzeo (1992) and Toivanen and Waterson (2001) model entry with more than one type of entrant and introduce two additional assumptions for uniqueness. First, they introduce Stackelberg competition, with an exogenously defined sequence in which firms make irrevocable choices whether or not to enter, and of which type. The second assumption is that the decrease in profits is larger if the competitor is of the same type.

In the supermarket industry there is no natural ordering, so the Stackelberg assumption seems implausible. Instead we consider firms to play a three-stage game. In the initial stage, firms that operate big stores decide whether to enter by opening a big store.[11] In the second stage, after these big store entry decision have been made, firms operating small stores decide whether to open and compete for the residual demand. Profits of big stores therefore do not depend on the presence of small stores, but small stores take the number of big stores into account when deciding whether to

[9] See, inter alia, Bliss (1988), Armstrong and Vickers (2001), Smith (2004), CC (2000).

[10] See Tamer (2002) for empirical strategies of estimating multiple equilibria in discrete games.

[11] We do not consider issues that arise due to chain stores taking joint decisions over opening a number of stores, this is beyond the scope of this paper.

enter or not. By separating the big and small store entry decisions (i.e. when deciding on whether to open a big store firms do not have to take the strategic decisions of small stores into account, and the decision of big is exogeneous to small) we have a unique equilibrium on the number of small and big firms. We justify this assumption by quoting the Competition Commission report into the Safeway-Morrison merger *"... supermarket product market definition may be asymmetric, in that stores above 1400 sq metres that cater largely for customers carrying out main grocery shops are less constrained by mid-range store than the other way round."*[12] In the final stage, once firms have made their entry decisions, symmetric price competition between each type ensues and payoffs are determined. To reflect the impact of land use regulation we introduce differential fixed costs across store type.[13]

In the Nash equilibrium the following inequalities hold (where Π_B indicates per-firm profits of a big store, Π_S per-firm profits of a small store, n_B is the total number of big stores, n_S the number of small stores, n_{B-i}, n_{S-i} is the number of big and small stores excluding i and C_B, C_S are the fixed costs of a big and a small store):

(1) entry of *Big* if $\Pi_B(n_{B-i}) > C_B$,

(2) entry of *Small* if $\Pi_S(n_{S-i}, n_B) > C_S$,

(3) exit from *Big* if $\Pi_B(n_{B-i} + 1) < 0$,

(4) exit from *Small* if $\Pi_S(n_{S-i} + 1, n_B) < 0$.

A store enters if profits are sufficient to cover fixed costs, and they exit the market if they make negative net profits. To prove the existence of a pure strategy equilibrium we need to impose some structure on the profit function. As discussed above, we assume that entry decisions are taken simultaneously among firms of the same type, and the restriction is that firm profits decline in rivals' entry (so we assume that

[12] Para 37 of Appendix B of CC report into Safeway-Morrisons merger.

[13] This is easier and more natural to incorporate into a simultaneous move game. In a sequential game like Mazzeo's (1992) varying fixed costs would effect the entry sequence as well as the product choice. He focusses on varying variable costs by type.

profits decline in the number of big firms in the first and second stage, and profits decline in the number of small firms in the second stage).

3.1 Market demand

Market demand is characterised in the following way. Consumers demand a composite good "groceries" and thus aggregate demand can be modelled in the form

$$Q = d(X, P)S(Y) \tag{1}$$

where Q is total quantity of groceries demanded, $d(X, P)$ is the demand of a representative consumer, which is a function of demographic variables X and the price P of the groceries. $S(Y)$ denotes the number of consumers. Demand is proportional to the number of consumers and thus the demand function is homogeneous of degree one. We assume that demand increases linearly in S.[14]

Different store formats arise through the demand function, in line with the one-stop shopping model. Different store formats arise because of consumer preferences and shopping habits. Consumers demand groceries. They buy a large portion of their groceries in one shopping trip, and then top-up forgotten items of perishables in small trips. For the one-stop shopping trip they prefer a large variety of different goods and therefore prefer a large store format. For the top-up shopping, on the other hand, a small convenient store that is in close proximity is preferred. Aggregate quantity demanded from one-stop shopping (Q_1) and top-up shopping (Q_2) is then

$$Q = Q_1 + Q_2 = d_1(X, P)S(Y) + d_2(X, P, Q_1)S(Y) \tag{2}$$

where $d_1(X, P)$ is the demand of a representative consumer from one-stop shopping and $d_2(X, P, Q_1)$ the demand from top-up shopping. Both are a function of demographic variables X and the price P of the groceries. This demand function is

[14] This assumption is crucial since non-linear demand in S might lead to multiple equilibria.

homogeneous of degree one, and we assume that demand increases linearly in S. Demand from one-stop shopping is unaffected by the demand from top-up shopping, the cross derivatives $\frac{\delta Q_1}{\delta d_2}$ is equal to zero, but $\frac{\delta Q_2}{\delta d_1}$ can be different from zero, since it depends on the residual demand after one-stop shopping of Q_1. This assumption of independent demand for one-stop shopping allows us to estimate the resulting profit functions for large format stores independently from small format stores, and so investigate the differential impact of planning regulation, using an ordered probit model. In estimating the resulting profit functions for small format stores we include the number of big stores, in line with the assumption that these firms compete over residual demand, treating the number of big stores as given.

3.2 Firm profits

We assume that profits are additively separable in observed and unobserved components, so take the following form, where subscript n denotes the number of firms (1 monopoly, 2 duopoly etc.), j denotes the market and f denotes the store format (big or small),

$$\Pi_{njf} = S_f(Y_j)V_f(W_j, \alpha, \beta) + F_f(R_j, \gamma_n, \theta) + \varepsilon_j, \tag{3}$$

where α, β, γ and θ are parameters to be estimated, Y_j are factors that vary across region and affect market size, W_j are factors that vary across region and affect per capita profits (demand and variable costs) and R_j are factors that shift fixed costs (e.g. regulatory constraints) and the unobserved error ε captures idiosyncratic variation in profits. We assume that the demand shock is the same for all firms within a market, is independent of the number of firms, and that ε are independent across markets and not correlated with observables. In the empirical application we allow for correlation between markets that are in the same Local Planning Authority.

We model market size as a simple linear function of population,

$$S_f\left(Y_j\right) = \lambda_f Y_j \tag{4}$$

and firms per capita variable profits as a linear function of the observables W,

$$V_f(W, \alpha, \beta) = \alpha + \beta_f W_j. \tag{5}$$

Fixed costs depend on exogenous factors R, including land use regulation, and a market structure level unobservable, γ_n

$$F_f(R_j, \gamma_n) = \theta_f R_j + \gamma_{nf}. \tag{6}$$

The γ_{nf} terms allow for fixed costs to vary with the number of firms in the market, in particular it allows later entrants to have higher fixed costs.

Putting these together (substituting (4), (5) and (6) into (3)) we have

$$\Pi_{nfj} = \lambda_f Y_j \left(\alpha + \beta_f W_j\right) + \theta_f R_j + \gamma_{nf} + \varepsilon_j. \tag{7}$$

3.3 Empirical model

Given the model described by (7), the probabilities of observing a particular market structure for the large store type are

$$\Pr\left[n_B = 0|Y, W, R\right] = \Pr\left[\lambda_B Y_j\left(\alpha_B + \beta_B W_j\right) + \theta_B R_j + \varepsilon_{Bj} < \gamma_{B1}\right] \tag{8}$$

$$\Pr\left[n_B = l|Y, W, R\right] = \Pr\left[\gamma_{Bl} < \lambda_B Y_j\left(\alpha_B + \beta_B W_j\right) + \theta_B R_j + \varepsilon_j < \gamma_{Bl+1}\right], \qquad l = 1, 2, 3$$

$$\Pr\left[n_B = 4|Y, W, R\right] = \Pr\left[\gamma_{B4} < \lambda_B Y_j\left(\alpha_B + \beta_B W_j\right) + \theta_B R_j + \varepsilon_j\right]$$

and for the small store type this differs in that there is an additional term in the number of large stores:

$$\Pr\left[n_S = 0|Y, W, R\right] = \Pr\left[\lambda_S Y_j \left(\alpha_S + \beta_S W_j\right) + \theta_S R_j + \phi n_B + \varepsilon_j < \gamma_{S1}\right] \tag{9}$$

$$\Pr\left[n_S = l|Y, WR\right] = \Pr\left[\gamma_{Sl} < \lambda_S Y_j \left(\alpha_S + \beta_S W_j\right) + \phi n_B + \theta_S R_j + \varepsilon_j < \gamma_{Sl+1}\right], \qquad l = 1, ..., 7$$

$$\Pr\left[n_S = 8|Y, WR\right] = \Pr\left[\gamma_8 < \lambda_S Y_j \left(\alpha + \beta_S W_j\right) + \phi n_B + \theta_S R_j + \varepsilon_j\right].$$

Under the assumptions that the errors ε_j are i.i.d. and normally distributed in the profit specification (3) and have zero mean and constant variance we can estimate these equilibrium market structure using a standard ordered probit model. The estimated coefficients can be directly interpreted as structural parameters of the underlying profit function. The choice probabilities allow identification only up to an arbitrary normalisation. Following B&R we make the additional assumptions that the constant coefficient in variable costs is zero, $\beta_0 = 0$, and that the variance of the error term equals unity.

It is difficult to interpret the magnitudes of coefficients in an ordered probit model. We do two things to aid interpretation. First, we calculate marginal effects for β and θ at the extremes - for the probability of leaving the zero state and for the probability of entering the market structure with the most firms (4 in the case of large stores and 8 in the case of small stores). Second, we consider the impact of specific policy changes, for example, a policy reform that led to all land use applications being approved.

4 Data

In order to estimate the model described above we combine data on the location of all existing grocery stores in England with detailed information on local demographics and on the approval rate of planning applications across markets. These data are available from several different sources.

4.1 Supermarket location

The data on grocery stores comes from the Institute of Grocery Distribution (IGD). We use the data for 2002. There are over 7,000 grocery stores listed in IGD data in England that are in operation in 2002.[15] The data record the company name, the fascia, the postcode, the opening and closing dates.

[Table 1 here]

Table 1 shows the distribution of store size by sales area (square foot). We need to be able to empirically distinguish stores by type in order to implement the model described above. The Competition Commission identifies stores above and below 15,000 square feet with different consumer purchasing behaviour for one-stop shopping versus top-up shopping. Consumers do the bulk of their shopping in a weekly one-stop shopping trip in a large store with sufficient product variety, which are above 15,000 sq feet. To accommodate unexpected demand they top-up their weekly bulk shopping with few items in smaller more conveniently (to work or home) located stores, which are on average below 15,000 sq feet.

[15] This covers all chain stores and all other large stores, as well as around 80% of independent small stores.

4.2 Market definition

One of the challenges facing empirical researchers in this area is defining the geographic boundaries of the market. B&R and other papers in the literature have used geographically isolated markets. However, the UK is a very densely populated country, with on average 383 people per sq km. This is more than Germany (235), double France (106) and nine times the US (27). There are, therefore, few isolated markets in England. However, economic activity in England is focused around town centres, or high streets, with most households shopping for groceries within close proximity of their house. For example, The Department for Transport National Travel Time Survey (2005) reports that the average distance travelled by consumers for grocery shopping is 4.3 miles. Town centres represent areas of economic activity, and have been identified in research carried out for The Office of the Deputy Prime Minister (ODPM).[16] They identified 973 town centres in England in 2002. Table 2 shows the distance between town centres. Over half of all town centres are within 5km of at least one other town centre, and only two town centres are over 30km from any other town centre.[17] This means that we are not able to take the approach that B&R do with US data (i.e. consider only geographically isolated communities). This means that most of our town centres are overlapping. We do two things to try and mitigate any impact that this will have on our estimates and policy conclusions. First, we include a variable indicating the distance to the next nearest town centre, to capture some of the effect of local competition from nearby retail establishments. Secondly, we focus on the difference in the estimated impact of planning regulation when we do and do not control for demographic and other local factors. We hope that any bias in the estimated coefficient on planning regulation is approximately constant across

[16] For more details on the methodology, see http://www.iggi.gov.uk/towncent/2002/entry.htm. Areas with less than 4 hectares are excluded

[17] Berwick-upon-Tweed is 44 km from Alnwick and Minehead is 31km from Wellington.

these two models. We also show that our results are robust to dropping major urban centres.

We allocate each store to the nearest town centre (by Euclidian distance). Of the 973 town centres we observe at least one grocery store in 960. Table 3 shows the distance of stores from their nearest town centre. We have complete data for 845 town centres. Table 4 shows the number of stores per town centre by store size. Columns (1) and (2) show the market configuration of large and small stores using 15,000 sq ft as the dividing line, as suggested by the one-stop-shopping model of demand and the Competition Commission's market definition. In columns (3)-(6) we break down the market structure further. The final column shows the market configuration based on the total number of stores.

[Table 4 here]

4.3 Planning applications

Data on planning applications comes directly from the ODPM. We have information on the number of applications received and the number approved for food retail establishments (use class A1 and A3). Class A1 is necessary to sell food (e.g. grocery stores) and A3 is necessary to sell hot food (for on-site food consumption). These include not only supermarkets, but also other large retail or leisure sites and restaurants. The data is provided to the ODPM by the Local Planning Authorities in England. To measure the extent to which the regulation poses an entry barrier we use the approval rate. To capture the lag between approval and opening we use the rate between 1996 the major change in the regulation and 2001.

Given our assumption that variation in the implementation of the planning approval process is largely exogneous (discussed above in section 2) we can use the approval rate to capture the constraint of the regulation in a given local authority. Figure 2 shows the share of planning applications that were approved. It is clear that the approval rate varies substantially across local authorities. Around 35% of authorities have an approval rate of over 90%, while nearly 10% have an approval rate that is less than 60%.

[Figure 2 here]

4.4 Demographic and other data

One contribution of this paper is to evaluate the impact of land use regulation, while controlling for other factors.

We include a range of demographic variables as proxies for income or which reflect variation in the price sensitivity of consumers or the types of products purchased. These include the total population, the unemployment rate, the proportion of people that are retired, the proportion that are identified as "working class", the density of office floor space, how far it is to the next nearest town centre, and whether the town centre is in Greater London. Variables that affect fixed costs include the value of retail land (we use the rateable value), along with planning regulations. We also allow fixed costs to vary across broad regions (North, Midlands, South, Greater London).

These data are available at a very disaggregate level (the Output Area level, of which there are 16,000 in England) from the Office of National Statistics (ONS) and the Office of the Deputy Prime Minister (ODPM). We match these to town centres, giving us very precise data on variation in demographic factors across regions. Descriptive statistics are shown in Table 5.

[Table 5 here]

5 Results

5.1 Main Results

We now turn to consider the estimates of the model described above. Table 6 shows the estimated coefficients from an ordered probit for the two size formats. In columns (1)-(3) we show estimates of the equilibrium number of big stores, described in (8), and in columns (4)-(6) for the number of small stores, described in (9). In general the estimates accord with our prior expectations. Profits are higher when there is a larger population. The factors that affect variable profits suggest that these are higher for larger stores (above 15,000 square foot) in areas with lower unemployment, further away from another town centre, with more density of office floor space. Unsurprisingly, higher retail land values are associated with lower profits. Regional effects are also included (but not shown) - for larger firms profits are higher in the South of England, while for the smaller format stores we find that variable profits are higher in more working class areas and fixed costs are lower in the North. There is some support for the one-stop shopping with top-up shopping model in that the number of big stores has a negative and significant effect on the profits of small firms.[18]

[Table 6 here]

In column (2) we include the share of A1 and A3 planning applications that were approved, and we see that the effect is statistically significant on big stores, but not on smaller store formats (columns (5) and (6)). The positive coefficient for larger stores makes sense - a higher approval rate means higher profits (lower fixed costs of entry). This accords with the policy changes described above, the new regime makes it more difficult to get approval for development of large out of town stores.

[18] We tried other demographic variables, including the proportion of single households and number of cars. They were insignificant and our main variable of interest - the rate of planning approvals - was robust to including these.

In column (3) we also include the share of A1 and A3 applications approved in the period before the policy reform, and find that this has no significant impact and did not change the size of the coefficient on application approvals in the relevant (more recent) period.

The estimates of the $\gamma' s$ are shown at the bottom of the table. These represent unobservable fixed costs and we expect them to increase with the number of stores in a market. They are significant and increase with the number of stores. For large stores when we compare monopoly (γ_1) to duopoly (γ_2) we see that they increase more than proportionally (i.e. $\frac{\gamma_2}{2} > \gamma_1$) indicating that entrants into duopoly markets have higher fixed costs than entrants in monopoly markets. But we are not able to distinguish whether this is true because of lower efficiency or higher entry barriers. The increase is less than proportional when we compare duopoly to triopoly and so on, suggesting that fixed costs do not continue to rise. For smaller stores the increase is more or less constant, suggesting that unobserved fixed costs of entry do not change much with the number of small stores entering.

5.2 Economic interpretation

While the sign and statistical significance of the coefficients in Table 6 make sense, in order to understand the economic significance we need to calculate the marginal effects. In an ordered probit it makes most sense to consider these for the extreme options of an empty market, or the maximum of four stores (in the case of large stores) or eight stores (in the case of smaller stores). Interpreting changes to the probability of market structures in the middle range is difficult without considering whether it leads to lower or higher market structures (we return to this issue below). Table 7 shows the marginal effects - column (1) shows the marginal effect of each variable on the probability of having no large stores, column (2) shows the marginal effect on the probably of having the maximum number of large stores (4); columns

(3) and (4) show the same marginal effects for zero and the maximum number (8) of small stores.

[Table 7 here]

Looking first at the impact of population - an additional thousand people (all else equal) decreases the probability that there will be zero large stores by a half a percentage point, and increases the probably that there will at least four larger stores by just over one-third of a percentage point. For small stores, the impact is smaller on the zero outcome but larger on the probability of having eight or more small stores. The marginal impact of higher unemployment is more crucial in economic terms. It increases the probability of having zero large stores by three percentage points, and reduce the probability of having four large stores by two. Being further away from other town centres decreases the probability of having zero large stores and increases the probability of having four substantially. More dense office space decreases the probability of zero large stores and increases the probability of having four stores. And, most importantly, areas with higher rates of approval of A1 and A3 applications, have a lower probability of having zero large stores, and a higher probability of having four or more. A percentage increase in the approval rate decreases the probability of having no large store by half a percent and increases the probability of having four or more stores by around a third of a percent. This is of a similar magnitude, but opposite sign, to a percentage increase in the unemployment rate.

We also consider the policy experiment of asking how would market structures differ if all planning applications made had been approved. To do this we set the variable % plan 97-01 to 1 everywhere and calculated the predict probabilities of each outcome. Table 8 shows the effect. There is a decrease in the probability that the market equilibrium is a monopoly, and an increase in the probability that is one of the equilibria with more than one big store (duopoly, triopoly or quadropoly).

After checking the robustness of our results we attempt to quantify the impact of this change further by looking at how the price of groceries differs across markets with these equilibria.

[Table 8 here]

5.3 Importance of demographics

One of the main contributions of this paper is to evaluate the impact of planning regulation on market outcomes, while controlling for other demographic variables. In order to see how important this is, in Table 9 we show estimates of a model where we include only planning regulation variables, and do not condition on any demographics. One striking difference is that these results imply that the effect of planning regulations is significant for both large and small stores.

[Tables 9 and 10 here]

In Table 10 we compare the marginal effects from the model where we do control for demographics (Table 6) with those where we do not (Table 9). What we see is that the model without demographics implies a marginal effect that is over twice as large as when we condition on demographics. For small firms the results without demographics imply a statistically significant effect, while the inclusion of demographics wipes that effect out. These results strongly support the importance of embedding planning decisions in a model that incorporates other important factors that affect market outcomes.

5.4 Robustness

5.4.1 Further disaggregation by size

In line with our consumer demand driven model we split the big and small stores using the Competition Commission's market definition of 15,000 square foot sales area. As a robustness check, and to shed light on the impact of planning regulations on stores of different sizes, we split our main groups of interest further into stores above 30k, 15-30k, 5-15k and <5 k. The cut-off at 30,000 sq ft is motivated by the fact that the Competition Commission identifies economies of scale for large stores above this size, i.e. this is the minimum efficient scale defined by Competition Commission in its 2000 report on the supermarket industry. The 5,000 sq ft cut off is motivated by the idea that very small convenience stores might also constitute a separate market from the mid-sized stores.

Table 11 shows the estimated coefficients from an ordered probit for these four size formats. We see that the impact of planning regulation is strongest, and only statistically significant, for the very big stores (over 30,000 sq ft). We also see an interesting pattern when we look at the impact of larger stores on the profitability of smaller stores. In column (3) we include the number of stores over 30,000 sq ft and those between 15-30,000 sq ft in the profit function for stores between 5-15,000 sq ft, and see that they have a similar impact. When we look at the profit function for stores under 5,000 sq ft we see that these larger stores have no significant impact, while the number of medium sized (5-15,000 sq ft) does have a negative impact on profitability of these very small stores.

[Table 11 here]

5.4.2 Dropping Greater London

One concern might be that Greater London is having a disproportionate effect on our results. We rerun the results shown in Table 6 but dropped all town centres located in Greater London. This reduced our sample to 712 town centres. The results, shown in Table 12, are similar to our baseline specification. We similarly reran the model dropping other urban areas and found quantitatively similar results.

[Table 12 here]

5.4.3 Supporting evidence using price data

Following B&R we also provide supporting evidence on how prices vary across markets - both how they vary with market structure and how they vary with planning regulations. The estimates are adapted from hedonic price regressions estimated in Griffith and Nesheim (2008), further details are given in the Appendix. We run a separate hedonic regression for 109 food categories, including a wide range of characteristics such as whether the product is branded/private label, organic, the fat content, flavour, origin and other details about the variety. We are able to explain a large part of the variation in prices using these characteristics. We do two things with the hedonic regressions: (1) we include market structure variables to see how prices vary with market structure, and (2) we omit the market structure variables and directly include our measure of land use regulations to see how prices differ in regions that have applied the regulations more restrictively.

These estimates are based on data from the TNS Homescan panel for the period 8 November 2003 to 7 November 2004. Households record all purchases that are brought into the home using hand-held scanners. We use information on expenditure and quantity purchased for 17,162 households and more than sixteen million purchases. Further details on how the data are collected are given in Griffith and Nesheim (2007).

Table 13 shows the mean and median of the estimated coefficients on market structure. The mean coefficient of -0.0170 suggests that prices of food products in duopoly markets are on average 1.7% lower than prices in monopoly markets. One feature of the estimates shown in Table 13 that is worth noting is that the main difference in price is between a monopoly and duopoly market, there is no difference between duopoly and triopoly, and the difference between triopoly and quadropoly is small. This is very much in line with the findings in B&R. It is also worth pointing out that the median is very similar to the mean of the coefficients.

[Table 13 here]

One thing that these estimates allow us to do is to quantify the loss to consumers that arises through higher prices due to the impact of land use regulation on entry estimated in Table 8. Recall that moving to a regime where all applications were approved would result in an increase in the probability of the market equilibrium being one with more stores (compared to the current equilibrium). The change in probabilities that is implied by our estimates (Table 6, column 3) is shown in Tables 14, 15 and 16. Table 14 shows the predicted probability of each market outcome, for each actual market outcome, using the observed values of all right-hand side variables. We see from this table that our model does a reasonably good job of predicting monopoly and quadropoly markets, but a less good job of distinguishing between the equilibria in the middle. In Table 15 we show the predicted probability when we consider the policy experiment that all planning applications that were made were approved (i.e. we set the variable "% plan 97-01" equal to 1). Table 16 shows the difference between the values in Table 15 and Table 14. We can see that relaxing planning regulations leads to a decrease in the probability of equilibria with fewer stores, and an increase in the probability of equilibria with more stores.

[Table 14 here]

[Table 15 here]

[Table 16 here]

We combine the change in the probabilities of each equilibria with the estimated price differentials between equilibria to get an estimate of the total cost of planning regulations arising through restricted entry leading to higher prices. This is shown in the first column of Table 17. We use the figure for average weekly household expenditure on food and non-alcoholic drinks from the Expenditure and Food Survey

2001/02, which was £41.90 per week,[19] to show in the second column what this percent reduction means in pence per week. In the final column we sum this up over households. This shows that households that live in town centers that were monopolies would collectively save around £95,357 in total per week as a result of completely relaxing the planning restrictions, those living in town centres where there were 2 stores would save around £67,326. The total savings in terms of weekly expenditure is £210,187. If we multiply that times 52 weeks we get an annual estimated loss to consumers arising through higher prices of £10,929,750.

[Table 17]

[Figure 3 here]

The second exercise we carry out using the price data is to corroborate our estimates by looking directly at how prices of groceries vary across markets with different levels of land use regulations. When we do this for the 109 food categories (in the context of a hedonic regression where we control for a large number of characteristics) we find that the mean coefficient is -0.0454 and the median is -0.0439, the distribution of coefficients across the food groups is shown in Figure 3. These estimates suggest that if we consider a town centre that sits at the 25th percentile in terms of the rate of approval of land use applications (this is 75% of applications approved) and compare that to one that sits at the 75th percentiles (this is 95% of applications approved) we would see a difference in prices of just under 1 percent on average.[20]

6 Conclusions and future work

This paper has applied a model of supermarket entry to data for the UK. We were interested in estimating the impact of restrictive planning regulation. We did this

[19] Table 1.1, ONS (2003).

[20] This is -0.0455*(0.95-0.75)=-0.0091.

by estimating the parameters of the profit function, controlling for demographic factors as well as planning policy. Our estimates suggest that planning regulation did have a statistically significant impact on market equilibrium outcomes and that it has represented an entry barrier. However, the economic magnitude of this effect is substantially overestimated if we do not control for variation in demographics and observable fixed cost drivers.

The literature has emphasised the importance of entry to productivity growth in US retail, perhaps enabling the more rapid introduction of ICT in newer stores or reallocation from less productive to more productive stores.[21] In contrast, in the UK growth has come mainly from incumbents.[22] A potential reason for this productivity gap, emphasised by the Competition Commission 2002 report, is that most stores in the UK operate below efficient scale.[23] What role has regulation had in shaping market structure? Our results suggest that the impact of planning regulation may have been overstated. While it has had an impact, the overall impact seems to have been relatively small in terms of the price that consumers' face.

[21] To the extent that retailing productivity growth is due to firms closing older, low productivity stores, and opening newer, high productivity shops to replace them, this might result in lower productivity growth, which may feed through into higher prices. Recent work has suggested that the adoption and use of ICT has been an important contributor to the US productivity acceleration of the late 1990s.

It is likely that ICT usage is higher and more effective in newer shops, but it is not clear whether a market with fewer large out-of-town stores or more small in-town-stores will lead to more entry and exit.

It may also be that ICT is easier to adopt in larger out-of-town stores.

[22] For the US see Foster, Haltiwanger and Krizan (2002) and for the UK see Haskel and Khawaja (2003).

[23] The Competition Commission (2000) report into supermarkets surveys the literature on economies of scale and argues that there are economies of scale up to 30,000 sq. m in supermarkets, but not after that. The economies of scale were especially in staff costs, which, the CC shows, are the bulk of value added in retailing. The CC present data on international comparisons of supermarket shop size. Britain has significantly fewer supermarkets and they are much smaller than the US, but they are larger than Continental Europe. In addition, US supermarkets are, on average just over 3,000 sq metres, which is just above the minimum scale required to achieve the highest levels of labour productivity. UK supermarkets are below that, suggesting that this might account for part of our productivity disadvantage.

A Price Regressions

We use estimates of hedonic prices from Griffith and Nesheim (2008) to estimate the way that prices vary geographically with the number of big stores. Specifically, we run a separate hedonic regression for 109 food categories of the form,

$$\ln(p_{ijt}) = \alpha + \beta_2 ms2_j + \beta_3 ms3_j + \beta_4 ms4_j + z_j^{'}\gamma + \tau_t + \varepsilon_{ijt}$$

where i indexes products, j indexes markets, t indexes transactions, p is unit price, $ms2 = 1$ if the market is a duopoly (has two big stores), $ms3 = 1$ if the market is a triopoly (has three big stores), and $ms4 = 1$ if the market has four or more big stores, z is a vector of characteristics of the products, is a complete set of time effects and e is an idiosyncratic error. We including a wide range of characteristics in z such as whether the product is branded/private label, fat, organic, flavour, origin and what variety it is. We are able to explain a large part of the variation in prices using these characteristics.

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Table 1: Sales area, all stores in 2002

Sales area	Frequency	Percent
less than 5000 sq ft	3080	43.07
5-10000 sq ft	1758	24.58
10-15000 sq ft	571	7.98
15-20000 sq ft	316	4.42
20-25000 sq ft	256	3.58
25-30000 sq ft	210	2.94
30-35000 sq ft	199	2.78
over 35000 sq ft	672	9.40
unknown	89	1.24
Total	*7151*	*100.00*

Source: Authors' calculations using Institute for Grocery Distributors (IGD) data.

Table 2: Distance from each town centre to next nearest town centre, 2002

Distance to next nearest town centre	Frequency	Percent
less than 1km	61	6.27
1-3km	332	34.12
3-5km	165	16.96
5-10km	219	22.51
10-15km	128	13.16
15km or more	68	6.99
Total	*973*	*100.00*

Source: Authors' calculations using Office of the Deputy Prime Minister (ODPM) data.

Table 3: Distance from store to nearest town centre, 2002

Distance from store to nearest town centre	Frequency	Percent
less than 1km	3169	44.32
1-3km	2291	32.04
3-5km	905	12.66
5-10km	572	8.00
10-15km	170	2.38
15km or more	44	0.62
Total	7151	100.00

Notes: Authors' calculations using data from IGD and ODPM. Distance is measured by Euclidean distance.

Table 4: Number of town centres with market configuration

Market configuration (number of stores)	(1) Stores of 15,000 sq ft or more	(2) stores less than 15,000 sq ft	(3) stores of 30,000 sq ft or more	(4) store 15,000 - 30,000 sq ft	(5) stores 5,000 - 15,000 sq ft	(6) stores less than 5,000 sq ft	*(7) All stores*
0	138	15	401	341	110	91	*0*
1	287	59	233	342	196	165	*27*
2	214	104	130	121	215	146	*69*
3	100	124	49	33	132	132	*74*
4	106	116	32	8	78	105	*111*
5		89			45	65	*95*
6		60			25	36	*83*
7		68			15	35	*57*
8 or more		210			29	70	*329*
Total	*845*	*845*	*845*	*845*	*845*	*845*	*845*

Source: Authors' calculations using Institute for Grocery Distributors (IGD) data.

Table 5: Descriptive Statistics

Variable	Mean	Standard deviation	Min	Max
Population (in 1000s)	51.512	32.388	6.613	288.63
Unemployment rate	0.031	0.013	0.013	0.096
Distance to nearest town centre (1000kms)	0.0063	0.0053	0.0005	0.0438
Office floor space per hectare	0.833	0.699	0.055	7.441
% of people that are retired	0.025	0.016	0.002	0.136
% of people that are "working class"	0.399	0.107	0.142	0.682
Retail rateable value	6.573	33.597	0 .046	1007.7
% A1 and A3 planning applications granted (1997-2001)	0.823	0.163	0	1
% A1 and A3 planning applications granted (1991-1996)	0.752	0.158	0	1
Greater London	0.157	0.364	0	1
South of England	0.567	0.496	0	1
Midlands	0.173	0.378	0	1
North of England	0.260	0.439	0	1

Notes: Population, unemployment rate, percentage of retired, and percentage of "working class" are from the ONS census data for 2001. Data on A1 and A3 use applications and those granted, retail rateable value and office floor space per hectare are from the ODPM..

Table 6: Ordered probit estimates of number of stores by format

	(1)	(2)	(3)	(4)	(5)	(6)
		15,000 sq ft +			less than 15,000 sq ft	
Population	0.0386	0.0378	0.0377	0.0399	0.0404	0.0404
(1000s)	(0.0068)***	(0.0068)***	(0.0068)***	(0.0080)***	(0.0081)***	(0.0081)***
Variable costs						
Uemployment	-0.2308	-0.2304	-0.2312	-0.1274	-0.1287	-0.1321
rate	(0.0988)**	(0.0982)**	(0.0979)**	(0.1305)	(0.1295)	(0.1298)
Dist to nearest	0.8941	0.9207	0.9381	-0.1832	-0.1925	-0.1633
town centre	(0.1603)***	(0.1620)***	(0.1632)***	(0.2477)	(0.2467)	(0.2498)
% retired	-0.1129	-0.1017	-0.0988	0.0906	0.0789	0.0834
	(0.0735)	(0.0727)	(0.0724)	(0.1237)	(0.1230)	(0.1244)
Office floorspace	0.0038	0.0038	0.0038	-0.0023	-0.0023	-0.0023
per hectare	(0.0014)***	(0.0014)***	(0.0014)***	(0.0014)	(0.0014)	(0.0014)
Greater London	-0.0057	-0.0056	-0.0057	-0.0084	-0.0085	-0.0084
	(0.0055)	(0.0055)	(0.0055)	(0.0060)	(0.0060)	(0.0060)
% “working	0.0073	0.0072	0.0068	0.0443	0.0447	0.0438
class”	(0.0121)	(0.0121)	(0.0121)	(0.0175)**	(0.0172)***	(0.0171)**
Fixed costs						
Retail rateable	-0.0024	-0.0023	-0.0024	0.0239	0.0238	0.0237
value	(0.0014)*	(0.0014)*	(0.0014)*	(0.0052)***	(0.0051)***	(0.0052)***
% plan 97-01		0.3897	0.3676		-0.1671	-0.2093
		(0.2076)*	(0.2089)*		(0.2432)	(0.2463)
% plan 91-96			0.1638			0.3127
			(0.2078)			(0.2819)
Large stores				-0.1057	-0.1025	-0.1056
				(0.0560)*	(0.0560)*	(0.0562)*
γ_1	0.69	1.00	1.11	-0.54	-0.66	-0.48
γ_2	1.98	2.30	2.40	0.44	0.31	0.50
γ_3	3.00	3.32	3.43	1.20	1.08	1.27
γ_4	3.81	4.13	4.23	1.87	1.75	1.94
γ_5				2.48	2.36	2.54
γ_6				2.97	2.85	3.04
γ_7				3.34	3.22	3.40
γ_8				3.84	3.72	3.91

Notes: Sample includes 845 town centres. Robust standard errors in parentheses, clustered at local authority level. Broad region dummies are included in all specifications (North, Midlands, South, Greater London).
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7: marginal effects from Table 6 column (3) and column (6)

	(1)	(2)	(3)	(4)
	15,000 sq ft +		less than 15,000 sq ft	
	outcome=0	outcome=4	outcome=0	outcome=8
Population	-0.0053	0.0036	-0.00005	0.01002
(1000s)	*(0.0011)****	*(0.0007)****	*(0.00003)**	*(0.00183)****
Variable costs				
Uemployment rate	0.0326	-0.0224	0.00016	-0.03274
	*(0.0138)***	*(0.0093)***	*(0.00017)*	*(0.03215)*
Distance to nearest	-0.1321	0.0907	0.00019	-0.04049
town centre	*(0.0244)****	*(0.0192)****	*(0.00031)*	*(0.06226)*
% retired	0.0139	-0.0096	-0.00010	0.02069
	(0.0104)	*(0.0071)*	*(0.00014)*	*(0.03172)*
Office floorspace	-0.0005	0.0004	0.00000	-0.00056
per hectare	*(0.0002)****	*(0.0001)****	*(0.00000)*	*(0.00035)*
Greater London	0.0008	-0.0005	0.00000	-0.00209
	(0.0008)	*(0.0005)*	*(0.00001)*	*(0.00150)*
% "working class"	-0.0010	0.0007	-0.00005	0.01087
	(0.0017)	*(0.0012)*	*(0.00003)*	*(0.00435)***
Fixed costs				
Retail rateable	0.0003	-0.0002	-0.00003	0.00587
value	*(0.0002)*	*(0.0001)*	*(0.00001)***	*(0.00138)****
% plan 97-01	-0.0518	0.0355	0.00025	-0.05190
	*(0.0298)**	*(0.0199)**	*(0.00033)*	*(0.06141)*
% plan 91-96	-0.0231	0.0158	-0.00037	0.07753
	(0.0296)	*(0.0203)*	*(0.00037)*	*(0.07010)*
Large stores			0.00013	-0.02618
			(0.00008)	*(0.01437)**

Notes: marginal effects are numerically calculated using the "mfx" command in Stata. They are evaluated at the mean of all variables. Numbers in parenthesis are standard errors.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 8: Impact on probability of market equilibria of policy experiment where all planning applications were approved

	Mean probability of market with	
	current planning regime	all applications approved
number of big stores=0	0.162	0.149
number of big stores=1	0.343	0.338
number of big stores=2	0.252	0.259
number of big stores=3	0.117	0.123
number of big stores=4+	0.125	0.132

Notes: The reported statistic is the mean of the probability of each market equilibrium across 845 markets, estimated using the coefficients reported in column (2) of Table 6. In the left-hand column we report the mean predicted probability using the actual values of percentage applications approved, in the right-hand column we report the mean predicted probability when we set the percentage approved to 1.

Table 9: Ordered probit with only planning applications

	(1) 15,000 sq ft +	(2) less than 15,000 sq ft
% plan 97-01	0.5335	0.4939
	(0.2027)***	(0.2504)**
γ_1	-0.55	-1.70
γ_2	0.45	-0.95
γ_3	1.14	-0.40
γ_4	1.59	0.04
γ_5		0.39
γ_6		0.66
γ_7		0.85
γ_8		1.09

Notes: Sample includes 845 town centres where all data is available. Robust standard errors in parentheses, clustered at local authority level.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 10: comparison of marginal effects of planning decision

	(1)	(2)	(3)	(4)
	15,000 sq ft +		less than 15,000 sq ft	
	outcome=0	outcome=4	outcome=0	outcome=8
from Table 6, controlling for demographics				
% plan 97-01	-0.0518	0.0355	0.00025	-0.05190
	*(0.0298)**	*(0.0199)**	*(0.00033)*	*(0.06141)*
from Table 10, not controlling for demographics				
% plan 97-01	-0.1311	0.1096	-0.0214	-0.0128
	*(0.0506)****	*(0.0419)****	*(0.0106)***	*(0.0078)*

Table 11: Ordered probit estimates of number of stores by format

	(1) 30,000 sq ft +	(2) 15,000 - 30,000 sq ft	(3) 5,000 - 15,000 sq ft	(4) < 5,000 sq ft
Pop in tc in 1000s	0.0278	0.0193	0.0107	0.0461
	(0.0059)***	(0.0063)***	(0.0055)*	(0.0062)***
Variable costs				
Uemployment rate	-0.3691	0.1034	-0.1350	-0.1784
	(0.0808)***	(0.1023)	(0.1234)	(0.1007)*
Distance to nearest	-0.2616	0.8970	0.2012	-0.3176
town centre	(0.1285)**	(0.1748)***	(0.1576)	(0.1832)*
% retired	-0.1385	-0.0724	-0.1087	-0.0705
	(0.0567)**	(0.0395)*	(0.0407)***	(0.0646)
Office floorspace	0.0051	-0.0016	-0.0000	-0.0037
per hectare	(0.0012)***	(0.0014)	(0.0012)	(0.0013)***
Greater London	-0.0178	0.0099	0.0041	-0.0046
	(0.0052)***	(0.0060)*	(0.0061)	(0.0048)
% "working class"	0.0512	-0.0294	0.0673	0.0154
	(0.0096)***	(0.0148)**	(0.0126)***	(0.0136)
Retail rateable value	-0.0014	-0.0011	0.0320	0.0138
	(0.0012)	(0.0010)	(0.0060)***	(0.0051)***
% plan 97-01	0.6366	-0.1031	-0.0359	-0.3880
	(0.2371)***	(0.2207)	(0.2256)	(0.2687)
30,000 sq ft +			-0.1129	-0.0199
			(0.0569)**	(0.0496)
15,000 - 30,000 sq ft			-0.1272	0.0111
			(0.0523)**	(0.0505)
5,000 - 15,000 sq ft				-0.0530
				(0.0321)*
γ_1	2.15	0.39	-0.01	-0.08
γ_2	3.25	1.61	0.99	0.82
γ_3	4.34	2.48	1.91	1.43
γ_4	5.23	3.25	2.62	2.02
γ_5			3.24	2.58
γ_6			3.77	3.03
γ_7			4.20	3.35
γ_8			4.62	3.76

Notes: Sample includes 845 town centres where all data is available. Robust standard errors in parentheses, clustered at local authority level. Region dummies included in all specifications (North, Midlands, South, Greater London).
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 12: Ordered probit estimates of number of stores by format without Greater London

	(1) 15,000 sq ft +	(2) less than 15,000 sq ft
Population	0.0332	0.0430
(1000s)	(0.0072)***	(0.0083)***
Variable costs		
Uemployment	-0.3943	-0.2625
rate	(0.1278)***	(0.1818)
Dist to nearest	0.8695	-0.0589
town centre	(0.1709)***	(0.2551)
% retired	-0.0654	-0.0621
	(0.0830)	(0.1115)
Office floorspace	0.0011	-0.0022
per hectare	(0.0017)	(0.0017)
% “working	0.0296	0.0698
class”	(0.0136)**	(0.0193)***
Fixed costs		
Retail rateable	0.0253	0.0200
value	(0.0079)***	(0.0052)***
% plan 97-01	0.5657	0.1058
	(0.2467)**	(0.2381)
Large stores		-0.1583
		(0.0536)***
γ_1	1.17	-0.46
γ_2	2.48	0.57
γ_3	3.57	1.36
γ_4	4.41	2.05
γ_5		2.66
γ_6		3.18
γ_7		3.53
γ_8		4.05

Notes: Sample includes 712 town centres where all data is available and excluding Greater London. Robust standard errors in parentheses, clustered at local authority level. Region dummies included in all specifications (North, Midlands, South).
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 13: coefficients from hedonic regressions of ln price on market structure

	mean	median
number of big stores=2	-0.0170	-0.0188
number of big stores=3	-0.0168	-0.0173
number of big stores=4+	-0.0188	-0.0188

Note: the reference group is monopoly results are adapted from Griffith and Nesheim (2007), each of the 109 regressions include characteristics such as branded/private label, fat, organic, flavour, origin and what variety it is.

Table 14: Actual versus predicted market structure, current planning regime

	Predicted equilibrium structure			
Actual equilibrium structure	0 or 1	2	3	4+
0 or 1	0.665	0.236	0.071	0.027
2	0.474	0.302	0.139	0.084
3	0.320	0.290	0.193	0.197
4+	0.102	0.176	0.185	0.536

Note: reported probabilities are predicted using the estimated coefficients shown in Table 6 column 3 using the actual value of all the right-hand side variables and averaging across town centres.

Table 15: Actual versus predicted market structure, policy experiment where all planning applications were approved

	Predicted equilibrium structure			
Actual equilibrium structure	0 or 1	2	3	4+
0 or 1	0.644	0.248	0.078	0.030
2	0.453	0.308	0.147	0.092
3	0.306	0.289	0.197	0.208
4+	0.095	0.171	0.184	0.550

Note: reported probabilities are predicted using the estimated coefficients shown in Table 6 column 3 using actual values of the right-hand side variables except "% plan 97-01" which we set to 1, and averaging across town centres.

Table 16: Difference between predicted market structures (Table 15 minus Table 14)

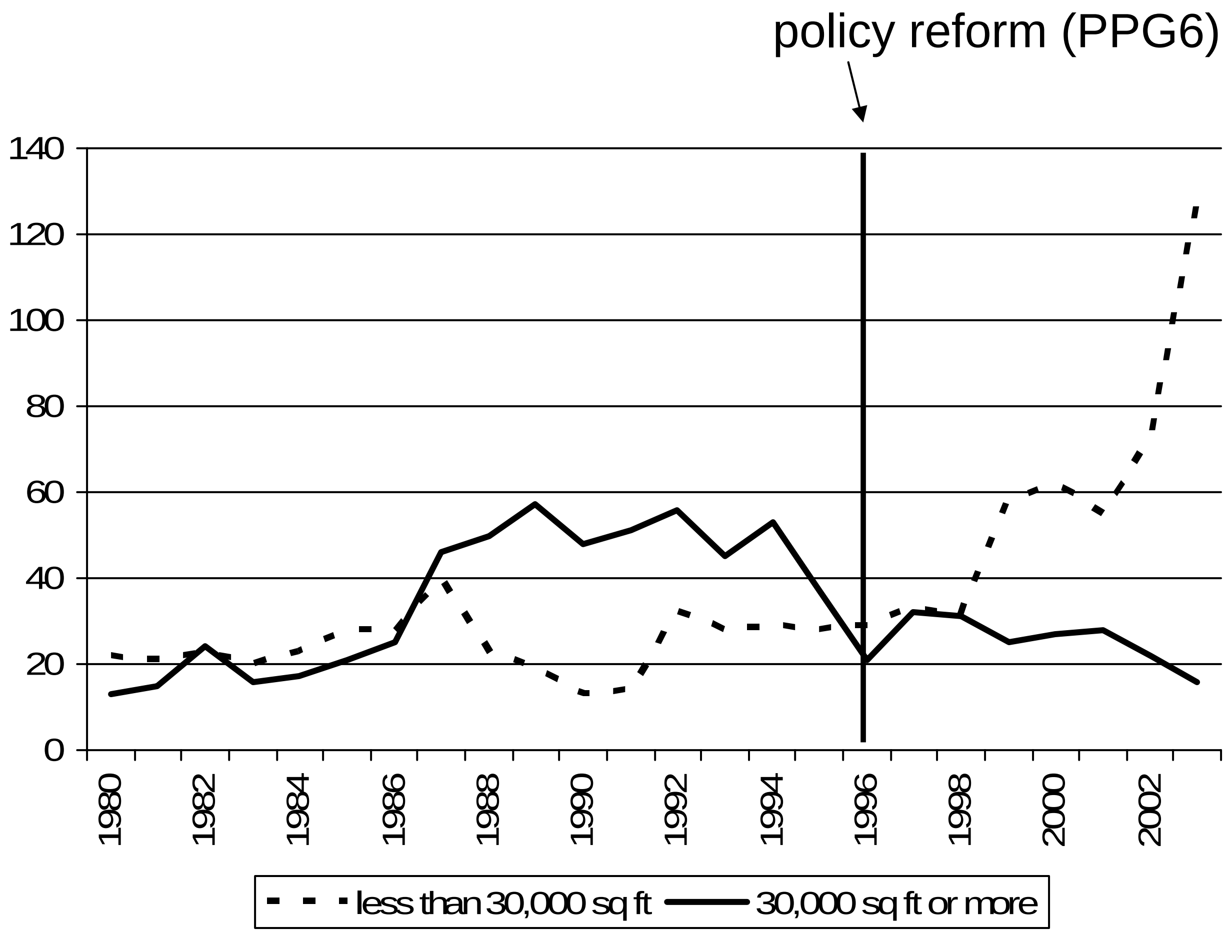
	Predicted equilibrium structure			
Actual equilibrium structure	0 or 1	2	3	4+
0 or 1	-0.021	0.012	0.006	0.003
2	-0.021	0.006	0.008	0.008
3	-0.014	-0.001	0.004	0.011
4+	-0.008	-0.005	-0.001	0.014

Table 17: Estimated impact on price from policy experiment where all planning applications were approved

Actual equilibrium structure	Mean % reduction in price	Mean reduction in pence on weekly household food expenditure	Total £ reduction in weekly household food expenditure
0 or 1	-0.03615%	-1.51	-£95,357
2	-0.03744%	-1.56	-£67,326
3	-0.02649%	-1.11	-£26,029
4+	-0.01561%	-0.65	-£21,475
Total	*-0.03276%*	*-1.37*	*-£210,187*

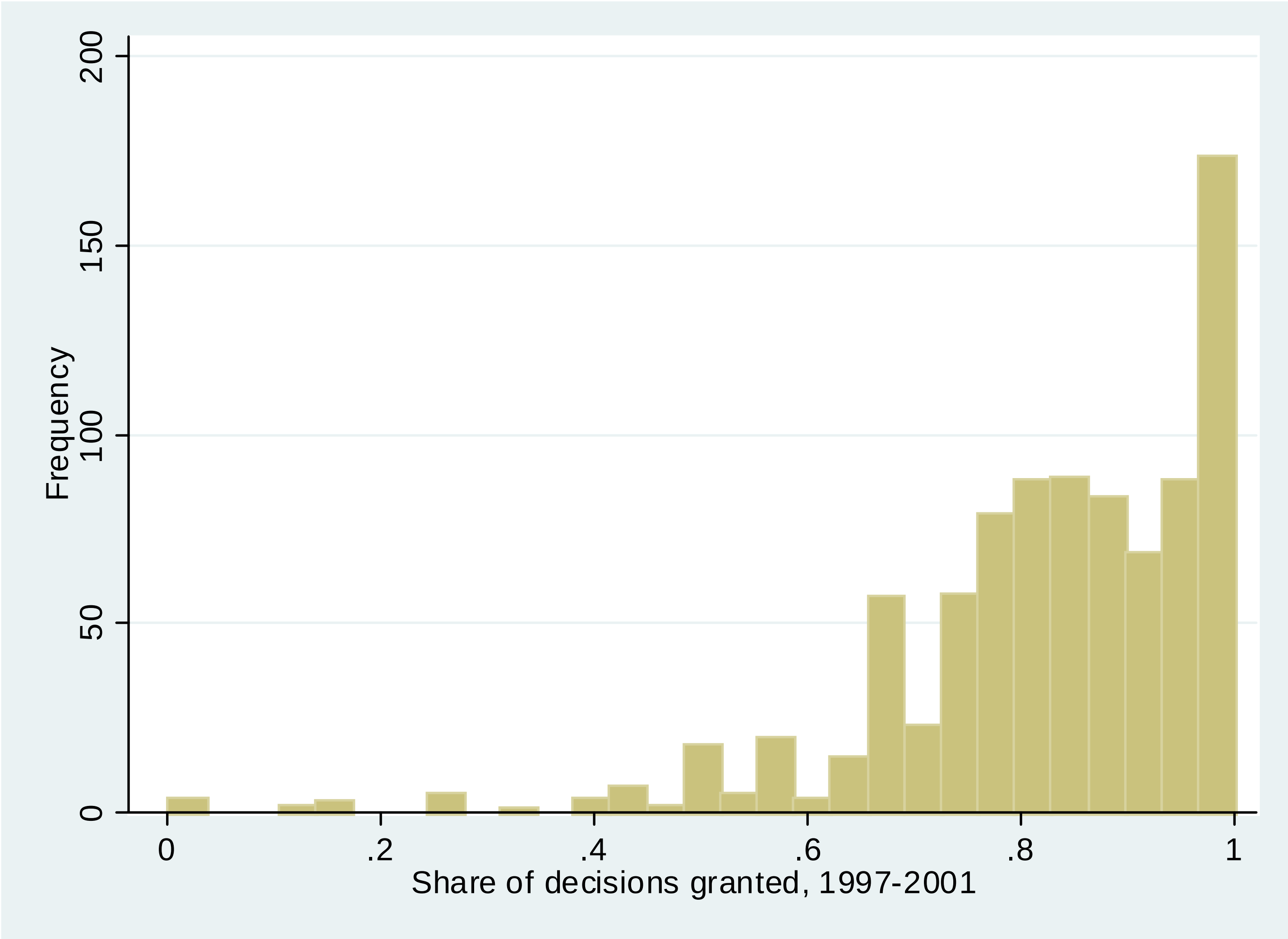
Notes: first column is the change in probability of each equilibria from Table 17 times the expected price reduction from moving to that equilibrium from Table 14; the second column is column 1 times average weekly household expenditure of £41.90, the third column is the sum of that across households (there are 6,392,533 in markets with zero or 1 big store, 4,523,840 households in markets with 2 big stores, 2,663,964 households in markets with 3 big stores and 4,549,705 households in markets with 4 or more big store

Figure 1: Supermarket openings in the UK by the big four firms (Asda, Sainsbury, Safeway/Morrison, Tesco), by store size



Source: Authors' calculations using Institute for Grocery Distributors data

Figure 2: Share of decision granted by Local Planning Authority, 1997-2001



Source: Authors' calculations using data provided by the Office of the Deputy Prime Minister

Figure 3: Coefficient on planning approvals in a ln price regression across 109 food categories