# Quality Competition in Retailing
# A Structural Analysis

Online Appendix

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## 1 Robustness: The Bounds Approach

A non-structural robustness check for the asymptotic number of firms can be performed using the bounds approach developed in Sutton (1991). In particular, if we assume a symmetric equilibrium in the final product market stage of Sutton's general ESC framework, a bounds regression provides a separate prediction for $N_s^\infty$, calculated by inverting $C_1^\infty \left(= \frac{1}{N_s^\infty}\right)$. This prediction can then be used to recover a separate estimate of $\gamma$ (or $\frac{1}{\gamma}$) by inverting equation (8):

$$\gamma = 2N_s^\infty - 4 + \frac{1}{N_s^\infty}$$

Following the bounds regression methodology developed in Sutton and applied to the supermarket industry in Ellickson (2002), a lower bound is estimated using the following functional form:

$$\widetilde{C}_{1i} = \beta_0 + \frac{\beta_1}{\ln(\alpha\theta Y M_i/p_L\sigma_s)} + \varepsilon_i \quad (\varepsilon_i > 0) \tag{1}$$

where a logit transformation of $C_1$ $\left(\widetilde{C}_1 = \ln(\frac{C_1}{1-C_1})\right)$ is used to ensure that predicted concentration ratios are bounded between 0 and 1. The asymptotic level of the transformed measure of concentration is captured by the intercept parameter $\beta_0$ and the shape or curvature of the lower bound by the parameter $\beta_1$. Sutton equates $p_L\sigma$ to a proxy for set-up costs that is intended to capture "the minimal level of sunk cost that must be incurred by each entrant to the industry prior to commencing production". In the context of supermarket competition, this corresponds to building a small chain of medium sized stores and a basic distribution center. Since the smallest vertically integrated firms consist of about 28 stores, I assume that $p_L\sigma$ is \$250 million.[1]

Equation (1) is then estimated using maximum likelihood, assuming $\varepsilon$ follows a Weibull distribution. The point estimate of the limiting level of concentration is calculated by solving $\beta_0 = \ln(\frac{C_1^\infty}{1-C_1^\infty})$ for $C_1^\infty$. The point estimate of the limiting level of concentration for the dominant firms is $C_1^\infty = 15.6\%$, with a 99% confidence interval of $(15.3, 15.9)$. This corresponds to a predicted $N = 6.40$, $\frac{1}{\gamma} = .110$, and $\gamma = 9.09$, which correspond closely to the estimates presented in Table 4.

## 2 The Construction of Geographic Markets

Defining geographic submarkets requires identifying the boundaries of the firms' distribution networks. Fortunately, this task is made easier by the fact that supermarket firms cluster their distribution

[1] According to the Food Marketing Institute, the cost of building a new 40,000 square foot store is roughly \$7 million, so a 28 store chain would cost \$196 million to build and equip. The remaining \$54 million is a rough estimate of the cost of building a small distribution center, based on SEC filings and various media announcements.

centers in major cities (typically near a railroad spur) and serve surrounding areas from these facilities. Constructing markets simply involves plotting distribution networks and drawing boundaries around them. This is the method used by Trade Dimensions in constructing the 52 marketing areas reported in their Marketing Guidebook. My own analysis produced only four changes (two of which accord with their most recent (2003) redefinitions), resulting in the same total number of distribution markets. I reallocated the stores in Albuquerque, NM to its neighboring markets, since all of the major supermarket firms operating in Albuquerque supply their stores from distribution centers (DCs) in surrounding markets. Charlotte, NC was split into two markets (Charlotte and Raleigh), since the dominant North Carolina firms operate DCs outside both cities. Finally, Sacramento, CA was added as a market and merged with Fresno, CA, reflecting the distribution patterns in central California. Figure 1 contains a map of these 52 markets.

Figure 1: The 52 Distribution Markets