DISCUSSION PAPER NO. 1

Product Quality and Market Size[1]

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Abstract

Do larger markets offer better products? The question has implications both for theories of cities and for theories of market organization. We document that in the restaurant industry, where quality is produced largely with variable costs, the range of qualities on offer increases in market size, with each product maintaining a small market share. In daily newspapers, where quality is produced with fixed costs, the average quality of products increases with market size, but the market does not offer much additional variety as it grows large. These results are consistent with recent IO theories of endogenous product quality and are consistent with theories of cities that place an emphasis on the consumption advantages of cities.

KEY WORDS: quality competition, newspapers, restaurants
JEL CLASSIFICATIONS: L11, L13, L82

1 Introduction

In the way that industrial economists customarily think about entry, increases in market size allow an industry to accommodate more firms. As entry operates beyond the first - monopolist - firm, prices fall toward competitive levels. Except that oligopolists price with market power, the relationship between market size and the number of firms present would be linear. This is a useful characterization for many industries, including retail and service firms in small towns. Yet, it is clearly a poor description of many others, such as local media firms. Some industries fragment as they grow large, while others do not. In this paper we empirically explore the role of product quality in the determination of concentration as markets grow large. Recent theoretical developments in industrial organization provide an invaluable framework for thinking about the relationship between product quality and market size.

In a series of important books and articles, Shaked and Sutton (e.g. Shaked and Sutton (1987) and Sutton (1991)) have sought to explain the circumstances in which markets remain concentrated as they grow large. In particular, Shaked and Sutton show that as markets grow large in industries where quality is produced mainly through outlays on fixed costs, at least one firm will have an incentive to invest in quality. Because quality is produced with fixed rather than marginal costs, a higher quality firm can undercut its rivals' prices and attain substantial market share. As a result, product quality in some industries will increase in market size, even as product variety need not increase (because markets remain concentrated at the product level). The process of quality competition is primarily of interest to industrial economists for what it reveals about how markets function when firms compete in quality (i.e. via vertical differentiation). It also may be of interest to urban economists.

The relationship between product quality and market size may also be of interest as a purely descriptive matter, adding to previous studies that look at the relationship between market size and the number and size of establishments. In this paper we will examine descriptive data on the relationship between product quality and market size, where the observations are a cross-section of U.S. metropolitan areas. Our paper builds, and in some ways, improves upon some existing empirical research on product quality and market size. First, although the theoretical relationship between product quality and market size has been well explicated, it has been difficult to document empirically in a fully satisfactory way. Sutton (1991), for example, uses cross-country case studies to document that many consumer goods industries remain concentrated in large markets. While highly suggestive, cross-country comparisons suffer from the problem that much more than market size is changing (and indeed Sutton's case studies emphasize this, but the problem is complicated enough to perhaps defy traditional econometric analysis.) For empirical work, cross-city comparisons within a single country may be easier to interpret. Ellickson (2001) does consider markets of varying size within the United States (his markets are supermarket distribution regions, not cities.) Ellickson's focus, following Sutton's theory, is on concentration and market structure. We will add a focus on direct measures of product quality and we will juxtapose two contrasting industries. Our paper also contributes to the literature that documents the relationship between market size, entry and product variety; e.g. Bresnahan and Reiss (1991), Berry and Waldfogel (1999) and Campbell and Hopenhayn (2002).

2 Review of the Theory of Product Quality

There is a well-developed literature in IO on product quality in market equilibrium that we can draw on to motivate the empirical illustrations in this paper. We informally review and illustrate that theory here; these arguments are also summarized in a slightly different fashion in Sutton (1991) and related works.

To address the issues in this paper, we begin with a simple vertical quality model. Suppose that the utility to consumer i of product j is

$$u_{ij} = \theta_i \delta_j - p_j, \qquad (1)$$

where δ_j is product quality and p_j is price. Note that we have assumed away income effects, and utility is measured in dollars, so that θ_i is the consumer's willingness-to-pay for quality. We assume that θ_i is distributed on the interval $(0, \infty)$ so that there are some consumers with arbitrary high θ's who will pay for an increase in quality to any level. We also assume that there is a "outside" good of quality zero, available at a price of zero (which is the marginal cost of a zero quality good.)

Turning to the cost side, Shaked and Sutton emphasize that increases in quality can involve increases in fixed and/or marginal cost. The relationship between market size and the distribution of quality depends on whether quality is produced primarily through fixed or variable (with respect to output) costs. In particular, if marginal cost increases only slowly in quality (so that the cost of quality is borne largely by fixed cost), then high quality products can use price to undercut lower quality products, potentially driving them out of the market and leading to a situation where there are a limited set of product qualities on offer, including at least one high quality good.

Assume for simplicity that marginal cost, mc, is constant in quantity (q_j) and is (weakly) increasing in quality, so that variable cost is

$$C(q_j, \delta_j) = q_j mc(\delta_j). \tag{2}$$

Fixed costs also depend on quality:

$$FC = F(\delta_j), \tag{3}$$

but by definition do not depend on q_j. We assume that fixed costs are strictly positive (so there are always economies of scale) and that fixed costs are weakly increasing in quality.

Let market size be M and assume some model of price-competition (as in Nash pricing for single-product firms), so that a quality vector δ leads to some per-capita variable profit function $V(\delta_j, \delta_{-j})$. Assuming single-product firms, firm j's profit function is then

$$MV(\delta_j, \delta_{-j}) - F(\delta_j) \tag{4}$$

Product Proliferation when Quality increases MC

In discussing the possible proliferation of products, one crucial point is the possibility that a high quality product could undercut a lower quality product and drive its sales to zero. If marginal cost is convex in quality (as opposed to utility which is assumed linear in quality), then such undercutting is not profitable when the lower-quality firm is pricing very near marginal cost. In very large markets, even prices near marginal cost can generate enough variable profit to cover fixed costs and so this allows products of many quality levels to survive in equilibrium.

Given marginal costs that are increasing and convex in quality, the appendix reviews the formal argument that the space of product qualities will fill in and the maximum quality offered in the market will increase as market size increases. The intuition is that the vertical model with increasing convex marginal costs is very much like a horizontal model. Given marginal cost pricing, different consumers prefer different goods. Assuming marginal cost pricing, the utility function becomes:

$$u_{ij} = \theta_i \delta_j - mc(\delta_j) \tag{5}$$

and the first-order condition for consumer i's optimal quality is

$$\theta_i - \frac{\partial mc}{\partial \delta_j} = 0 \tag{6}$$

with second-order condition

$$\frac{\partial^2 mc}{\partial \delta_j^2} > 0. \quad (7)$$

The second-order condition is satisfied if marginal cost is convex in quality and it is easy to state regularity conditions under which there is a unique solution to the first-order condition for every θ, with higher θ's demanding higher qualities.

In considering different real world markets, it will not be obvious whether marginal cost is convex in some abstract measure of quality. However, the key empirical idea is that marginal cost rises sufficiently fast in quality so that higher-quality firms cannot undercut low quality firms in price. In this case, we expect that as market size increases, products will proliferate so that every segment of the quality line will eventually be offered by some product. In particular, larger markets can support more high-quality goods and (if the support of θ is unbounded at the top) there is a upper bound on the maximum quality level that increases in market size.

The product proliferation result also guarantees that product-concentration will go to zero as market size increases. Sutton (1991) emphasizes that firm-level concentration indexes may not go to zero even in this case, because multi-product firms are common in differentiated products industries. However, we will consider simple product-level measures in this paper, which to some degree obviates use of the "bounds" approach of Sutton's case studies made necessary by Sutton's use of firm, rather than product-level data.

Quality and Concentration when Quality increases Fixed Costs

If higher-quality firms can undercut low-quality firms (even when the lower quality firms are pricing near marginal cost), then product proliferation becomes unlikely. This case occurs when marginal cost is constant in quality and can also occur when marginal cost is increasing but concave in quality. When increased quality does not greatly increase marginal cost, it seems empirically reasonable to think that the cost of quality may be born in part by fixed costs. Such "endogenous sunk cost" models are reviewed in Shaked and Sutton (1987) and related works.

In the appendix, we review Shaked and Sutton's argument that when the burden of quality improvements falls on fixed costs, product proliferation will not occur. Instead, the concentration of products within the market will not go to zero as market size increases, but will have some lower bound. In particular, there is a lower bound (independent of market size) to the market share of largest product, and there will be at least one high-quality product in the market (which may or may not also be the largest product in the market.) The maximum quality level offered in the market is constrained by market size, but will go off to infinity as market size increases.

Thus, the direct empirical implications of the Shaked and Sutton model are for the market share of the largest product (which should have a lower bound in market size) and for the maximum quality level in the market. More generally, we might expect to see high levels of product concentration even in larger cities and we might also expect to see higher quality products in larger cities.

Extensions and Caveats

The literature shows that the flavor of these results does not depend on the extreme assumptions. For example, one could add a horizontal dimension of quality as in the utility function

$$u_{ij} = \theta_i \delta - \alpha_i p_j - \gamma(\nu_i - x_j)^2, \tag{8}$$

where ν_i is the preferred horizontal location of consumer i and x_j is the horizontal location of product j. In this case, demand is a mixture of pure vertical models, with each small interval of the horizontal line giving rise to a "nearly" vertical model. Given the horizontal dimension, there will be more entry and more product variety than in the pure vertical model. Especially if there is a correlation between ν_i and θ_i, there may be very popular low quality products even in the endogenous fixed cost case. However, the Shaked and Sutton result can still go through so that there is a lower bound to the one-firm concentration ratio.

One might also consider economies or diseconomies of scale in the variable production function. Diseconomies of scale will strengthen the product proliferation result, while further economies of scale will strengthen the Shaked-Sutton concentration result.

3 Industry Background and Data Sources

The basic data for this study are cross sections of product quality measures and measures of entry and product consumption - and therefore market share and concentration - for local markets in the daily newspaper and restaurant industries. The data are drawn from a variety of sources, and different sorts of measures are available for different industries.

3.1 Newspapers

Across markets, daily newspapers offer strikingly different product characteristics. Some newspapers offer only a dozen or so pages of news, together with a limited number of specialized sections (such as sports) and a limited number of advertisements. Other newspapers offer hundreds of pages of news, advertisements and specialized content. Many newspapers produce a large number of original news and feature articles, whereas other papers rely largely on outside news services and syndicated content. Clearly, the quality of a newspaper is an endogenous choice of the publisher.

Furthermore, much of the cost of quality is fixed with respect to output. In particular, the marginal cost of more and better content is limited to the cost of paper, printing and distribution, whereas the salaries of more (or better) reporters and editors are fixed with respect to output. These facts, together with the existence, in the US, of [i] a large number of separated metropolitan newspaper markets of varying sizes and [ii] a number of good direct measures of product quality, seem to make newspapers the ideal empirical embodiment of the Shaked and Sutton endogenous fixed cost theory.

In the newspaper industry, there may also be some economies of scale in the variable production function (that is, in printing and distribution.) This will tend to reinforce the Shaked and Sutton effect. However, note that daily newspapers survive in very small markets without charging unusually high prices, so the economies of scale in printing and distribution cannot be overwhelmingly large.

We recognize that newspapers derive revenue from both readers and advertisers. In this paper we analyze product quality and market share from the perspective of readers. Implicitly we are treating advertising revenue as a per-reader proportional subsidy.

Intuitively (and from a casual examination of newspaper pricing) it seems at least plausible that the increase in marginal cost from high quality is sufficiently low that high quality newspapers can undercut lower quality papers and therefore drive low quality competitors from the market. However, this competitive effect will be offset by some degree of product differentiation. For example, when there are two competing major metropolitan dailies within one market, they often differ in format (tabloid versus broadsheet) and in politics (with editorials leaning somewhat more to the left or right.)

Also, within a broad metropolitan area there can be a large number of daily newspapers with a tight (typically suburban) geographic focus. For example, Table 1 shows a list of daily newspapers in the general New York city metropolitan

Table 1: Example of New York City MSA Daily Newspapers

PMSA (County)	**Name**	**MSA Share**	**City Share****
New York, NY (New York)	The New York Times	.2588	.4794
New York, NY (New York)	The New York Daily News	.1835	.3399
New York, NY (New York)	New York Post	.0975	.1806
New York, NY (New York)	New York Daily Challenge*	.0185	
New York, NY (Westchester)	The Journal News	.0356	
New York, NY (Richmond)	Staten Island Advance	.0181	
New York, NY (Kings)	The Brooklyn Daily Eagle	.0011	
Nassau-Suffolk, NY	Newsday	.1332	
Newark, NJ (Essex)	The Star-Ledger	.0949	
Newark, NJ (Morris)	Daily Record	.0138	
Newark, NJ (Sussex)	The New Jersey Herald	.0040	
Bergen-Passaic, NJ (Bergen)	The Record	.0401	
Bergen-Passiac, NJ (Passiac)	North Jersey Herald News	.0163	
Jersey City, NJ (Hudson)	The Jersey Journal	.0139	
Middlesex-Somerset, NJ (Middlesex)	Home News Tribune	.0177	
Middlesex-Somerset, NJ (Somerset)	Courier News	.0104	
Monmouth-Ocean, NJ (Monmouth)	Asbury Park Press	.0373	
Monmouth-Ocean, NJ (Ocean)	Ocean County Observer	.0043	

*The *Daily Challenge* is targeted at an African-American audience.

**City Share is MSA circulation as a share of the central city newspapers ("major metropolitan dailies") without a geographic or ethnic specialization.

region as of late 2001. In our data, only New York City has three major metropolitan dailies and all the other daily newspapers in the metropolitan region have a tight regional (or ethnic) specialization, almost always specializing in a particular county. Indeed, web sites for some of the suburban papers boast of their regional monopoly status ("Ocean County's only daily newspaper").

This raises an important issue of the market definition. We will in some cases look just at the major metropolitan dailies, but we will typically err on the side of caution and include all the daily newspapers in the MSA. One should keep in mind, then, that our results will hold despite a purposeful introduction of a large degree of horizontal (geographic) differentiation.

Much of our data on daily newspapers comes from *Burrelle's Media Direc-*

tory which provides information on each daily newspaper published in the US. We have the name of the newspaper, the language of publication, the "target audience" (e.g. general interest), and the circulation. From the circulation figures, we can compute measures such as the market share of the largest firm (the 1-firm concentration ratio) as well as traditional measures like the product-level HHI or its reciprocal, the number of "newspaper equivalents". We exclude non-English newspapers, as well as daily newspapers with a specialized business audience (e.g. Platt's Oil Gram or Daily Variety.)

Turning to the level of geographic aggregation, our data are at the level of the Census Metropolitan Statistical Area (MSA) for urban areas greater than 50,000. An MSA consists of a city, plus its surrounding county, plus any adjacent counties that are considered to be part of the same urban agglomeration.[1]

Turning to newspaper quality, we have three measures. The first is the size (number of pages) of the paper. More content is presumably preferred to less and therefore the size of the paper is a natural vertical quality attribute.[2] Our second measure is the is number of reporters on staff (from *Burrelle's*), which may be thought of a measure of locally produced (as opposed to syndicated) content. This is a measure of inputs rather than output and is therefore similar to Sutton's measurement of, for example, R&D expenditure. We aggregate pages and reporters to the market level weighting by circulation.

Our third measure is a direct output measure of how good the reporters are, the number of Pulitzer Prizes awarded, 1980-1999. We aggregate across 20 years to reduce the lumpiness of the measure. We exclude the breaking news category from the tally because they appear to be awarded to the paper in the locale of the year's calamity.[3] The are some possible biases in the Pulitzer prize process (such as a bias toward New York City), that we consider in the empirical analysis below.

Table 2 shows that our broad MSA newspaper dataset has data on 283 metropolitan areas with an average of about 3 newspapers (including suburban dailies.) As expected, the distribution of market shares is quite skewed, with the aver-

[1]This can be contrasted with "Primary" MSA's (PMSA's), which aggregate less and which can contain only parts of counties. On the other side, "Consolidated" MSA's aggregate larger areas. Our restaurant data contain some PMSA (and some similar "New England County Metropolitan Areas".

[2]Number of pages of the paper might be alternatively thought of as a measure of one input into the content of the newspaper.

[3]In the last seven years, four of the breaking or spot awards for journalism have gone a paper local to: the Columbine High School shooting, the crash of TWA flight 800, the Northridge earthquake, and the bombing of the World Trade Center. See www.pulitzer.org.

age product-level Herfindahl index being larger than the Herfindahl of a two-firm duopoly market (0.69 versus 0.50).

Table 2: Sample Characteristics

	Newspapers N=283	Restaurants N=316
Number	3.23	472.5
Number equivalent	1.81	164.6
Log Number	0.83	5.48
Log Number Equivalent	0.46	4.52
Product HHI	6922	161.8
Largest Newspapers Staff	31	
Average Newspaper Staff (Circ.-weighted)	24.2	
Longest Newspapers Length (Pages)	47.7	
Avg. Newspaper Pages	41.1	
Pulitzer Prizes/100 staff, 1980-1999	0.51	
4 or 5 Star Restaurants (N=284)		0.46
Population (mil)	0.681	0.679

3.2 Restaurants

Product quality is also endogenously chosen by restaurants. However, increased restaurant quality arguably raises marginal cost at a fairly rapid rate. It seems plausible that if a high quality French restaurant priced its meals at marginal cost, there would still be a market for McDonald's. The French restaurant's quality comes in part from expensive ingredients, expensive labor of the kitchen staff and intensive and customized table service. This does not rule out an increase in restaurant fixed cost as well, but the theory does not require exogenous fixed cost, just a marginal cost function that allows for product proliferation.[4] Restaurants seem to be a good industry to illustrate product proliferation.

[4]The compensation of the head chef, for example, may be a fixed cost that increases in product quality.

Even more than in newspapers, the restaurant industry is also marked by horizontal differentiation, in type of cuisine, in the quality of the service and decor, and in geography. The geographic dispersion of restaurants is particularly tricky and raises the issue of whether all restaurants in an MSA are properly thought of as being in the same market. We can imagine two extreme scenarios. In one scenario, everyone eats in restaurants in their own neighborhood. The growth of cities, in this scenario, just adds new neighborhoods. If the number of restaurants per neighborhood is constant, then the number of restaurants will have a linear relationship to city size, but there is no clear utility gain to consumers. In this scenario (with consumption of only "local" restaurants), a welfare gain would come only from an increase in restaurants *per capita* (meaning more restaurants per neighborhood.). However, in another extreme scenario (perhaps more applicable to high quality establishments), every restaurant serves all consumer in the metro area equally. In this case, any increase in the number of restaurants is a welfare gain, even if the per-capita number of restaurants does not increase. As the truth is probably between the two scenarios (even for high-quality restaurants), we will present information on both per-capita and total numbers of restaurants.

For restaurant quality we have two sources of data. First, we have the number of restaurants given four or five Mobil stars, from *America's Best Hotels and Restaurants* (Connolly 1998). Mobil employs the same quality criteria throughout the country, so the number of restaurants earning 4 or 5 stars provides a measure of the number of restaurants in the locale with quality above some absolute level.[5]

Table 2 shows that there are a total of 131 4 or 5-star restaurants in our 316 MSA sample of restaurant data. Most markets (87 percent) have no 4 or 5-star restaurants.

Zagat's local surveys of restaurants provide our second source of quality data. Zagat's provides ratings of restaurants within each of 43 US markets. These ratings are based on surveys of residents of the respective cities. Hence, the ratings are not comparable across markets. In addition to the basic Zagat ratings (based on price, food quality, service, and decor), in 1999 Zagat's also provided "popularity" rankings of the top 20 restaurants, among three age groups, in each of 20 US markets at their website (www.zagat.com). The age groups are 20-29, 30-39, and 40-49.

Chain restaurants - with more than one location - frequently appear among

[5] According to the Mobil guide, restaurants receive stars "after an extensive review of inspection reports from experienced field representatives, the written evaluations of experts who stay and dine anonymously... A Five-Star lodging or restaurant is one of the best in the country, while a Four-Star property is outstanding and worth a special trip." (Connolly 1998)

Zagat's most popular top 20 restaurants in a locale. Of the 460 restaurants in the sample, 30 correspond to restaurants that appear in more than one sample market. For example, California Pizza Kitchen is present in 12 of the 20 covered markets and appears in 26 of 60 Zagat's age-group-specific top 20 rankings for the 20 covered markets. Assuming that restaurants within a chain offer equal quality wherever they are located, we can use the Zagat's data to determine whether larger markets have more restaurants above some quality threshold by asking whether, for example, California Pizza Kitchen is lower-ranked in larger markets.

The US County Business Patterns databased provides data on the number of eating and drinking establishments by MSA.[6] In addition to the total number of establishments, the retail census also reports the size distribution of restaurants according to employment. We use these data to calculate numbers of restaurants and measures of concentration. Using employment figures to calculate concentration assumes that output is roughly proportional to employment, which (while not perfectly correct) doesn't seem too bad for this industry.

4 Empirical Results on Market Size, Variety and Concentration

To review, theoretical considerations, together with our beliefs about the cost structure of the industries, lead us to expect the following: 1) larger markets will have more restaurants of all types, including higher quality restaurants, 2) the quality of the best newspapers in a market will improve in market size, 3) there should be lower bound to the market share of the largest newspaper in a market and 4) the number of establishments will increase in market size for both industries, but presumably much less rapidly for newspapers than for restaurants.

4.1 Market Size, Maximum Share, Concentration and Numbers

As expected, across the two industries there is a strikingly different relationship between market size, the number of products and the distribution of market shares. Figure 1 plots the number of products in the MSA by the population of the MSA.

[6]Eating and drinking establishments are NAICS code 722 , and the data are available as of this writing at the census web site, www.census.gov.

The upper-left plot graphs both relationships on the same graph – there are obviously many more restaurants than newspapers. Graphing restaurants alone (upper right) shows a nearly perfectly linear relationship, consistent with the finding (on nearly the same data) of Campbell and Hopenhayn (2002). The number of newspapers also increases, although not in nearly as systematic a fashion (lower left).

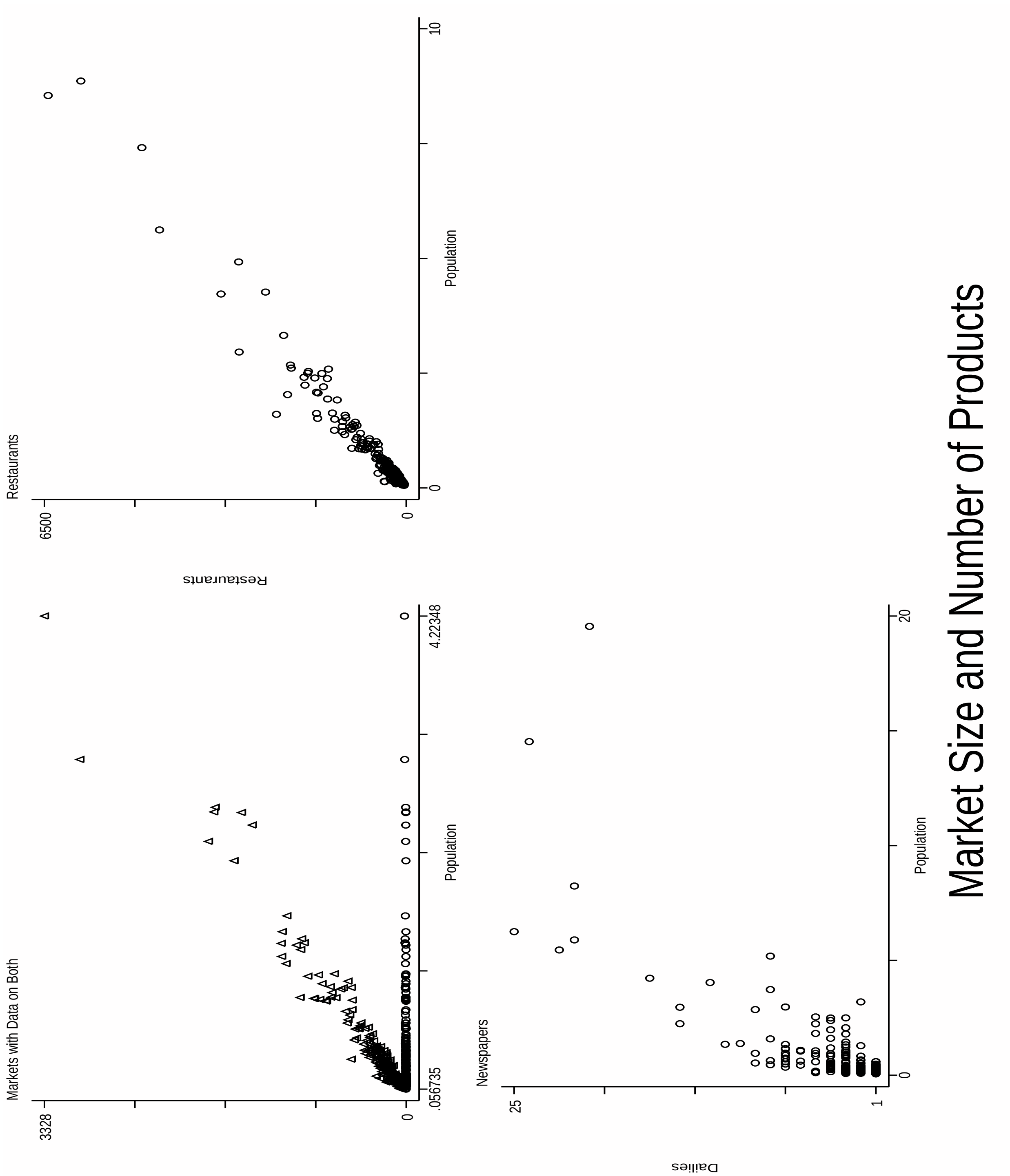
Sutton (1991) emphasizes the prediction for the maximum share. Figure 2a graphs the maximum market share of the newspapers in the MSA. There appears to be a lower bound to this share, of about 0.2, even as the cities become very large.

If we take the suburban dailies out of the data, the results on numbers and market shares for newspaper become more dramatic. Figure 2b considers data on the major metropolitan dailies for the 25 largest US cities (as classified by industry sources.) The market share on the vertical axis is the share of the largest metropolitan daily as a fraction of all the metropolitan dailies. The symbols on the figure indicate the total number of such dailies; only in New York is the number as large as 3. Strikingly, the lower bound on the largest share seems to be about 50%.[7]

We could try to graph the maximum share of restaurants by market size, using the employment classes in the CBP data to approximate size. However, the maximum share of a restaurant is always very small and gets even smaller in large cities. There is no clear lower bound to the maximum share, other than zero.

The maximum market share is a traditional "one-product concentration ratio." As a descriptive matter, we can also measure concentration by a traditional product-level HHI, showing how it varies by market size in restaurants and newspapers. Figure 3 illustrates the distribution of HHI's by market size; in this figure the HHI's are the sum of squared percentage shares, so they vary from zero to 10,000. The HHI figures are hard to graph on a scatterplot, because of a build-up of points on perfect concentration (in newspapers) and virtually zero concentration (for restaurants). Instead of a scatterplot, we use a STATA-generated box-and-whisker plot, where the x-axis plots deciles of the population distributions and the box-and-whisker figures summarize the distribution of HHIs on the y-axis. The three lines in each box are, from the top, the 75th 50th, and 25th percentiles of the distribution. The lines outside the box are the 90th and 10th percentiles, and the individual circles (not always shown) give outliers. The box partly collapses when,

[7]This is another way of saying the number of products almost never drops below 2; however, in the one 3 paper town (New York), the maximum share is still nearly half. The result of apparently bounded maximum share also holds up, again at a different level, to graphing maximum product share as fraction of population instead of as a fraction of total output.



Market Size and Number of Products
Markets with Data on Both
Restaurants
Newspapers
Dailies
Population
3328
0
.056735
4.22348
6500
10
25
1
20

Figure 1

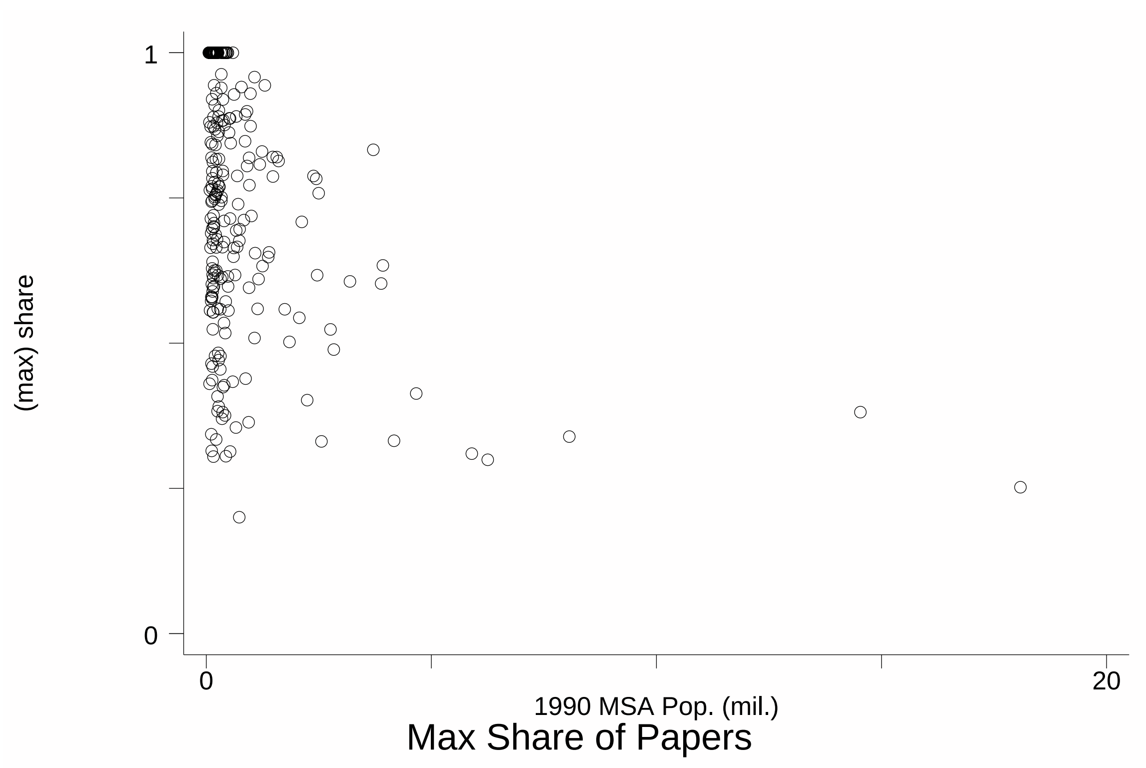


Figure 2a

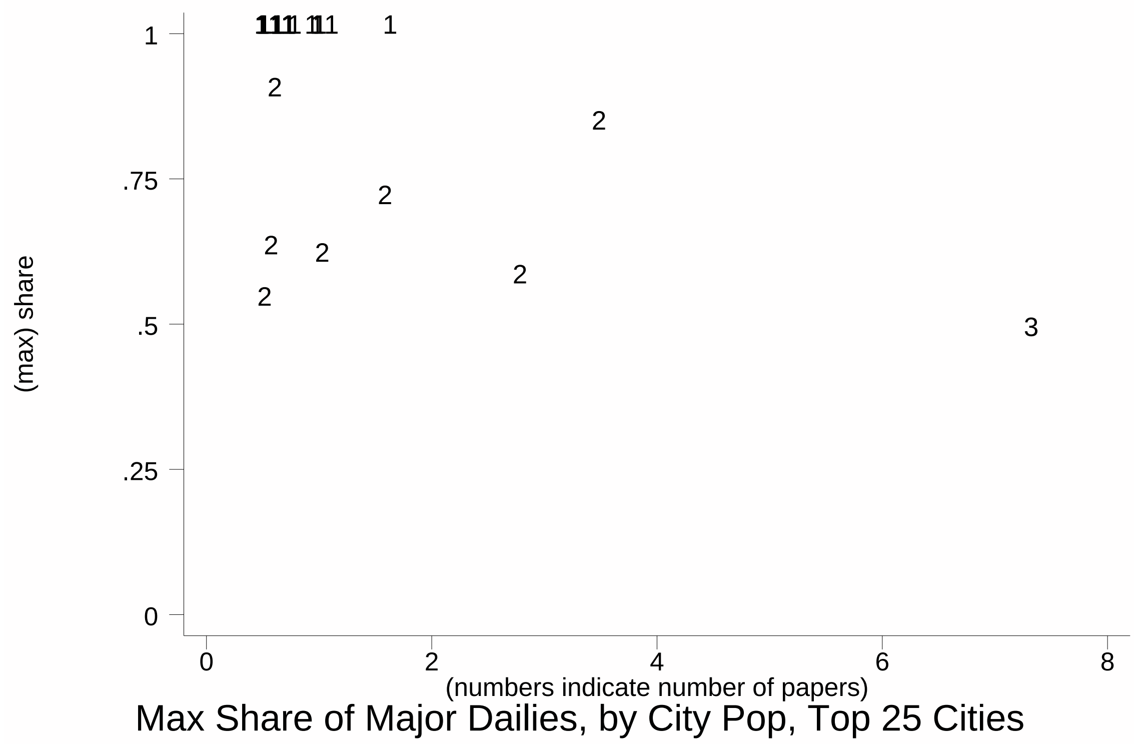

(max) share
1
.75
.5
.25
0
0
2
4
6
8
(numbers indicate number of papers)
Max Share of Major Dailies, by City Pop, Top 25 Cities

Figure 2b

for example, the median and 25th percentile are equal, completely collapses when the 75th and 25th percentiles are equal and even the whiskers disappear when the 10th percentile equals the 90th.

In Figure 3, we see that concentration is, of course, much lower in restaurants than in newspapers. The juxtaposition of figures 3b and 3c, however, shows that concentration falls in market size in restaurants while it is relatively constant even as market size increases in newspapers. Even though the largest markets have roughly 20 dailies (including suburban papers, etc.), the median newspaper HHI even across markets in the top decile is roughly 5000, the same level as in a symmetric duopoly.

So far, we have been considering only plots of the data with no tests of significance or controls. Table 3 reports regressions of the numbers of newspapers (and restaurants) on market size. In addition to the log of the raw number, the table gives results using as the dependent variable the log of the "numbers equivalents" (the inverse HHI.) The coefficient on market size (log population) is much smaller for newspapers than for restaurants. While the restaurant coefficient in the $ln(N)$ regression without controls (column two) is roughly one (indicating proportionality), the newspaper coefficient on $ln(N)$ is 0.5 and on the numbers equivalent is less than 0.23. The numbers of both newspapers and restaurants increase in market size, but the increase is much slower for newspapers.

The fourth and last columns give results using a limited number of demographic controls. The percentage of the population with some college has a statistically significant positive association with the restaurant log numbers equivalent. The "% Young" (those under 35) is associated with a decline in the numbers equilavent for newspapers and the "% Old" (those over 65) has a smaller and possibility insignificant effect (note that those "middle-aged", the omitted category, seem to be the newspaper readers.) The bottom line is that the contrast between the two markets remains in the presence of demographic controls. Further, that constrast is robust across regressions (not reported here) that vary the definition of the dependent variable (levels vs. logs), the list included demographics and the set of markets in the sample.

To conclude this section, then, we have illustrated dramatic differences, across market size, in the share distribution of the two industries. We have argued that quality is endogenously choosen in each industry, but the fact that newspaper quality is largely fixed with respect to output means that the maximum share of a newspaper should have a lower bound. Figure 2b provides the most dramatic illustration of this, showing that the number of major metropolitan dailies hardly increases, constrasting greatly with the linear increase in the number of restaurants.

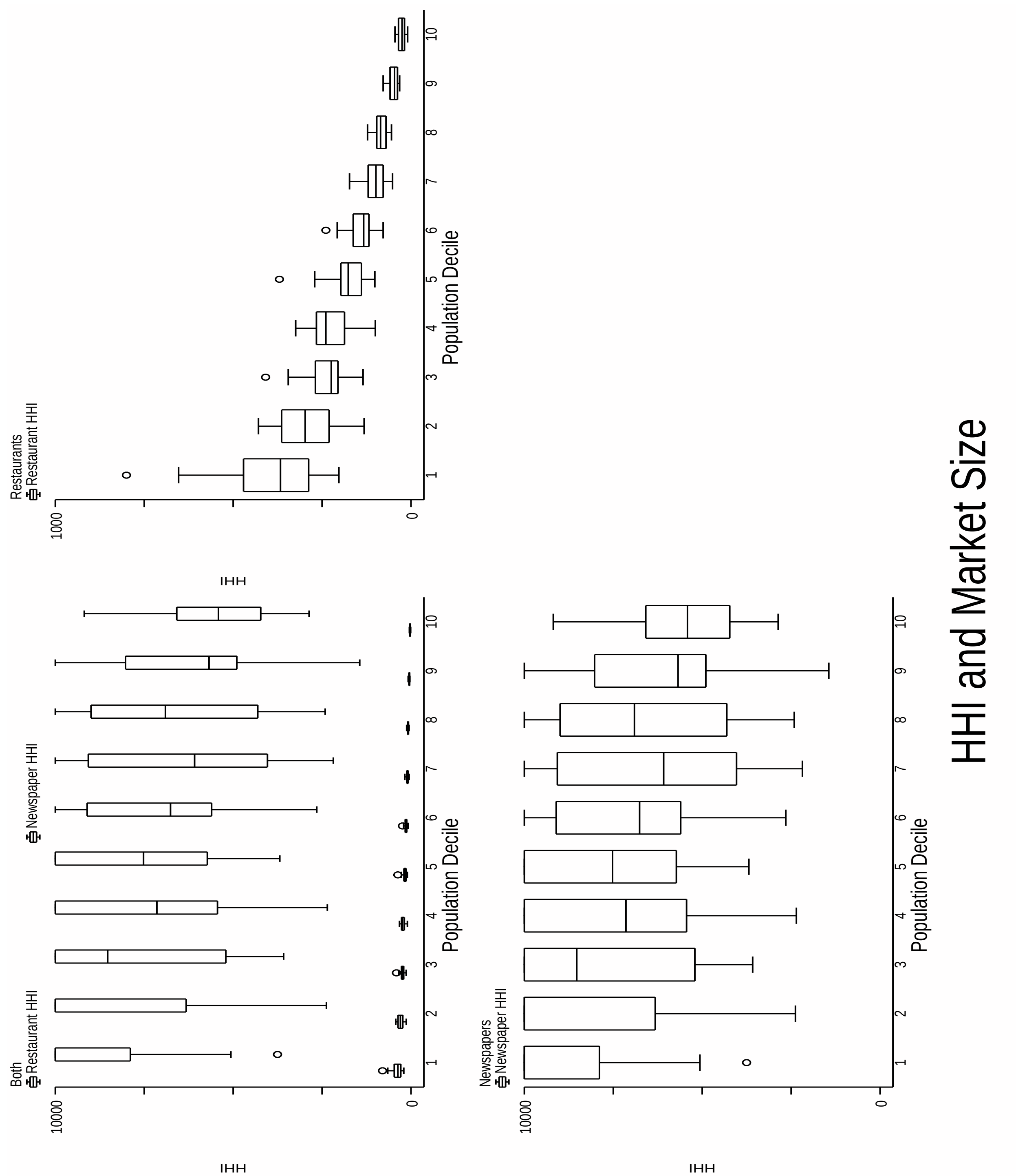

HHI and Market Size
Both
Restaurant HHI
Newspaper HHI
Restaurants
Restaurant HHI
Newspapers
Newspaper HHI
HHI
Population Decile
10000
1000
0
1
2
3
4
5
6
7
8
9
10

Figure 3

Table 3: Market Size and Fragmentation Newspapers and Restaurants

	Restaurants			Newspapers		
Variable	Log N	Log N-Equiv	Log N-Equiv	Log N	Log N-Equiv	Log N-Equiv
Log Pop.	0.99	0.91	0.876	0.521	0.226	0.206
	(0.014)	(0.016)	(0.022)	(0.029)	(0.023)	(0.025)
Med. Income			0.016			0.013
($1,000s)			(0.005)			(0.006)
% College			1.878			-0.495
			(0.329)			(0.475)
% Young			-1.400			-5.702
			(0.953)			(1.368)
% Old			0.779			-2.483
			(0.986)			(1.365)
Intercept	6.613	5.564	-7.007	1.455	0.733	2.663
	(0.023)	(0.026)	(0.499)	(0.046)	(0.036)	(0.674)
# obs	316	316	241	283	283	283
R^2	0.94	0.91	0.91	0.54	0.26	0.34

Notes: Standard errors in parentheses. The unit of observation for newspaper data is msa/cmsa. For restaurants, data are available by necma/msa/pmsa. Consequently , sample sizes differ. Also, our demographic data match the msa/cmsa and in Column 4 (restaurants with demographic controls) we simply drop the restaurant markets that do not match the msa/cmsa data.

The qualitative nature of this result is robust to alternative market definitions and measures of concentration.

4.2 Product Quality

We expect to find that the quality of the best newspaper in a market increases dramatically, while restaurants should be filling out the entire quality distribution (including at the top).

Newspapers and Quality

While the number of newspapers changes relatively little (especially aside from the horizontally differentiated suburban dailies), the nature and quality of newspapers change very dramatically across market size. Figure 4 shows box-and-whisker plots of various

maximum quality measures across market size. These box-and-whisper plots give a simple descriptive and "non-parametric" feel for the distribution of the maximum quality levels across the market sizes.

Figure 4 demonstrates the large changes in the nature of newspapers across markets. The physical page size of the papers increases (see the upper left panel), which is associated with both more news and more advertising, both of which are valued by some consumers. The local journalistic staff increases (upper right panel), indicating that more news is produced with a local angle (as opposed to relying on wire reports.) (The staff size variable is especially obvious as a component of fixed but not marginal cost.)

The staff may be of higher quality in larger cities, as well. The larger cities appear to win more Pulitzers per staff member (lower panels of Figure 4). This is observed not just in the largest cities, as the pattern clearly remains when the top decile of the distribution is removed (in the lower right panel.)

While we have only imperfect measures of quality, the same pattern shows up using each measure. It is clear that the nature of the papers is changing much more than the number of papers.

In our (biased) opinion, the across-metro area U.S. newspaper data is the cleanest empirical example of Sutton's endogenous sunk cost argument, because [i] the market size "experiment" is (relatively) clean, [ii] there is clear prior reason to believe that the cost of quality is largely fixed with respect to output, [iii] the total number of products increases fairly slowly in market size, [iv] there is a clear lower bound to the maximum share and [v] we have direct measures of quality, which increase very rapidly in market size.

The descriptive results on newspaper quality are robust with respect to the introduction of controls in a regression analysis, as shown in Table 4.

Restaurants and Quality

In restaurants, we predict that the full distribution of quality levels will fill in. We would like data on the quality of each restaurant in the market. Our actual data fall short of the ideal but still allow us to test for these effects. Rather than observing

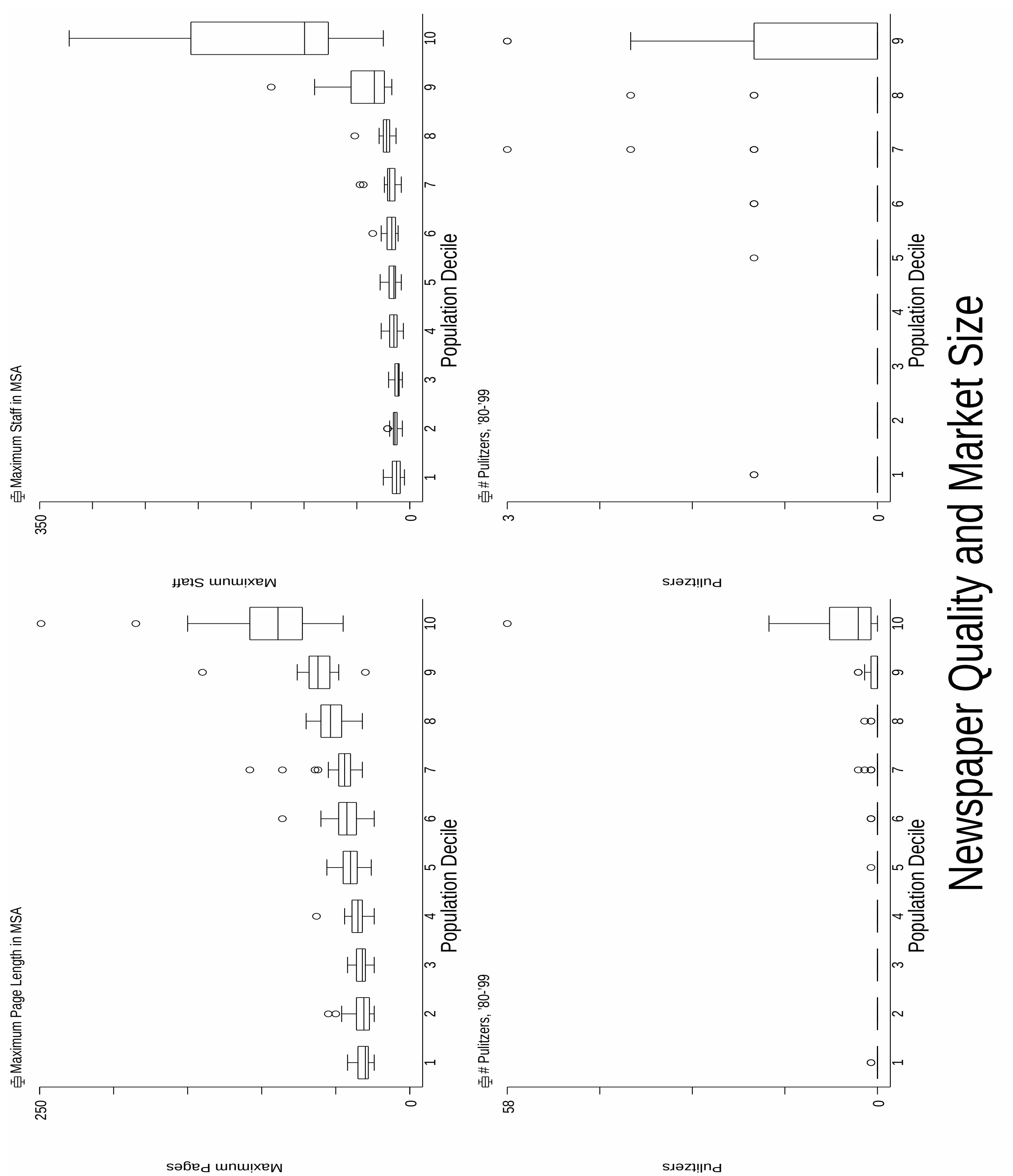

Newspaper Quality and Market Size
Maximum Page Length in MSA
Maximum Pages
Maximum Staff in MSA
Maximum Staff
Pulitzers, '80-'99
Pulitzers
Population Decile

Figure 4

Table 4: Newspaper Quality and Market Size

Variable	Ave Log Pages	Ave Log Staff	Max Log Pages	Max Log Staff
ln(pop)	0.208	0.475	0.287	0.560
	(0.021)	(0.025)	(0.015)	(0.025)
Median	-0.001	0.009	0.005	0.012
Income	(0.005)	(0.006)	(0.004)	(0.006)
% College	1.106	0.900	1.025	0.961
	(0.388)	(0.479)	(0.275)	(0.477)
% Young	2.387	1.173	1.119	0.428
	(1.115)	(1.380)	(0.790)	(1.375)
% Old	2.480	0.183	1.982	0.006
	(1.113)	(1.377)	(0.789)	(1.371)
Intercept	2.591	2.611	3.165	3.010
	(0.549)	(0.680)	(0.389)	(0.677)

Notes: Standard errors in parentheses; Averages are circulation weighted averages; Qualitative results are robust to different measures of population and functional form (logs vs. levels).

the full distribution of qualities, in the *Mobil* restaurant data we instead observe the number of restaurants in each market above a (high) absolute quality threshold. Furthermore, using the *Zagat's* data we can examine whether the distribution fills out in larger market above the (somewhat lower) thresholds defined by various multi-city chain restaurants. Finally, since the number of "lower quality" restaurants is the total number minus the number of "higher quality" establishments, we also have information on the lower end of the quality distribution.

Figure 5 characterizes the relationship between top restaurant availability and market size. The box-and-whisker plots are again very useful here, as it is hard to plot the very large number of zeros in the data. The figure shows a clear positive relationship: there are more top restaurants in larger markets. New York City alone has 31 such restaurants. The relationship does not depend on the inclusion of New York, however. The upper right panel excludes the top decile, and the positive relationship remains clear. The lower panels reproduce the upper panels, but using top restaurants *per capita* instead of the total number of restaurants. These last figures are consistent with the number of high quality restaurants increasing faster than population, which suggests that the "neighborhood replication" (geographic dispersion) argument discussed above does not entirely explain the market size / top restaurant relationship.

Figure 5 cannot control for other observable variables, or for the implicit censoring problem that many cities have zero top restaurants. Table 5 reports regressions of the top restaurant count on population and controls, and the positive relationships evident in Figure 5 appear here as well and are statistically significant. We estimate both OLS and tobit models.

We take the evidence in Figure 5 and Table 5 as a clear indication that the number of high quality restaurants increases in market size and that even the number of high quality restaurants *per-capita* is higher is larger cities.

What about the remainder of the restaurant quality distribution? We have two ways to address this. First, consider figure 2 showing the relationship between market size and the total numbers of restaurants (and newspapers). Clearly, the number of "non-top" restaurants is increasing in market size as well. This relationship is nearly linear, which does not rule out the neighborhood replication argument for lower-quality restaurants (as would make sense if consumers will not travel very far for lower quality restaurants.)

The Zagat's data allow us to examine the filling out hypothesis for other cutoffs. To use the Zagat's chain restaurant data, we have to assume that the "true" quality of chain restaurants is the same in even city in which they operate. (Chain management is typically designed to ensure that this is so.) Each chain then defines a quality level that is constant across cities and we can check for the number of restaurants above each quality ranking. In fact, we don't observe the total number of restaurants above a quality threshold, but we do have the data on the Most Popular Top 20 restaurants (by age group). Thus, we know the [censored at 20] number of restaurants considered by each age group of Zagat respondents to be "better" than a given chain, censored at 20 and above.

Figure 6 shows the tendency for the most widespread chains to appear in the "Popular Top 20" when operating in smaller and larger markets. First, the data is divided into large and small markets (the dark and light bars). Each panel represents a different age group: the decades of the 20s, 30s and 40s. Each restaurant chain has a bar of dark/light bars representing the % of (large or small) markets featuring that chain in the top 20. Long bars are indications of low market quality (in the sense of a low number of restaurants above the assumed threshold). In all cases but one, the dark (small markets) bars are longer than the large market bars so, with one exception, a chain's restaurants are more likely to be highly

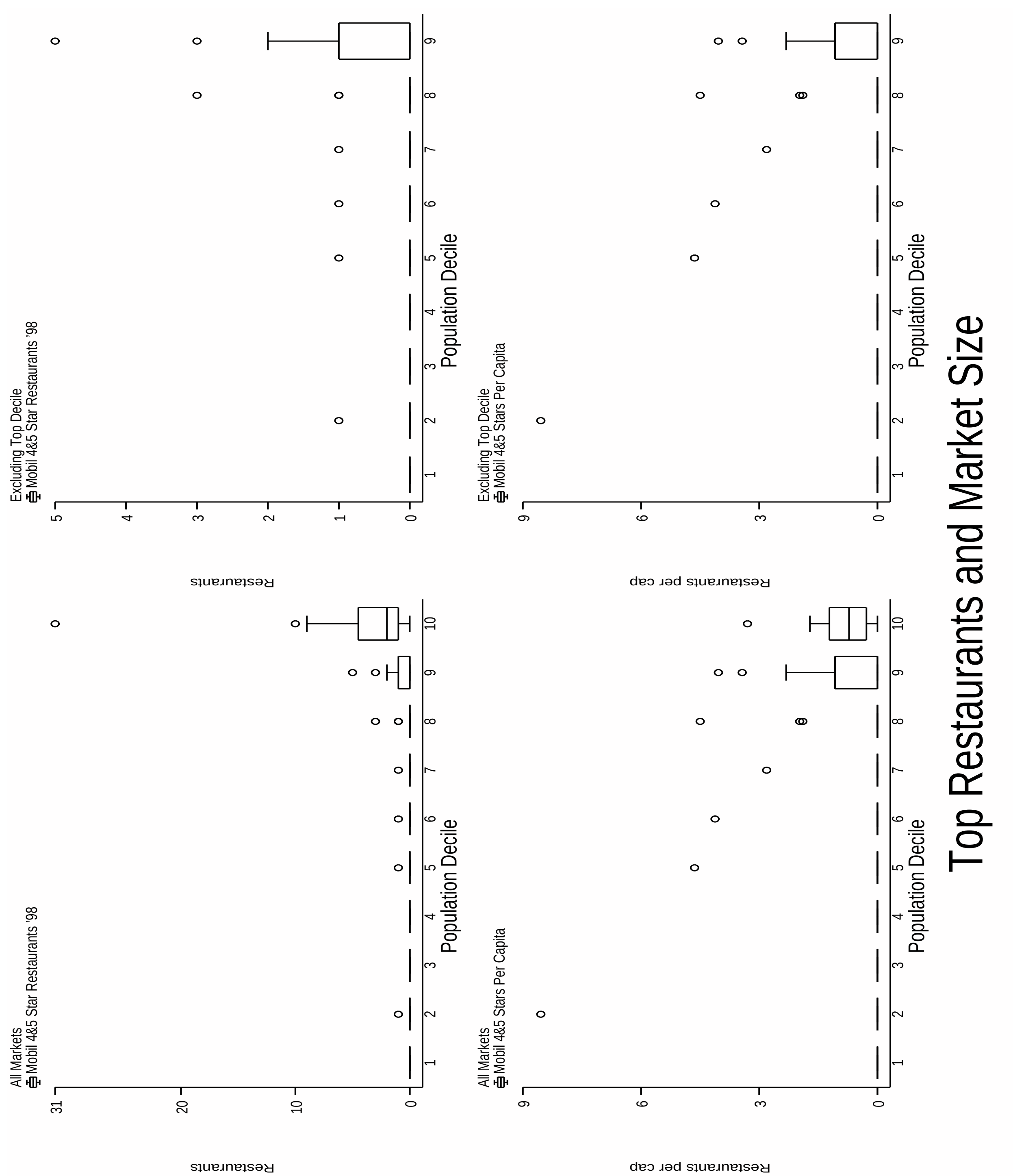

Top Restaurants and Market Size
All Markets
Mobil 4&5 Star Restaurants '98
Excluding Top Decile
Mobil 4&5 Star Restaurants '98
All Markets
Mobil 4&5 Stars Per Capita
Excluding Top Decile
Mobil 4&5 Stars Per Capita
Restaurants
Restaurants per cap
Population Decile

Figure 5

Table 5: Restaurant Quality and Market Size

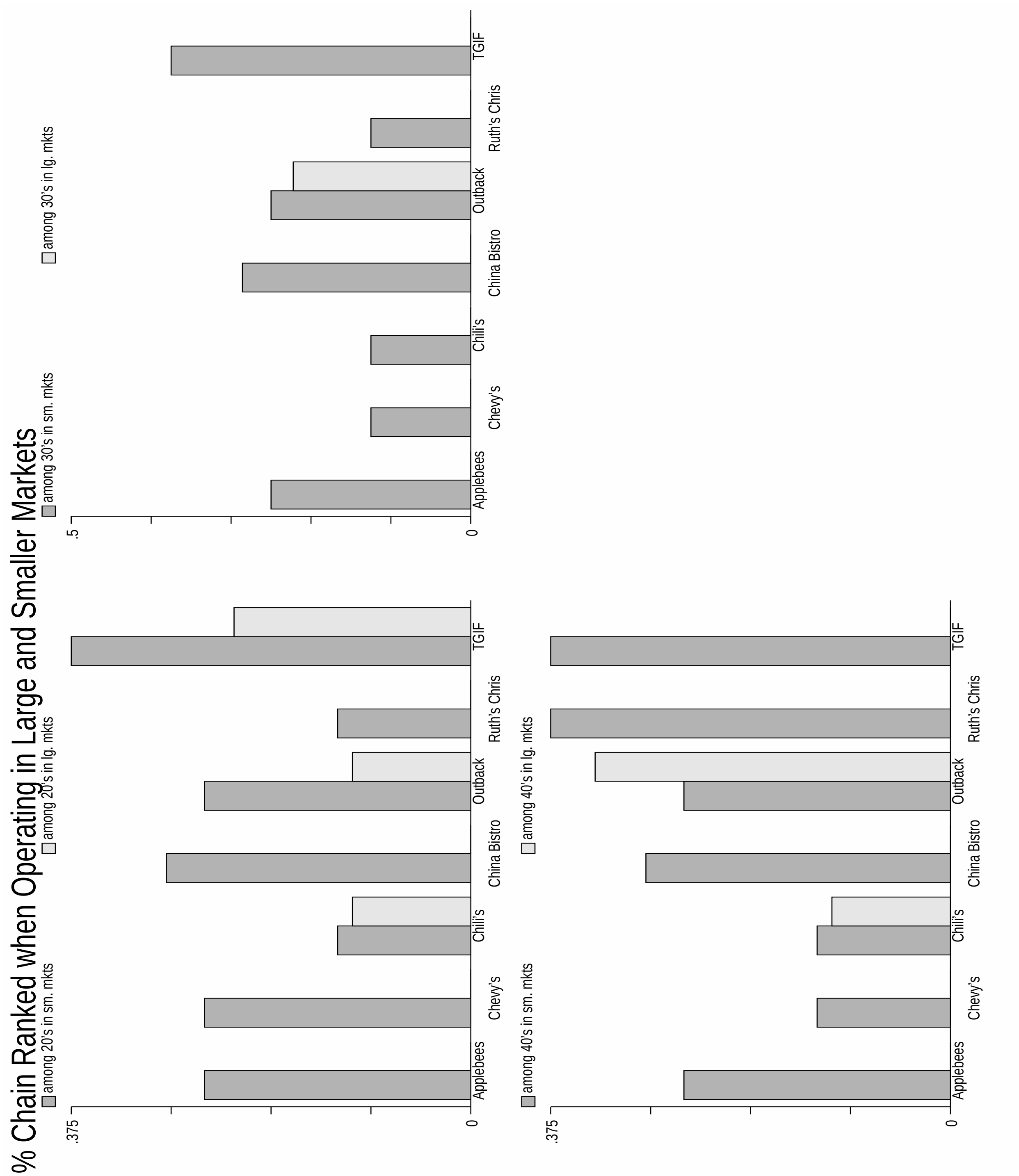
	OLS		Tobits	
Variable	Mobil 4&5 Star	5 Star	4&5 Star	5 Star
Population	1.149	0.155	1.588	0.385
(1,000,000s)	(0.047)	(0.007)	(0.155)	(0.089)
% College	1.784	0.010	15.482	1.565
	(1.450)	(0.225)	(7.434)	(5.569)
Med. Income	-2.964	-0.595	12.529	3.927
($100,000s)	(1.851)	(0.288)	(9.322)	(5.879)
% Young	-2.258	-0.379	3.779	-1.064
	(4.148)	(0.645)	(23.485)	(17.836)
% Old	0.576	-0.412	9.350	-13.892
	(4.162)	(0.647)	(21.156)	(21.844)
Intercept	0.850	0.284	-14.560	-2.607
	(2.010)	(0.313)	(11.250)	(9.241)
σ			3.348	1.291
(Tobit se)			(0.402)	(0.358)
Observations	284	284	284	284
R-squared	0.72	0.65		

Notes: Standard errors in parentheses.

ranked when operating in smaller markets. The figure doesn't address the issues of heterogeneity in markets and in restaurant chains, so Table 6 presents regression evidence with controls.

Table 6 presents the results of Tobit regressions of censored chain rank on population, MSA demographics and survey respondant age. The regression includes restaurant-chain fixed effects.[8] All models confirmed the following result: chains

[8]The results in Table 6 pool the data on each age category, but include age dummies as controls in the regression, imposing that the chain fixed effects (as well as the other slope coefficients) do not change in age. The number of observations for each fixed effect is then the number of MSAs times 3 age groups. This greatly aids in the estimation of the non-linear fixed effects. Note that we obtain virtually identical results with random effects or conventional tobits. Note that we constrain



% Chain Ranked when Operating in Large and Smaller Markets
among 20's in sm. mkts
among 20's in lg. mkts
among 30's in sm. mkts
among 30's in lg. mkts
among 40's in sm. mkts
among 40's in lg. mkts
.375
.5
0
Applebees
Chevy's
Chili's
China Bistro
Outback
Ruth's Chris
TGIF

Figure 6

appearing in multiple markets are ranked lower in larger markets. Assuming that the quality of a given chain restaurant is constant in all markets, this result confirms our prediction that larger markets have more restaurants above particular quality thresholds.

Table 6: Tobit Regression of Chain Rank on Market Size

Variable	Coeff	(SE)
ln(Pop)	5.078	(1.021)
Survey Age 30-40	2.404	(1.378)
Survey Age $>$ 40	0.650	(1.335)
MSA % College	96.214	(19.212)
MSA % Black	19.394	(7.916)
MSA % Young	-208.319	(72.050)
MSA % Old	-0.276	(70.866)
MSA Med Income ($1000s)	-0.935	(0.277)
Intercept	26.623	(32.776)
Tobit σ	11.618	(0.670)

Notes: Tobit estimates with restaurant-chain fixed effects. Dependent variable is rank if the restaurant appears in the Zagats popularity top 20; if the chain is present in the market but unranked and its rank is presumed to be worst than 20 (i.e. rank $>$ 20). A larger rank means there are more restaurants above the quality threshold defined by the chain. Only chain restaurants (with locations in multiple markets) are included.

The positive relationship between market size and the number of restaurants above various quality thresholds has two potential "horizontal" explanations, in addition to the "vertical" explanation of filling in the range of available qualities. First, it may reflect "neighborhood replication" in market size; this involves horiztonal differentiation in geography. Second, it may reflect growth in the types of food (cuisine) that is offered in each location. In practice, there may be some proliferation in horizontal dimensions together with some proliferation in a vertical dimension and the distinction may matter very little in most policy applications. However, for the purpose of comparing Sutton-like predictions across city-sizes, it may be of interest to know if the proliferation in restaurants is largely vertical or else appears to be largely horizontal.

the slope coefficients to be constant across restaurants and across age groups.

As for the neighborhood replication argument, the chain restaurants actually do appear in multiple locations. One might think this would give them a special advantage in large cities, but they are not more popular in larger cities.

On balance then, we doubt that the neighborhood replication argument explains the relationship between market size and high quality restaurants. First, on a priori grounds we suspect that high quality restaurants, unlike neighborhood pizza joints, serve entire metropolitan areas. Second, our results show that market size is positively related to not only the number of high quality restaurants but also the per capita number. Finally, under the neighborhood replication argument, restaurants with multiple locations within a market would tend to achieve higher popularity rankings than standalone neighborhood restaurants, contrary to the results in Table 6. However, for lower quality restaurants, the "neighborhood replication" argument (under which city neighborhoods would offer about the same choices in small and large cities) is difficult to rule out with our present data. The number of lower-quality restaurants does appear to increase approximately proportionately to market size.

What about horizontal proliferation through the proliferation of types of cuisines? Data available at the Yellow Pages web site[9] give the number of restaurants in each city in each of 49 different cuisine categories. We obtained these for the top 25 cities (not metropolitan areas). The number of restaurants in these cities ranges from 758 in El Paso to 5574 in New York. The number of distinct cuisines available ranges from 27 in Detroit to 46 in Chicago. A regression of the log number of restaurants on log population yields a coefficient of 0.72 (s.e.=0.095). Since the number of restaurants is the product of the number of cuisines available (NC) and the number of restaurants per cuisine (N/NC), we can decompose the log poopulation coefficient of 0.72. A regression of log(NC) on log population gives a coefficient of 0.098 (s.e.=0.029), while a regression of log (N/NC) on log population yields a coefficient of 0.624 (s.e.=0.75). This is consistent with a belief that only small fraction of restaurant growth in market size is cuisine differentiation as measured by Yellow Pages data. Of course, we can not rule out more subtle forms of horizontal differentiation.

To summarize the restaurant quality evidence, then, we find that the entire distribution of restaurants fills out in larger markets, giving rise (among other things) to more high quality restaurants, even *per capita*. However, the increase in the number of products is at least as dramatic as any changes in the quality of the products and we can present no evidence that average quality increases at all.

[9]See http://www.yellowpages.com/, accessed October 18, 2002.

5 Concluding Discussion

In this paper, we have presented evidence, consistent with Shaked and Sutton (1987), that the distribution of product quality bears different relationships with market size depending on the process for producing quality. In one market (restaurants) where quality is created largely through variable costs, markets fragment as they grow large, and the number of varieties – including levels of quality – increases. Consequently, the number of high-quality products increases in market size as well. In another market (newspapers) where the cost of creating quality is largely fixed with respect to output, markets do not fragment as they grow large and average product quality increases in market size.

Our empirical evidence is descriptive and does not provide parameter estimates of an underlying model. Nonetheless, our evidence may improve on existing cases studies (e.g. Sutton (1991)) by focusing on a cross-section of U.S. metropolitan areas (instead of relying on cross-country regressions) and by emphasizing direct measures of quality in addition to evidence on market structure. In newspapers, we show that the number of metropolitan dailies hardly changes at all, while the quality of the product increases greatly in market size. We think this provides the best descriptive example to date of the Shaked and Sutton theory of endogenous fixed costs. The contrast to an industry like restaurants (where maximum quality increases but the market fragments as size increases) is vivid.

The evidence in this paper has implications for a number of areas of economics, including entry, trade and rationales for urban agglomeration. Much of the empirical entry literature is driven off the assumption that different sized markets can accommodate different numbers of firms. For example, some authors seek to draw inferences about how prices fall with entry from the relationship between market size and the number of firms operating. This literature would be greatly complicated by quality competition, which implies that both fixed costs and product characteristics change in market size. Future structural work might profitably explore the endogeneity of quality and sunk costs.[10]

As noted, there is a large economic literature on rationales for cities. The vast majority of this literature focuses on various production-side rationales for cities. However, the empirical literature in industrial organization has already documented the consumption-side benefit of increased product variety: recent work documents the relationship between market size and the number of local options

[10]Some preliminary structural results are in the Berry and Waldfogel (1999) study of entry in local radio broadcasting markets, which finds a strong relationship between station fixed costs and market size. That study, however, does not take the further step of endogenizing product quality.

in retail, radio, television, newspapers, and the Internet.[11] This work, predicated explicitly on the presence of exogenous fixed costs, implies that consumers face more options and therefore achieve more satisfaction in larger markets.[12] The present paper shows that the welfare benefits of larger markets are driven not only by the number of products but also by the kinds of products available in larger markets. The presence of higher quality goods in larger markets presumably heightens the consumption-side benefits of agglomeration.

A separate literature examines urban quality of life, explaining land values as capitalized amenities, where the fundamental amenities include weather, pollution and local tax and spending mixes (for example, see Gyourko and Tracy (1991)). To our knowledge this literature ignores effects of endogenous product quality and availability on consumer welfare. Given the rather substantial differences in the nature of products in local service industries like media, restaurants and retail this omission may be important.

As noted by Krugman, there is a good deal of overlap between the study of geography and the study of trade. In Krugman style trade models, one major benefit of trade is an increase in product variety. In media markets like newspapers, trade may do more to change the quality of the product than to change the variety of products available, as higher quality products (spreading the cost of quality across a world market) drive local alternatives out of business. As in newspapers, horizontal differentiation will keep some local alternatives alive.

In light of arguments in this paper, the market for content on the Internet provides an interesting possible case study. The Internet, and attendant information technologies, have simultaneously reduced exogenous fixed product costs and, by wiring geographically dispersed consumers together, increased market size. Under conventional understandings of entry, this would be expected to lead to a proliferation of firms and products. Some observers herald a new retail and media landscape where a great diversity of sellers and voices will be available and heard. Yet if fixed costs are determined endogenously by a quality competition process, then the new information and retail economy may remain as concentrated as the old.

[11] Studies include Bresnahan and Reiss (1991), Berry and Waldfogel (1999), , Waldfogel (forthcoming), Waldfogel (2001), George and Waldfogel (forthcoming), Sinai and Waldfogel (2001) and Campbell and Hopenhayn (2002).

[12] Of course, these consumption benefits might be offset by congestion, crime and other urban disamenities. In the traditional model of production externalities, it is these disamenities that limit the size of cities.

A Appendix

In this appendix, we lay out some of the mathematics behind the review of theory in the text.

A.1 Pricing in the The Vertical Model

Consider the utility function of consumer i for product j of

$$u_{ij} = \theta_i \delta - p_j, \tag{9}$$

where θ_i is willingness-to-pay for quality. If an ordered set of products $\delta_1 < \delta_2 < \delta_3 < \ldots < \delta_J$ are all purchased by some consumer, then it is easy to show that each product substitutes only with the next-highest and next-lowest product in quality. The set of consumers who prefer product j to the lower quality product $j-1$ is then defined by θ_i's that satisfy:

$$\theta_i \delta_j - p_j \quad > \quad \theta_i \delta_{j-j} - p_{j-1} \Rightarrow \tag{10}$$

$$\theta_i \quad > \quad \frac{p_j - p_{j-1}}{\delta_j - \delta_{j-1}}. \tag{11}$$

Similarly, j is preferred to the next higher quality product if

$$\theta_i < \frac{p_{j+1} - p_j}{\delta_{j+1} - \delta_j}. \tag{12}$$

The last two conditions are jointly satisfied only if

$$\frac{p_{j+1} - p_j}{\delta_{j+1} - \delta_j} > \frac{p_j - p_{j-1}}{\delta_j - \delta_{j-1}}. \tag{13}$$

This in turn places a restriction on the price of good j – if p_j is too high then no one will buy product j. In particular, there is a kind of convexity restriction – with δ on the horizontal axis and p on the vertical axis, the the slope of the line between (δ_{j-1}, p_{j-1}) and (δ_j, p_j) has to be less than the slope of the line between (δ_j, p_j) and (δ_{j+1}, p_{j+1}). Formally, we can re-write (13) as:

$$p_j < \lambda p_{j-1} + (1-\lambda) p_{j+1} \tag{14}$$

where $\lambda = (\delta_j - \delta_{j-1})/(\delta_{j+1} - \delta_{j-1})$ so that $\delta_j = \lambda \delta_{j-1} + (1-\lambda)\delta_{j+1}$. Thus, we find that prices as a function of δ must be convex in δ if every product is to be purchased.

This result on the convexity of prices relates to the shape of marginal cost in quality. If marginal cost is concave in quality, then a higher price good can price above its own marginal cost and yet drive a lower price good out of the market. This is not true in the case of convex marginal cost. The potential ability to price lower-quality products out of the market in turn has large effects on the incentive to product both high and low quality goods.

Product Proliferation and Convex Marginal Costs

Here we show that the product-quality line will fill in as market size increases if: marginal costs are increasing and convex in quality (and constant in quantity), demand is generated by the vertical model and θ has positive density on $(0, \infty)$ That is, under these assumptions, as as market size goes to infinity, there will be a product on every quality segment of positive length on $(\underline{\delta}, \infty)$, where $\underline{\delta}$ is some lower bound on quality.

We consider simultaneous move equilibria in prices and qualities. There are an infinite number of potential firms, each of whom can offer any combination of products with any price and quality combinations. As is typical in this literature, we don't try to establish the existence or uniqueness of equilibria (which is very difficult), but we instead consider outcomes that necessarily occur in any equilibria.

In this paper, we are not much concerned with what happens on the lower regions of the quality, because we don't have good data on low quality products. Suppose then as market size increases, at some point there are two goods, δ_1 and δ_2 (this is easy to establish given some conditions on the outside good.) We will then show that the quality levels above δ_1 will eventually fill in.[13]

First suppose that there is no product on a segment (δ_1, δ_2) and consider the profits of a potential entrant into that segment. The worst-case scenario for the potential entrant into the segment is that the products at δ_1 and at δ_2 are pricing at marginal cost. In this worst-case scenario, the potential entrant will make positive sales by entering at $\delta \in (\delta_1, \delta_2)$ (and a price of p) if the condition in (14) holds:

$$p < \lambda mc(\delta_{j-1}) + (1 - \lambda) mc(\delta_{j+1}), \tag{15}$$

with $\lambda = (\delta - \delta_1)/(\delta_2 - \delta_1)$.[14]

The new entrant can set such a low price, and yet still price above marginal cost, if marginal cost is convex in quality. Since sales are then a positive fraction of the market and price is above marginal cost, per-capita variable profits V are positive and no matter what is the (finite) level of fixed costs $F(\delta)$, eventually as M grows large $MV(\delta) - F(\delta)$ will be positive and so a product must be offered in that segment in any equilibrium. Note that since a product is offered in every segment above some minimum level, "product concentration" declines – the maximum share of any product goes to zero.

Now consider a high-quality segment, (δ_2, ∞), that does not have a product (for any finite δ_2). At any price p, there are some θ's that will prefer a higher quality good, with quality $\delta > delta_2$. Specifically, the set of consumers that will buy the good satisfy

[13] Of course, new products below δ_1 may also be introduced.

[14] As long as the sales of δ_1 and δ_2 are positive in the absence of the new good good, then we don't have to worry about competition with the other goods of even lower and even higher quality – as long as the condition is met then the sales of the new good are positive.

$\theta > (\delta - \delta_2)/(p - p_2)$. By choosing $p > mc(\delta)$, once again the per-capita variable profit for this product is positive and so as M increases the product is eventually offered.[15]

So, in this sub-section we have established that when marginal cost is increasing and convex in quality, then as the market size increases products proliferate, filling in the product space (so that product-concentration declines) and also the maximum quality in the market increases.

A.2 Sutton's "Endogenous Fixed Cost Models"

Shaked and Sutton (1987) consider models where products do not proliferate as market size increases, but rather where some high-quality products maintain some fixed minimum fraction of the market even as market size increases. In the vertical model where marginal cost is not convex is quality, higher quality products can possibly undercut lower-quality products and drive them from the market, thus taking a significant fraction of the market. Shaked and Sutton show conditions under which this action can lead to concentration in the limit. We also emphasize that once again the maximum quality in the market increases and indeed the mechanism for maintaining share in the face of increased market size is to continue to increase quality.

Shaked and Sutton consider a general class of vertical models in which a high quality product can capture a fixed level of per-capital products via a sufficiently high increase in quality. Specifically, suppose that if δ_j is k times higher then any other δ, a firm can in equilibrium capture some fraction, α, of total income, $M\bar{Y}$ as variable profit. That is, if δ_j is k times higher than any other δ, then the firm producing j has profits of at least $M\alpha\bar{Y}$. This is certainly true in the vertical model if marginal cost does not increase in quality and if some (possibly small) fraction of consumers will pay for increased quality.

For example, consider the vertical model where marginal cost, mc, is constant in quality and where currently purchased products are $(\delta_j, p_j; j = 1, \ldots, J)$. Now consider a new product with quality $\delta_j = k\delta_J$, where J indexes the highest quality existing product. Let the new product have price $p_{J+1} = p_J + D\delta_J$, where D is any constant. Since p_J exceeds marginal cost, the markup on the new product is at least $D\delta_J$. The new product is preferred to the old highest quality product for consumers whose tastes θ satisfy:

$$\theta > \frac{(p_{J+1} - p_J)}{(k\delta_J - \delta_j)} = \frac{D}{k-1} \tag{16}$$

The last inequality does not depend on δ_j – one can always get a fixed positive share of sales by increasing quality k times and setting price as described. Further, given constant marginal cost in quality (or marginal costs that do not increase too fast in quality) the price increase is sufficient to generate a positive markup per sale (and the markup increases in

[15] Note that this last result does not depend on the convexity of marginal cost.

the quality of the best rival and so has some lower bound as long as equilibrium quality has some lower bound). This is just one example of how the Shaked-Sutton conditions on the variable profit function can be satisfied when marginal costs do not increase at a convex rate.

As for fixed costs, Sutton assumes that $\frac{\partial ln(F)}{\partial ln(\delta)} < \beta$. That is, increasing δ by k times drives up fixed costs by less than k^{β} times. This insures that fixed costs are not increasing at some unbounded rate in quality.

Define market share as the revenue of product j as a fraction of the total market income. Shaked and Sutton then show a lower bound to the maximum market share. In particular, they prove that there is an ϵ so small that if the largest firm's market share fell below ϵ, then that firm would increase δ enough to get a share above that level. Further, $\epsilon \equiv \frac{1}{1+k^{\beta}}$.

To establish this result, again following Shaked and Sutton, let us suppose to the contrary that the maximum market share is below the alleged lower bound. In this supposed equilibrium, variable profits are no more than $\epsilon M\bar{Y}$ and fixed costs are also no larger (because profits are positive). Now suppose that a firm deviates from the proposed equilibrium and chooses a quality level k times higher than the maximum quality. In the new equilibrium, the deviating firm gets variable profits of at least $\alpha M\bar{Y}$ and has fixed costs of no more than $k^{\beta}\epsilon M\bar{Y}$ and so the deviating firm has profits of at least

$$\alpha M\bar{Y} - k^{\beta}\epsilon M\bar{Y}. \tag{17}$$

This deviation is certainly profitable if

$$\alpha M\bar{Y} - k^{\beta}\epsilon M\bar{Y} \quad > \quad \epsilon M\bar{Y} \Rightarrow \tag{18}$$

$$\epsilon \quad < \quad \frac{\alpha}{1+k^{\beta}}, \tag{19}$$

which completes the proof.

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