Testing for Endogenous Sunk Costs in the Retail Industry

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Abstract

This paper uses data from retail industries in Chile to test Shaked and Sutton's (1987) hypothesis of endogenous sunk costs. I find that industries which are less likely to have endogenous sunk costs display a significant negative relationship between market size and concentration. In contrast, in the supermarket industry, where investment in advertising is presumed to be more intense, the tests show that concentration does not vary with market size and is bounded away from zero.

1 Testing for Endogenous Sunk Costs in the Retail Industry: The Chilean Case

1.1 Introduction

The goal of this paper is to test the hypothesis of endogenous sunk costs proposed by Shaked and Sutton (1987) and Sutton (1991). The main implication of Sutton's model is that one observes large markets with only a few large firms instead of a large number of firms. Many theories of oligopolistic competition predict, on the contrary, that when the market increases in size more firms enter and thus concentration decreases. The novelty of Sutton's result relies on the presence of endogenous sunk costs.

There are some papers that have empirically tested Sutton's theory. Sutton himself did it for twenty narrowly defined food and drink industries across six developed countries (Sutton, 1991). Also, Robinson and Chiang (1996) analyze a cross-section of consumer and industrial goods manufacturing businesses in some of the largest markets in the US finding that most results are robust to Sutton's theory. More recently, Berry and Waldfogel (2003) test the theory for restaurants and newspapers, and Bronnenberg, Dhar and Dubé (2005) for consumer package goods' industries using a database of 31 industries located in the 50 largest US metropolitan markets. Both papers find support for Sutton's theory. Finally, Dick (2007) runs the tests for the banking industry and Ellickson (2007) studies the theory for supermarkets and beauty salons for 51 distinct geographic markets in the US, being the first work of this kind to be focused on the retail industry.

This paper is a contribution to the empirical work that focuses on retail markets, being the first one to use panel data. Furthermore, it is one of the very few that tests the theory for industries in a developing country. The only other study I have knowledge of is Rosende (2008) who tested the theory for the Brazilian manufacturing industry in 2005, finding no evidence of endogenous sunk costs.

Sutton's idea is simple, and based on a 2-stage game. At stage 1 of the game, a firm decides how much to spend in advertising (or R&D), assuming that it is possible to enhance consumers' willingness-to-pay for a given product to some minimal degree by way of a proportionate increase in fixed cost (with either no increase or only a small increase in unit variable cost). At stage 2, firms compete on prices. The difference with respect to the case of exogenous sunk costs is that in this case, the decision of a firm about incurring a greater advertising (or R&D) expenditure at stage 1 enhances the demand for its product at stage 2. Then, the game played at stage 1 might involve some escalation of the advertising outlays that leaves only a few firms able to compete in the second stage. Therefore, at the end of the game, an equilibrium is achieved where few firms compete in the second stage, all of which incurred fairly high (endogenous) sunk costs, and where this structure remains no matter how large the market becomes.

In order to test the theory I use annual data for local markets (*comunas*)[1] for the retail industry in Chile, from 1994 to 2000. To maximize the probability of defining a local market through a *comuna*, I focus on industries that are present in at least 60% of the *comunas* and for which customers primarily belong to the same *comuna* where the firm operates. This is most likely to happen within the retail industry especially if I focus on markets that are non-metropolitan. Also, I chose retail industries in non-metropolitan areas to minimize the problem of dealing with firms that have more than one establishment in that area.

I estimate lower bounds for concentration and also run a linear panel data (random effect) regression with a concentration index as the dependent variable. The key independent variable is a measure of market size. I also include a set of control variables that takes into account the

[1] A comuna is comparable to a county. It is the definition of local market we use throughout the paper.

socioeconomic differences among *comunas.* For most industries, the results show a significant negative relationship between market size and concentration. I also find that this effect is stronger in industries that I presume make little investment in the first stage of the game, replicating the results found in the literature for most oligopoly markets. Nevertheless, there is one industry, supermarkets, where I find that the elasticity of concentration with respect to the market size is not statistically different from zero for some of the specifications, replicating the results predicted by Sutton's model.

2 Related Papers

Although most of this paper is based in Sutton (1991) there are three other studies that are closely related. The first one is Campbell and Hopenhayn (2005), where two approaches are empirically contrasted to modeling competition among a large number of producers. One approach is monopolistic competition, in which the distribution of producer's actions, profits and sizes are invariant to the number of consumers. The second approach is oligopolistic competition in which producer's size increases as the number of consumers increases. In particular, the latter implies that larger markets present tougher competition as implied by lower markups. Using data for 13 retail trade industries with an important presence in 225 Metropolitan Statistical Areas in the United States, the authors compare producer's size across large and small markets and find evidence that supports the oligopolistic approach. The results are robust to different measures of producer's size, market size and to different estimation techniques, as well as being robust to the use of different control variables and sample sizes. Most of the data was obtained from the 1992 Census of Retail Trade and the 1992 County Business Patterns.

The second related paper is that of Bresnahan and Reiss (1991), where they propose to measure how fast price-cost margins fall in competition, especially in concentrated markets. They use data of geographically isolated monopolies and oligopolies and study the relationship between the number of firms in a market, the size of the market, and competition. The results suggest that competitive conduct changes quickly as the number of incumbents increases. Surprisingly, when there are 1 or 2 firms in the market the addition of an extra one makes the price go down. Nevertheless, once the market has between 3 and 5 firms, the next entrant has little effect on competitive conduct. They use a model of entry for situations in which one does not observe incumbents' or entrants' price-cost margins. They observe 202 markets that differ primarily in the number of local residents, and they estimate probit models of the equilibrium number of markets. Structural shifts in these models allow for the estimation of the effect of entry on firm profits. This paper is related to mine in that it intends to explain the features of oligopolistic markets and that the sample is composed by small geographically isolated markets. However it departs from mine in the use of a more structural model and in that it is focused particularly on concentrated markets.

The last related paper is Ellickson (2007). He tests the hypothesis of endogenous sunk costs for supermarkets in the US adapting Sutton's (1991) model of advertising to include some specific features of the supermarket competition. In particular, he assumes that supermarkets compete for customers by offering a greater variety of products. To be able to offer a large variety of products a firm needs to have invested in a large portion of land and in an advanced distribution systems. Firms that fail to match these variety increases cannot survive, so as markets grow, firms need to incur higher costs to stay in business, and this escalation of costs will prevent other firms from entering the market. He uses data from the Trade Dimension's Tenant Database for 1998, containing supermarkets with at least $2 million in yearly revenues in 51 US markets, defining the distribution areas as those using the observed networks of stores and warehouses. Ellickson estimates lower bounds of concentration showing that the supermarket industry does not fragment as market size increases. He also contrasts these results with an estimation of lower bounds for barber shops and beauty salons (clearly an exogenous cost industry). In this case the lower bound of concentration decreases monotonically to zero.

3 Data

The dataset used in this paper consists of the universe of firms competing in different economic sectors in the Chilean economy. By universe of firms I mean that for each year I observe practically all the firms in the formal sector that were economically active. The period covered is 1994-2000, that is, I have information for 7 years. The data was gathered by the Chilean Internal Revenue Service (SII from its name in Spanish) directly from the firms by means of their tax forms. For each observation (each firm) I have the following information:

1. ID: Unique identification number that allows one to track each firm throughout the years.

2. Economic Sector: International Uniform Industrial Classification (CIIU) with 5 digits. Hence one can differentiate more than 580 different sectors.[2]

[2]For this particular project we work with 17 different retail or services industries

3. Geographic location (*comuna*): Each firm is located in one of 341 municipalities, or local governments.

4. Sales: Each firm is classified into one of 13 tiers. This is enough to approximate the size of the firm.

The period 1994-2000, is characterized in general terms by the reestablishment of democracy and the consolidation of the internationalization of the Chilean economy. The average growth rate of real GDP was close to 5%, the highest being 10.49% in 1994, and the lowest being -0.73% in 1999, the latter explained by the effects of the Asian crisis.

For the analysis, I chose 13 industries that are present in 342 *comunas* along the country. Not all industries are present in each *comuna*. To have a better idea, Table 1 shows the chosen industries and their presence in local markets. For the purpose of this paper, only industries with presence in more than 60% of the *comunas* are selected.

In order to define a local market I consider each *comuna* as an isolated local market. For that reason, I chose those that were non-metropolitan areas because in metropolitan areas the relevant market of firms operating in a *comuna* is probably determined by many of the *comunas* around. In addition, I eliminate all *comunas* with more than 50,000 people because it is likely that for some industry there is more than one market in those *comunas*. In the end, I keep 198 non-metropolitan *comunas* with populations smaller than 50,000 people.

In order to show how heterogeneous the sample is, Table 2 presents the number of firms by industry and year for the chosen non-metropolitan local markets.

Given that I observe the universe of firms present in each market, I construct a Herfindahl concentration index (H) by year, industry and *comuna* using the sales variable. In order to do this, I assume that, on average, each firms' total sales correspond to the midpoint of each tier. For instance, tier 1 is composed of firms that sell between $1 and $14,999 per year, and I assume that average sales on tier 1 are $7,500. For the last tier, where firms sell more than $225 million per year, I assume that the $225 million point is the midpoint between the average sales for tier 11 and the average sales for tier 12. I tried with other rules, but the main results remained unchanged. In Table 3, it is interesting to check how heterogeneous industries are in terms of concentration with grocery stores having a Herfindahl index (averaged by *comuna*) of 0.168 and gas stations with one of 0.789. We also report the 4-firm concentration ratio, C4.

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which are presented in Table 1.

Table 1: Industries and Presence in Local Markets

Industry	CIIU Code	Comunas	Percent
Gas stations	62536	121	61.1%
Propane stores	62531	133	67.2%
Office supply stores	62547	143	72.2%
Hardware stores	62538	149	75.3%
Clothing stores	62412	151	76.3%
Cold cut stores	62131	162	81.8%
Candy stores	62181	162	81.8%
Butcher's shops	62121	176	88.9%
Greengrocer's stores	62161	177	89.4%
Supermarkets	62103	180	90.9%
Liquor stores	62111	180	90.9%
Home supply stores	62524	186	93.9%
Grocery stores	62101	192	97.0%
Total		**198**	**100.0%**

Table 2: Number of Firms by Industry and Year

Industry	1994	1995	1996	1997	1998	1999	2000
Gas stations	239	246	253	256	260	262	255
Propane stores	254	287	313	333	358	380	372
Handcraft shops	214	233	262	287	351	418	439
Hardware stores	442	470	502	524	533	538	545
Office supply stores	430	470	497	524	552	571	581
Butcher shops	1,027	1,010	995	949	917	843	807
Clothing stores	828	885	929	896	888	876	846
Candy stores	644	718	822	882	1,003	1,121	1,185
Cold cut stores	650	734	841	934	1,059	1,140	1,199
Supermarkets	1,885	2,060	2,205	2,323	2,437	2,454	2,473
Liquor stores	2,353	2,468	2,588	2,606	2,687	2,711	2,685
Greengrocer stores	1,936	2,140	2,386	2,533	2,793	2,944	3,015
Home supply stores	3,603	3,992	4,393	4,548	4,879	4,957	4,982
Grocery stores	11,579	11,720	11,795	11,404	11,380	11,037	10,641
Total	**25,870**	**27,200**	**28,519**	**28,712**	**29,746**	**29,834**	**29,586**

Table 3: Concentration Indexes by Industry

Industry	H	C4
Grocery stores	0.168	0.522
Home supply stores	0.331	0.746
Liquor stores	0.382	0.814
Greengrocer stores	0.407	0.812
Supermarkets	0.439	0.863
Butcher shops	0.503	0.923
Cold cut stores	0.537	0.914
Candy stores	0.553	0.923
Clothing stores	0.599	0.926
Office supply stores	0.650	0.966
Hardware stores	0.678	0.981
Propane stores	0.736	0.984
Gas stations	0.789	0.996

In order to measure the size of the market, it would be ideal to know the population in each *comuna*, but unfortunately this information is not available on a yearly basis. As an alternative, I construct a proxy measure of GDP by *comuna*, given that GDP is only measured at the national level. From the same database, for each year, I construct a variable that consists of the summation of all the retail sales of the firms in each *comuna*. Since I have information for all firms operating in the formal sector this seems like a good proxy for the size of the market. Information about the average retail sales by industry can be found in Table 4.

The control variables are obtained from the CASEN Survey that is one of the very few sources of information that has data at the *comuna* level. This survey measures the socioeconomic standard of living in Chile and it is available every two years. I use the surveys for years 1994, 1996, 1998 and 2000. The variables chosen are: percentage of homes with running water, percentage of homes with electricity (with a kW counter), literacy rate, average number of years of schooling, percentage of the population that had a paid job during last week, and average age. A summary with the main results taken from this survey can be found in Appendix 1.

4 Model

This section briefly describes a model that relates market size and concentration. First, I analyze the case when sunk costs are exogenous and

Table 4: Average Sales by Comunas: Bottom and Top Ten

Comunas	Annual Avg. Sales Year 2000 (USD)*
Bottom ten	
General Lagos	4,286
Laguna Blanca	6,857
Colchane	7,450
Timaukel	8,100
Camarones	9,420
Chillan Viejo	9,900
Hualaihue	10,859
Antuco	12,000
Tortel	12,643
San Juan de La Costa	13,160
Top Ten	
Santa Cruz	114,634
Limache	116,181
Rio Negro	118,222
Castro	137,665
Coyhaique	157,294
Algarrobo	160,208
Aysen	174,297
Puerto Varas	273,865
Santo Domingo	286,957
Romeral	368,333

* In dollars of year 2000

where the relationship (negative) between market size and concentration is the usual one found in most oligopoly models. Then, I analyze the case where sunk costs are endogenous, and find that under some general conditions, concentration is bounded away from zero no matter how large the market becomes.

4.1 Exogenous Sunk Costs

In order to keep the algebra simple, I show the case of an isoelastic demand schedule. All the relevant features remain if any other demand schedule is used.[3]

If p denotes price, X the quantity sold and S the total expenditure, our measure of market size, then

$$X = \frac{S}{p}, \tag{1}$$
$$p = \frac{S}{\sum x_i}.$$

Suppose that N firms enter the market at stage 1. At stage 2, firm i's profit is:

$$\Pi_i = p\left(\sum x_j\right) x_i - cx_i \tag{2}$$
$$= \frac{S}{\sum x_i} x_i - cx_i \tag{3}$$

$$\frac{\partial \Pi_i}{\partial x_i} = \frac{S\sum x_i - Sx_i}{(\sum x_i)^2} - c = 0 \tag{4}$$
$$\Leftrightarrow \sum x_i - \frac{c}{S}(\sum x_i)^2 = x_i.$$

In equilibrium $x_i = x$ for all i, then

$$\frac{\partial \Pi}{\partial x_i} = 0 \Rightarrow x = \frac{(N-1)}{N^2} \cdot \frac{S}{c}. \tag{5}$$

Now, using this expression in the demand function, I obtain the price

$$p = c\left(1 + \frac{1}{N-1}\right), \tag{6}$$

and profits

[3] A more general model can be found in Sutton (1991).

$$\Pi^* = (p - c)x_i \tag{7}$$
$$= \frac{S}{N^2}.$$

Now, an entrant at stage 1 incurs a sunk cost of F_0, so the profits become:

$$\Pi^* = \frac{S}{N^2} - F_0. \tag{8}$$

There will be entrants until profits are zero, so:

$$\frac{S}{N^2} - F_0 = 0 \tag{9}$$
$$\Rightarrow N^* = \sqrt{\frac{S}{F_0}}.$$

The number of entrants increases monotonically as the size of the market, relative to the level of setup costs, increases. Hence, a more fragmented market structure is observed. In other words, there exists a negative relation between market size (relatively to the setup costs) and market concentration.

4.2 Endogenous Sunk Costs

In order to include the endogeneity of sunk costs into the model, I need to consider the possibility of firms producing goods that have different perceived qualities (w_i). The different qualities can be achieved with different outlays in advertising or R&D at the first stage.

Let the demand function be defined as:

$$p_i = \frac{Sw_i}{\sum_{j=1}^{N} w_j x_i}. \tag{10}$$

The profit function for firm i is:

$$\Pi_i = p_i x_i - cx_i \tag{11}$$
$$= \frac{Sw_i}{\sum_j w_j x} x_i - cx_i.$$

Solving the first order conditions I get:

$$w_i x_i = \sum_j w_j x_i \left(1 - \frac{\sum_j w_j x_i}{Sw_i}\right), \tag{12}$$

and then summing over all products and rearranging, the equilibrium quantity is:

$$x_i = \frac{S}{c} \cdot \frac{N-1}{w_i \sum_j (\frac{1}{w_j})} \left[1 - \frac{N-1}{w_i \sum_j (\frac{1}{w_j})} \right]. \tag{13}$$

Solving now for prices:

$$p_i = \left[\frac{cw_i}{N-1} \sum_j \frac{1}{w_j} \right]. \tag{14}$$

Plugging x_i and p_i into the profit function and simplifying, the profit function becomes:

$$\Pi_i = S \left[1 - \frac{N-1}{w_i} \cdot \frac{1}{\sum_j (\frac{1}{w_j})} \right]^2. \tag{15}$$

With this function I can calculate a threshold level for w (w_0) that makes profits equal to zero and so any firm that chooses to produce with quality $w < w_0$ will not survive,

$$S \left[1 - \frac{N-1}{w_0} \cdot \frac{1}{\sum_j (\frac{1}{w_j})} \right]^2 = 0, \tag{16}$$

$$\Rightarrow \text{the threshold is } w_0 = \frac{N-1}{\sum_j (\frac{1}{w_j})}. \tag{17}$$

Therefore, the summation in the profit expression considers the N firms that produce with quality $w \geq w_0$.

Let us now consider a 3-stage game where in the first stage firms decide whether to enter or not. If they decide to enter they need to pay a fixed cost $F_0 > 0$. At stage 2 they choose the quality level $w \in [1, \infty)$ for an additional fixed cost $A(w)$, which makes it the total fixed cost equal to $F(w) = F_0 + A(w)$. At the final stage, firms compete à la Cournot, taking quality as fixed, as solved above. The relevant firm payoff equals: $\Pi - F(w)$.

A complete treatment of this model is developed in Sutton (1991), so here I use some simplifications and parameterizations just to show the theoretical relationship between market size and concentration.

Stage 2 At the second stage of the game, the number of firms are taken as a parameter (from stage 1) and so at this point all entrants have already incurred a fixed cost F_0 and also $A(w)$, that is the portion of fixed costs associated with quality. The symmetric Nash equilibrium outcome takes one of these two forms $\frac{\partial \Pi_i}{\partial w_i}|_{w_i = \bar{w} = 1} \leq \frac{\partial F(w)}{\partial w}|_{w=1}$ or $\frac{\partial \Pi_i}{\partial w_i}|_{w_i = \bar{w} = 1} > \frac{\partial F(w)}{\partial w}|_{w=1}$.

If it is assumed that all firms produce with quality $\bar{w} = 1$, then a firm finds it profitable to deviate slightly above $\bar{w} = 1$ if and only if $\frac{\partial \Pi_i}{\partial w_i}|_{w_i=\bar{w}=1} > \frac{\partial F(w)}{\partial w}|_{w=1}$, hence if $\frac{\partial \Pi_i}{\partial w_i}|_{w_i=\bar{w}=1} \leq \frac{\partial F(w)}{\partial w_i}|_{w=1}$ holds, and the only possible equilibrium is the one I described for the case of exogenous sunk costs, with no advertising and where every firm offers a common level of quality at equilibrium. If a firm finds it profitable to deviate, then it must be true that $\frac{\partial \Pi_i}{\partial w_i}|_{w_i=\bar{w}=1} > \frac{\partial F(w)}{\partial w}|_{w=1}$, and so it chooses a higher value of w until $\frac{\partial \Pi_i}{\partial w_i}|_{w_i=\bar{w}=1} = \frac{\partial F(w)}{\partial w}|_{w=1}$ is reached.

Now, a functional form for $F(w) = F_0 + A(w)$ is assumed with $A(w) = \frac{a}{\gamma}(w^\gamma - 1)$,where a is a parameter and the convexity of this function is such that there are diminishing returns from increases in advertising outlays. This means that higher values of γ are associated with more rapidly diminishing returns.[4] Finally, $F(w) = F_0 + \frac{a}{\gamma}(w^\gamma - 1)$ and $\frac{\partial F(w)}{\partial w}|_{w=1} = \frac{\gamma}{w}\left(F - \left(F_0 - \frac{a}{\gamma}\right)\right)$. Therefore,

$$\begin{aligned} \frac{\partial \Pi}{\partial w}|_{w=\bar{w}=1} &= \frac{\partial F(w)}{\partial w}|_{w=1} \\ 2\frac{S}{w} \cdot \frac{(N-1)^2}{N^3} &= \frac{\gamma}{w}\left(F - \left(F_0 - \frac{a}{\gamma}\right)\right) \\ F^*(N,S) &= 2\frac{S}{\gamma} \cdot \frac{(N-1)^2}{N^3} + \left(F_0 - \frac{a}{\gamma}\right), \end{aligned} \tag{18}$$

where $F^*(N,S)$ is the level of fixed outlays incurred at equilibrium by firms as a function of N and S.

Stage 1 The equilibrium structure of the industry is determined at the first stage of the game. All firms that enter the market choose the same level of w with $F^*(N,S) > F_0$. At stage 1, firms enter until $N = \sqrt{\frac{S}{F^*(N,S)}}$.[5]

$$\begin{aligned} N &= \sqrt{\frac{S}{F^*(N,S)}} \\ F^*(N,S) &= \frac{S}{N^2}. \end{aligned} \tag{19}$$

Using expression 1.19 in equation 1.18 and the zero profit condition,

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[4] I assume that γ is above some threshold such that it guarantees that we are looking for a global maximum.

[5] We will assume N to be a continuous variable to simplify the algebra, but strictly speaking, we should choose the largest integer that satisfies $N \leq \sqrt{\frac{S}{F^*(N.S)}}$

an equilibrium is found:

$$\frac{S}{N^2} = 2\frac{S}{\gamma} \cdot \frac{(N-1)^2}{N^3} + \left(F_0 - \frac{a}{\gamma}\right) \tag{20}$$
$$1 = \frac{2}{\gamma} \cdot \frac{(N-1)^2}{N} + \frac{N^2}{S}\left(F_0 - \frac{a}{\gamma}\right)$$
$$\frac{(N-1)^2}{N} = \frac{\gamma}{2}\left[1 - \frac{N^2}{S}\left(F_0 - \frac{a}{\gamma}\right)\right] = \frac{\gamma}{2}\left[1 - \frac{\left(F_0 - \frac{a}{\gamma}\right)}{F}\right].$$

This equilibrium in the advertising zone is described by the intersection of this combination of N and F and the zero profit condition. As $S \to \infty$, the above expression is transformed into

$$\frac{(N-1)^2}{N} = \frac{\gamma}{2}. \tag{21}$$

The N that solves this implicit function is $\tilde{N}(\gamma/2)$ and it only depends on γ.

Next, I analyze the shape of this relation between F and N in order to find the possible equilibria:

$$\frac{(N-1)^2}{N} = \frac{\gamma}{2}\left[1 - \frac{\left(F_0 - \frac{a}{\gamma}\right)}{F}\right] \tag{22}$$
$$F = \frac{\left(F_0 - \frac{a}{\gamma}\right)}{1 - \frac{2(N-1)^2}{\gamma N}}.$$

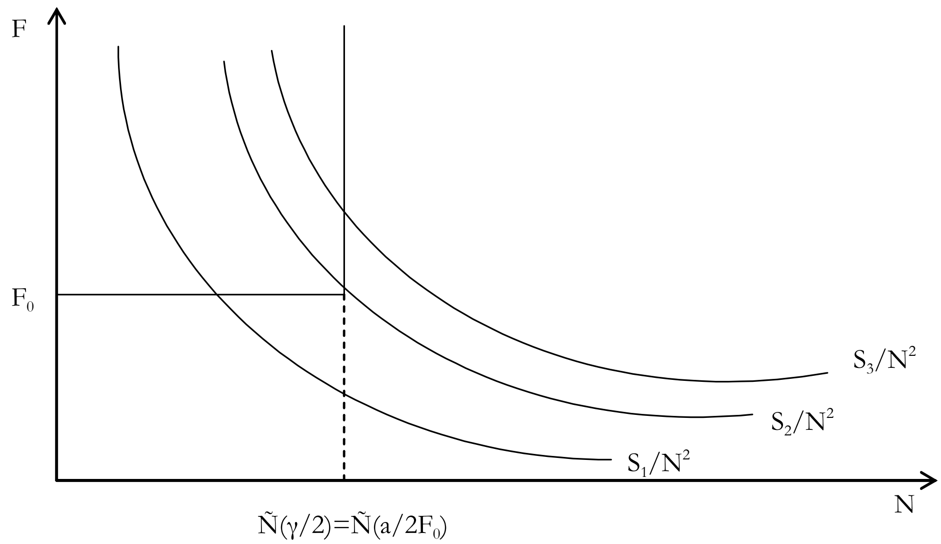
The slope of this F function is given by:

$$\frac{\partial F}{\partial N} = \frac{\left(F_0 - \frac{a}{\gamma}\right)}{\left(1 - \frac{2(N-1)^2}{\gamma N}\right)^2} \frac{2(N^2-1)}{\gamma N^2} \tag{23}$$
$$= \frac{\left(F_0 - \frac{a}{\gamma}\right)}{(+)} \frac{(+)}{(+)}.$$

The sign of the slope determines three different cases:

$$If\ F_0 = \frac{a}{\gamma} \to \frac{\partial F}{\partial N} = 0, \tag{24}$$

Figure 1: Equilibrium Configuration when: $F_0 = a/\gamma$, $(S_1 < S_2 < S_3)$



$$If\ F_0 < \frac{a}{\gamma} \rightarrow \frac{\partial F}{\partial N} < 0, \text{ and} \tag{25}$$

$$If\ F_0 > \frac{a}{\gamma} \rightarrow \frac{\partial F}{\partial N} > 0. \tag{26}$$

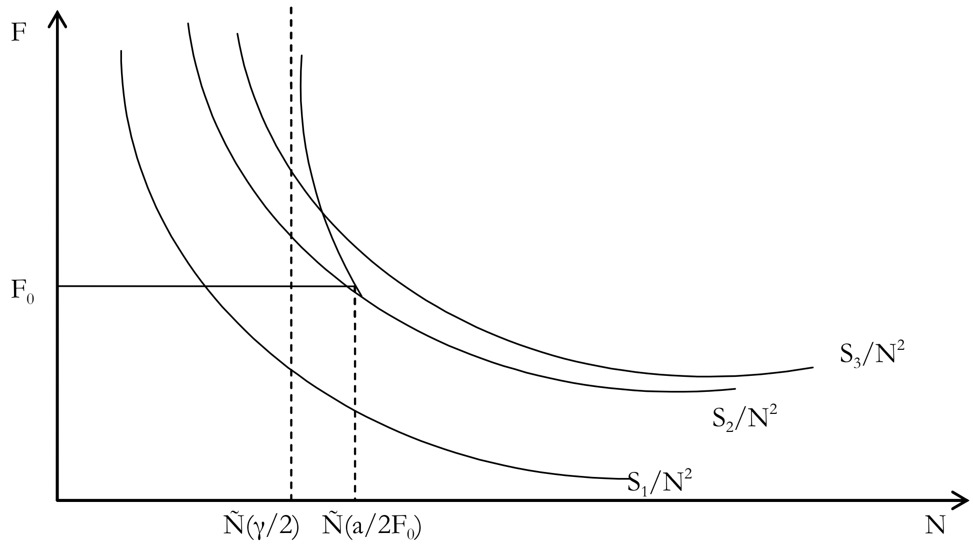
4.2.1 Case 1 $F_0 = \frac{a}{\gamma}$

As Figure 1 shows, the equilibrium can be found in two different zones. The first one, where advertising is not present since the size of the market is not large enough and where market size increases (to a level below$\tilde{N}(\gamma/2) = \tilde{N}(a/2F_0)$), implies lower concentration levels. The second is a zone where advertising is present no matter how large the market becomes, the concentration remains the same.

4.2.2 Case 2 $F_0 < \frac{a}{\gamma}$

As seen in Figure 2, when no advertising is involved, the result is the same as in case 1 up to $\tilde{N}(a/2F_0)$, but there is a region between $\tilde{N}(a/2F_0)$ and $\tilde{N}(\gamma/2)$ (with $\tilde{N}(a/2F_0) > \tilde{N}(\gamma/2)$) where the schedule is downward sloping until it reaches $F = F_0$. As S increases, N first increases until it reaches $\tilde{N}(a/2F_0)$, then after this point, further increases in S will cause a decrease in N, but asymptotically it goes to the same level as case 1 (that is, to $\tilde{N}(\gamma/2)$). In this case it is worth mentioning that the relation between market size and concentration is non-monotonic,

Figure 2: Equilibrium Configuration when: $F_0 < a/\gamma$, $(S_1 < S_2 < S_3)$



although concentration remains bounded away from zero as market size increases.

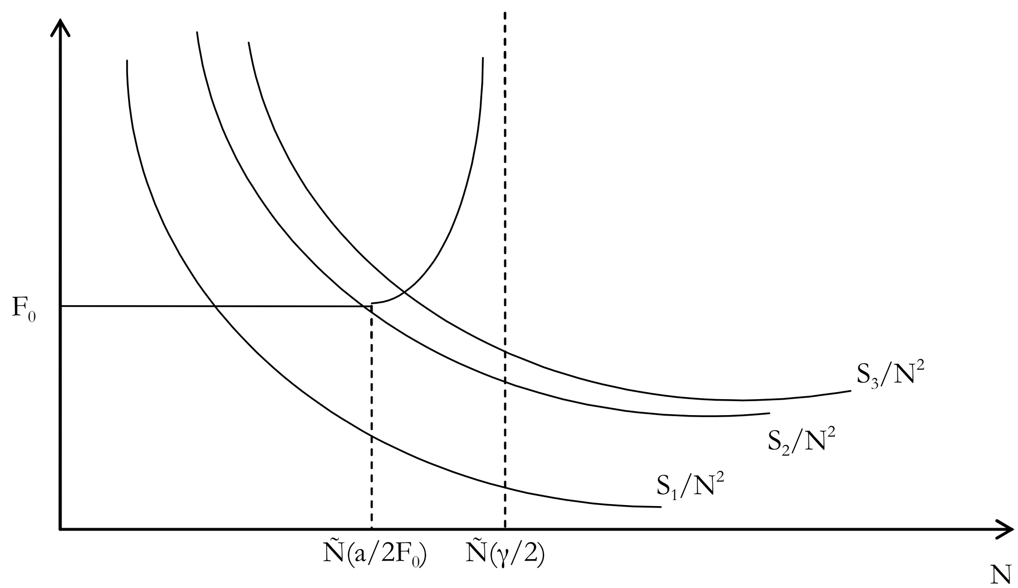
4.2.3 Case 3 $F_0 > \frac{a}{\gamma}$

In this case, as shown in Figure 3, when no advertising is present, the results are the same as case 1 and 2 only until $\tilde{N}(a/2F_0)$. After this point, the schedule that relates F and N is upward sloping until $\tilde{N}(\gamma/2)$ (for this case $\tilde{N}(a/2F_0) < \tilde{N}(\gamma/2)$). Hence, as S increases the concentration drops, but it is asymptotically bounded by $\frac{1}{\tilde{N}(\gamma/2)}$, converging to the same point as the other two cases.

5 Estimation

In this section, I test the central implications of the theory. I begin testing whether the level of concentration is bounded away from zero when market size increases in the advertising intensive industries. This is the approach taken by most empirical work in this area (Ellickson 2007, Bronnenberg et al. 2005, etc.), since the presence of market heterogeneity makes it hard to uncover a clear relationship between concentration and market size. Nevertheless, since I am using a panel dataset for the estimation that permits to control for unobserved heterogeneity, I also estimate the elasticity of concentration on market size. I expect a negative estimated coefficient for industries where I presume exogenous sunk costs are involved and one close to zero for advertising-intensive

Figure 3: Equilibrium Configuration when: $F_0 > a/\gamma$, $(S_1 < S_2 < S_3)$



industries.

5.1 The Lower Bound to Concentration

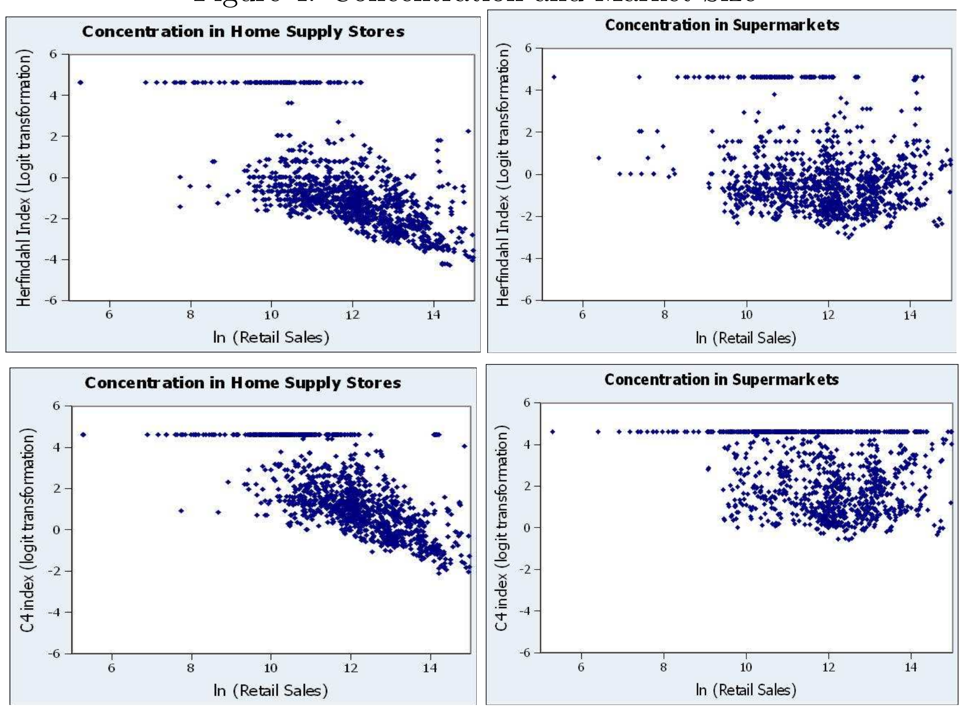
Figure 4 shows a scatter plot of the relationship between concentration and market size. The upper panels are constructed using the Herfindahl concentration index and the lower panels use C4. In both cases a logit transformation of H is plotted, $\ln \tilde{H}(S_{it}, X_{it}) = \ln\left(\frac{H_{it}}{1-H_{it}}\right)$,[6] to avoid the problem that both measures of concentration are constrained to lie between zero and one.[7] The left panels show information about home supply stores, an industry I presume relates closely to the model of exogenous sunk costs because of the low level of advertising that is usually involved. The right panels present the information for supermarkets which, on the contrary, I presume belong to the group of advertising-intensive industries which behave like Sutton predicted in his model of endogenous sunk costs.

The estimation of a lower bound for each plot is performed following Sutton (1991). I assume that the measure of concentration is generated

[6] Or $\ln \tilde{C}4(S_{it}, X_{it}) = \ln\left(\frac{C4_{it}}{1-C4_{it}}\right)$ for the case of the $C4$ concentration index.

[7] Because of the logit transformation, the Herfindahl Index and the C4's maximum value are set equal to 0.99.

Figure 4: Concentration and Market Size



by an extreme value Weibull distribution that can be estimated by a two-step approach proposed by Smith (1985, 1994), given that the maximum likelihood estimation does not work for some ranges of parameters of the Weibull.[8] In order to parameterize the lower bound, Sutton suggests estimating:

$$\tilde{C}_n = a + \frac{b}{\ln(S)} + \varepsilon_i \qquad (\varepsilon_i > 0), \tag{27}$$

where $\tilde{C}_n$ is a measure of concentration and the residuals ε_i are distributed as a two parameter Weibull ($\varepsilon \sim$Weibull(α, s)). Then,

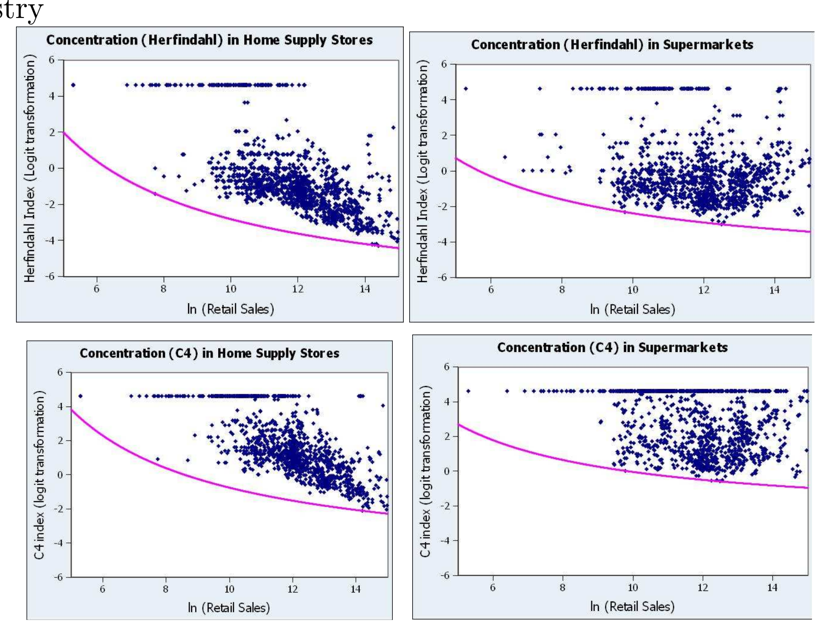
$$F(\varepsilon) = 1 - e^{\left(-\frac{\varepsilon}{s}\right)^{\alpha}}. \tag{28}$$

On a first step, the parameters a and b are estimated by the simplex method, solving:

$$\min_{a,b} \sum_{i=1}^{n} \left[\log\left(\frac{H_i}{1-H_i}\right) - \left(a + \frac{b}{\ln(S_i)}\right) \right] \tag{29}$$

[8] As Sutton (1991) estates "For $1 < \alpha \leq 2$, a local maximum of the likelihood function extist, but it does not have the usual asymptotic properties; for $0 \leq \alpha \leq 1$, no local maximum of likelihood function exist."

Figure 5: Lower Bound Estimations in Supermarket and Home Supply Industry



s.t.

$$\log\left(\frac{H_i}{1-H_i}\right) \geq \left(a + \frac{b}{\ln(S_i)}\right).$$

Then, assuming $\varepsilon \sim$Weibull(α, s), on a second step I estimate the two other parameters, α and s, by maximizing the pseudo-likelihood that was constructed by substituting the value of the estimated residuals obtained in the first step,

$$\max_{\alpha,s} \sum_{i=1}^{n} \log\left[\frac{\alpha}{s}\hat{\varepsilon}_i^{(\alpha-1)} \exp\left(-\frac{\hat{\varepsilon}_i^{\alpha}}{s}\right)\right]. \qquad (30)$$

The results obtained using the described procedure can be seen in Figure 5. At first sight the results are not that promising since both industries show that concentration will go to zero as market size increases. Nevertheless, the lack of difference is due to the presence of outliers. As Robinson and Chiang (1996), Giorgetti (2003) and Rosende (2008) state, a lower bound function can be strongly influenced by even a single outlier. In a sample of 1,224 observations it is not surprising that a few outliers distort the analysis. Following Robinson and Chiang (1996) I delete 1% of the sample that has the smallest market size and 1% of the sample that has the lowest level of concentration. This simple guideline was enough to remove a few obvious outliers but was harmless

Figure 6: Lower Bounds in Supermarket and Home Supply Industry (without outliers)

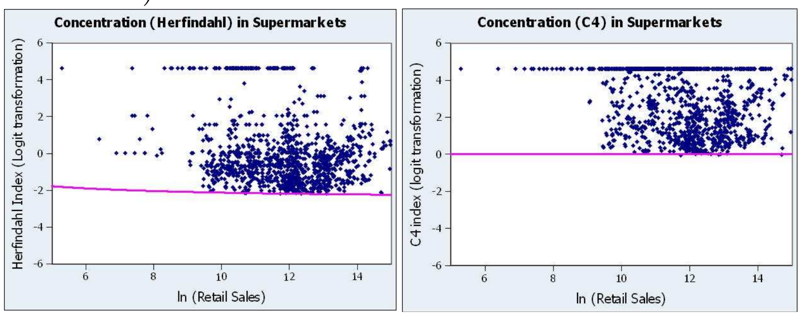


Table 5: Lower Bounds Estimation by Industry using Herfindahl

Industry	a	b	α	s	Asymptotic H%	Number of Obsevations
Clothing stores	-9.88	91.47	1.56	8.22	0.01	943
Cold cut stores	-9.19	79.28	1.63	8.13	0.01	1,024
Liquor stores	-7.99	57.26	1.74	6.74	0.03	1,228
Home supply stores	-7.65	48.20	1.73	7.10	0.05	1,263
Grocery stores	-7.48	42.55	1.56	2.96	0.06	1,335
Candy stores	-7.34	62.24	1.51	6.14	0.06	950
Greengrocer stores	-6.80	43.79	1.53	5.77	0.11	1,155
Butcher shops	-6.63	51.33	1.46	4.79	0.13	1,142
Office supply stores	-6.19	57.13	1.29	4.43	0.20	903
Handcraft shops	-5.48	36.23	1.63	13.22	0.42	618
Hardware stores	-5.37	46.56	1.50	6.29	0.46	965
Gas stations	-4.79	48.63	1.48	6.77	0.82	760
Supermarkets (wo)	-2.49	3.48	1.21	2.79	7.67	1,214
Propane stores	-1.96	3.00	1.54	8.77	12.36	811

enough to keep 98% of the data for the lower bound estimation. In fact, re-estimating and considering the criteria explained above, I obtain the differences that confirm Sutton's pattern, as seen in Figure 6 and Table 5. I repeat this procedure for some other industries, but in these cases the results change very little compared to when I do not eliminate the outliers.

The estimates show a limiting concentration close to 0 for all industries but supermarkets (without outliers) and propane stores[9], with

[9] The propane industry in Chile is composed of retailers of propane bottles. Each one of these retailers buys from only one of the three firms in charge of filling and distributing the bottles throughout the whole country. Concentration is bounded above zero, but in this case, endogenous sunk costs are probably not a good explanation. Instead, a particularity of this industry gives a better intuition. The firms in charge of the distribution have the incentive to allow for retailers to grow (up to an optimal scale) as market size increases (instead of letting new retailers in the market) since there are transportation, logistics, and paperwork costs associated with each new

limiting concentrations of around 8% and 12%, respectively. The estimated values for the parameter α range between 1 and 2, justifying the use of the method proposed by Smith (1994). Results for C4 are presented in the Appendix.

5.2 The Elasticity of Concentration on Market Size

In this section I report the results of estimating the following linear regression equation by industry:[10]

$$\ln H(S_{it}, X_{it}) = \beta_0 + \beta_1 \ln S_{it} + \beta_2 \ln X_{it} + \varepsilon_{it}, \tag{31}$$

where $\ln H_{it}$ is the natural logarithm of the Herfindahl index in the *comuna* i and year t; lnS_{it} is the natural logarithm of the market size measured by the summation of sales for all firms in market i during year t; the control variable $\ln X_{it}$ corresponds to the natural logarithm of the socioeconomic variables from the CASEN survey for *comuna* i and year t. Additionally, since H is bounded by 0 and 1, this linear specification might be inappropriate, and therefore I also run the test using a logit transformation like the one used for the estimation of the lower bounds, where the domain of the transformed variable changes from [0,1] to the real line. I also repeat these regressions for a different measure of concentration, C4, and the results are reported in the Appendix.

An alternative to this model uses, as the dependant variable, average sales, as Campbell and Hopenhayn (2005) did. They find that in most retail industries analyzed, establishments are larger in larger cities. Unfortunately, they cannot identify if the predominant effect has to do with total sales or with the number of firms in the market. On the other hand, if I use the number of firms as the dependent variable, I am not able to identify what happens to the sales of those firms. Using a concentration index, instead, allows us to have a more conclusive result as it considers both effects.

The results obtained using the described procedure can be seen in Table 7. The number of observations used in the regressions are presented in Table 6. I begin by considering the results of a linear regression (pooled OLS) and find that the estimated coefficient for the variable of interest (elasticity of concentration with respect to market size) is nega-

store. If the market is large enough, then the same firm in charge of the distribution can install a store and act as a retailer. In this case, given the characteristics of the database, it is not possible to observe the retail stores belonging to one of the three firms in charge of the distribution since the ID will be the same for all the firm's activities.

[10]Doing the regressions industry by industry allows us to ignore the setup costs in the estimation since we can assume that they are the same for all incumbent firms.

tive and significantly different from zero (at a 99% confidence level) for 12 out of 13 industries. These industries are presumed to have a small component of sunk costs since advertising (or R&D) is not usually seen. For these industries, for instance in home supply stores, greengrocer stores and office supply stores among others, I find that the estimated elasticity is the most negative, a result that is in line with the one predicted by the model with exogenous sunk costs (as market size increases the concentration decreases steadily).

Nevertheless there is one industry, supermarkets, where the elasticity coefficient is pretty close to zero, or not statistically different from zero at the 5% level. For this industry, the results behave in a fashion like the one predicted by Sutton (1991), indicating that, no matter how big the market becomes, the concentration index changes very little and it is bounded away from zero. One explanation for this result would be that firms in the supermarket industry tend to invest more in advertising, and this investment will improve their position in order to compete on prices as market size increases. Nevertheless, in this case, the supermarket industry is composed of small single-unit firms in markets belonging to non-metropolitan areas where probably advertising expenditures are not very common especially those incurred as a sunk fixed cost. In this case, probably Ellickson's (2007) explanation might be better suited, where investment in land allows firms to offer, in the future, a larger variety of products as market size increases, making entry less attractive to other firms and keeping concentration bounded above zero.

Next, I estimate the regressions again, industry by industry, but using a Panel data model (random effect) that controls for unobserved heterogeneity, since ignoring this might bias the results presented earlier. The coefficient of the elasticity for this case is again negative and significantly different from zero (at a 99% confidence level) for 12 out of 13 industries. Although the coefficients change, supermarkets still behave according to the model of endogenous sunk costs and results are even stronger, confirming the results commented upon earlier.

I also estimate the OLS and Panel R.E. models without the control variables and most of the results still hold, as the estimates and their statistical significance change very little. For supermarkets, the coefficient continues to be the lowest of all industries but it is different from zero at 99% confidence. The inclusion of these variables results in added explanatory power but only slightly changes the estimated effect of market size on concentration.

Finally, I repeat all regressions for the logit transformation of the Herfindahl and this time the coefficient on the market size variable is no longer statistically zero. Nevertheless, the coefficient for the supermar-

Table 6: Number of Observations for the Regressions

Industry	Number of Observations for regressions with control Variables	Number of Observations for regressions without control Variables
Home Supply Stores	496	1263
Office Supply Stores	392	903
Clothes Stores	381	943
Grocery Stores	509	1335
Cold Cuts	420	1024
Hardware Stores	388	965
Candy Stores	415	950
Gas Stations	323	760
Liquor Stores	489	1228
Butcher's Shops	454	1142
Greengrocer's Stores	384	877
Propane Stores	342	811
Supermarkets	475	1238

kets' regression is the closest to zero of all industries, being close to -0.3 for all the specifications. The estimation results for C4 can be found in the Appendix.

Table 7: Regressions of Concentration Ratios (H) on Market Size

	Panel R.E (over Comunas)	Pooled OLS	Panel R.E. no control Var.	Pooled OLS no control Var.
Home supply stores	-0.494 (0.032)	-0.507 (0.026)	-0.355 (0.022)	-0.428 (0.013)
Office supply stores	-0.342 (0.027)	-0.338 (0.022)	-0.289 (0.021)	-0.290 (0.012)
Clothing stores	-0.293 (0.034)	-0.315 (0.026)	-0.247 (0.025)	-0.293 (0.015)
Grocery stores	-0.281 (0.031)	-0.306 (0.027)	-0.199 (0.022)	-0.327 (0.013)
Cold cut stores	-0.265 (0.034)	-0.269 (0.027)	-0.229 (0.024)	-0.253 (0.015)
Hardware stores	-0.245 (0.026)	-0.265 (0.020)	-0.196 (0.019)	-0.242 (0.011)
Candy stores	-0.234 (0.027)	-0.247 (0.023)	-0.272 (0.021)	-0.296 (0.014)
Gas stations	-0.229 (0.025)	-0.250 (0.020)	-0.168 (0.019)	-0.199 (0.011)
Liquor stores	-0.222 (0.033)	-0.316 (0.026)	-0.162 (0.024)	-0.281 (0.014)
Butcher shops	-0.207 (0.031)	-0.243 (0.025)	-0.128 (0.020)	-0.198 (0.012)
Greengrocer stores	-0.194 (0.039)	-0.226 (0.031)	-0.188 (0.029)	-0.238 (0.017)
Propane stores	-0.112 (0.029)	-0.137 (0.025)	-0.112 (0.022)	-0.130 (0.013)
Supermarkets	-0.040+ (0.035)	-0.051* (0.027)	-0.070 (0.023)	-0.099 (0.014)

See Table 1.6 for the number of observations.
All Coefficients significant at 1% level.
*   Significant at the 10% level.
\+ Not statistically significant.

Table 8: Regressions of Concentration Ratios (H) on Market Size (Logit Transformation)

	Panel R.E (over Comunas)	Pooled OLS	Panel R.E. no control Var.	Pooled OLS no control Var.
Home supply stores	-1.177 (0.093)	-1.116 (0.070)	-0.971 (0.069)	-1.098 (0.038)
Office supply stores	-1.891 (0.164)	-1.885 (0.131)	-1.709 (0.127)	-1.732 (0.073)
Clothing stores	-1.412 (0.173)	-1.435 (0.126)	-1.146 (0.135)	-1.405 (0.076)
Grocery stores	-0.487 (0.048)	-0.463 (0.038)	-0.386 (0.043)	-0.694 (0.025)
Cold cut stores	-1.209 (0.152)	-1.173 (0.117)	-1.076 (0.118)	-1.112 (0.069)
Hardware stores	-1.466 (0.167)	-1.641 (0.124)	-1.311 (0.126)	-1.488 (0.074)
Candy stores	-1.144 (0.137)	-1.168 (0.110)	-1.478 (0.111)	-1.517 (0.070)
Gas stations	-1.653 (0.198)	-1.704 (0.163)	-1.325 (0.151)	-1.558 (0.091)
Liquor stores	-0.459 (0.085)	-0.765 (0.068)	-0.482 (0.069)	-0.752 (0.043)
Butcher shops	-0.744 (0.133)	-0.985 (0.107)	-0.533 (0.085)	-0.909 (0.054)
Greengrocer stores	-0.746 (0.167)	-0.685 (0.131)	-0.924 (0.130)	-0.914 (0.079)
Propane stores	-0.963 (0.203)	-1.114 (0.163)	-0.911 (0.156)	-1.065 (0.087)
Supermarkets	-0.300* (0.111)	-0.265** (0.086)	-0.341 (0.076)	-0.442 (0.047)

See Table 1.6 for the number of observations.
All Coefficients significant at 1% level.
* Significant at the 10% level.
** Significant at the 5% level.

6 Conclusions

The purpose of this paper is to present empirical evidence of Sutton's hypothesis of endogenous sunk costs. I present the estimations of lower bounds to show that concentration is bounded away from zero for supermarkets, an industry that I presume has an important component of endogenous sunk costs. I complement these results with the estimation of the elasticity of concentration with respect to market size, being able to control for unobserved heterogeneity captured by R.E. estimations, providing more evidence to Sutton's hypothesis. The nature of these results can be explained by investment in advertising in the initial stages or an alternative explanation proposed by Ellickson (2007), which is investment in land and/or distribution centers. This investment allows firms to offer, in the future, a larger variety of products as market size increases, making entry less attractive to other firms and keeping concentration bounded above zero. The idea of distribution centers probably does not apply since the supermarket industry I analyze here is an industry of small single-plant supermarkets in local markets so the scale is not enough to make the investment in sophisticated distribution centers profitable.

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7 Appendix: Tables and Figures

Table 9: Socieconomic Information by Comuna from the CASEN survey

Comuna	% of Homes with Electricity (with kW counter)	% of Homes with Running Water	% Population with a Paid Job (last week)	Literacy Rate	Years of Schooling
Camarones	10.5	21.5	67.0	84.2	6.4
Camina.	14.4	76.8	62.4	89.3	6.3
General Lagos	15.0	30.0	60.6	71.8	4.8
Colchane	15.8	61.1	39.1	76.9	5.5
Quinchao	36.2	26.6	48.6	94.1	7.4
Canela	37.1	29.9	34.3	83.9	6.0
Huara	37.1	47.3	55.8	90.8	7.2
Quemchi	43.8	22.4	50.0	91.2	6.6
Contulmo	46.8	25.7	40.2	83.6	5.5
Los Sauces	50.9	23.7	41.0	82.7	5.6
San Pedro De Atacama	51.0	80.1	49.8	88.3	7.0
Mariquina	51.1	43.0	38.3	88.3	6.8
Chonchi	51.6	18.7	43.7	90.1	6.2
Lonquimay	52.1	32.4	39.7	86.8	6.3
Tirua	56.7	36.8	36.8	84.6	6.1
Chile Chico	58.8	58.0	55.1	83.7	5.3
Hualaihue	61.4	27.6	42.2	91.5	6.9
Lumaco	62.0	32.2	37.3	83.4	6.1
Curaco De Velez	63.4	26.6	44.0	89.8	6.8
Collipulli	66.0	55.9	37.5	86.5	6.7
Putre	66.3	72.5	64.1	81.9	6.5
Santa Barbara	69.0	22.9	39.3	87.1	6.5
San Juan De La Costa	69.1	8.0	44.4	89.1	6.3
Punitaqui	69.2	30.6	36.7	88.4	6.6
La Higuera	69.3	49.2	46.6	84.3	5.9
Quilaco	69.8	35.9	30.2	86.7	6.2
Los Muermos	71.5	19.5	46.9	89.2	6.2
Calbuco	72.6	39.8	44.3	93.8	7.0
Fresia	74.0	22.6	47.5	91.3	6.9
Porvenir	74.0	71.9	53.0	97.7	8.5
Dalcahue	75.1	27.8	50.9	90.9	6.8
Los Lagos	76.3	10.4	36.7	88.6	6.5
Rio Ibañez	77.1	74.4	51.0	86.5	6.4
Rio Hurtado	77.4	70.0	42.6	86.9	6.2
Panguipulli	77.8	46.5	33.6	94.0	7.6
San Fabian	77.8	45.0	39.2	81.3	6.2
Combarbala	78.4	68.1	39.1	88.6	7.1
Cochamo	80.4	60.8	46.6	92.5	7.2
Santa Cruz	82.1	61.0	43.5	88.4	7.5
El Carmen	82.1	13.9	37.5	86.7	6.4
Puerto Octay	82.3	18.9	47.1	91.6	6.7
Ancud	82.4	63.9	46.9	93.6	7.8
Taltal	82.7	74.6	43.7	95.8	8.5
Maullin	83.1	59.8	48.3	92.8	7.3
Puerto Natales	83.5	72.6	51.5	94.8	7.7
Portezuelo	83.5	38.0	30.3	79.8	6.0
Lago Ranco	84.0	36.9	32.7	90.9	7.0
Ercilla	84.2	53.5	39.4	85.0	6.2
Paillaco	84.7	39.0	34.9	83.7	6.2
San Ignacio	84.9	47.3	33.8	86.6	6.4
Mulchen	85.3	69.6	37.2	90.0	7.0
Chepica	85.6	72.4	40.8	85.7	6.9
Coyhaique	85.8	83.8	50.4	92.7	8.2
Trehuaco	86.0	34.6	34.9	81.6	5.7
La Union	86.1	68.2	38.5	92.8	7.8
Sierra Gorda	86.2	99.0	49.5	96.3	8.7
Los Vilos	86.3	84.3	43.4	93.3	8.0
Cañete	86.6	67.3	36.0	87.0	7.1
Petorca	86.7	84.7	35.9	89.9	7.4

Comuna	% of Homes with Electricity (with kW counter)	% of Homes with Running Water	% Population with a Paid Job (last week)	Literacy Rate	Years of Schooling
Victoria	87.2	65.4	38.1	90.1	7.5
Rauco	87.3	43.3	44.9	85.0	6.3
Nacimiento	87.5	79.4	36.9	89.6	8.0
Cisnes	87.5	88.0	53.3	91.6	7.1
Pelluhue	87.9	54.4	39.4	78.6	6.1
Cobquecura	88.0	45.5	42.7	85.6	6.7
San Pablo	88.2	27.8	32.5	89.6	6.7
Illapel	88.2	72.2	37.9	90.1	7.9
Ninhue	88.3	24.4	34.7	78.3	5.5
Vichuquen	88.4	52.2	44.2	87.8	6.7
Quilleco	88.8	50.7	36.3	88.2	6.4
Pozo Almonte	89.0	85.7	45.6	87.6	8.3
Pichilemu	89.3	74.8	39.2	88.7	7.6
Tierra Amarilla	89.3	69.1	53.7	94.5	8.0
Freirina	89.4	79.2	39.8	93.1	7.8
Alto Del Carmen	89.4	53.9	50.6	85.3	6.2
Monte Patria	89.5	70.2	49.2	89.0	6.8
Chanco	89.7	57.2	43.5	87.7	6.5
Retiro	89.8	53.9	40.9	84.9	6.0
Caldera	90.1	90.3	50.2	96.7	9.3
Ranquil	90.3	65.1	35.1	87.5	6.6
Pemuco	90.4	52.0	38.4	87.7	6.4
Licanten	90.5	80.2	43.6	86.8	7.2
Hualañe	90.5	67.1	41.8	86.6	6.9
Cauquenes	90.7	72.7	38.1	89.8	7.3
Lebu	90.8	84.3	36.6	90.1	7.9
Traiguen	91.3	79.8	39.9	89.2	7.8
Longavi	91.3	45.1	44.6	86.8	6.2
San Nicolas	91.6	24.2	36.8	84.4	6.3
Sagrada Familia	91.7	81.6	45.4	85.6	6.4
Bulnes	91.7	66.3	39.6	87.5	7.2
Puren	91.8	88.0	36.9	92.5	7.9
Coelemu	91.9	67.7	38.8	87.5	6.7
Antuco	92.0	68.8	31.5	90.2	6.9
Paihuano	92.1	56.2	50.6	93.7	7.6
San Carlos	92.2	66.8	43.8	87.7	7.4
Lolol	92.4	9.6	36.4	76.0	5.3
Tucapel	92.4	80.1	36.7	91.0	7.1
Los Alamos	92.4	63.6	38.3	89.5	7.6
Salamanca	92.5	89.4	39.9	88.4	6.9
Puerto Varas	92.5	73.6	46.8	93.0	8.5
Quillon	92.8	27.6	35.4	82.2	6.2
Futrono	93.0	64.1	43.5	93.2	7.3
San Gregorio De Ñiquen	93.2	37.4	38.1	86.0	6.1
Huasco	93.2	91.8	40.8	96.3	9.1
Arauco	93.3	68.5	38.4	91.8	8.0
Aysen	93.4	76.9	50.2	93.2	7.7
San Javier	93.6	63.1	41.4	86.5	7.2
Catemu	93.7	84.0	42.4	90.5	7.5
Pinto	93.7	58.4	37.0	88.7	7.1
Angol	93.9	89.4	42.0	91.3	8.5
Paredones	93.9	56.0	39.7	80.8	6.1
Chanaral	94.0	97.1	41.3	95.1	8.6
Vicuña	94.0	77.5	49.4	92.1	7.7
San Rosendo	94.1	85.9	30.3	92.3	7.8
Santo Domingo	94.3	56.9	43.9	93.9	8.6
Parral	94.3	72.4	44.3	90.1	7.7
Coihueco	94.3	53.2	41.3	86.3	6.5
La Estrella	94.3	33.3	40.8	86.5	6.4

Comuna	% of Homes with Electricity (with kW counter)	% of Homes with Running Water	% Population with a Paid Job (last week)	Literacy Rate	Years of Schooling
Rio Bueno	94.4	54.1	38.3	92.1	7.3
Castro	94.5	84.4	53.1	97.0	9.0
Tocopilla	94.7	94.9	40.2	98.4	9.3
Yungay	94.8	81.7	38.5	91.5	7.8
Curanilahue	94.8	89.9	34.2	90.0	7.6
Litueche	94.9	47.5	39.4	84.7	7.3
Yumbel	95.1	64.7	32.7	88.0	6.9
Colbun	95.2	83.2	42.3	91.3	7.3
Peralillo	95.2	93.5	39.8	89.4	7.7
Llay-Llay	95.4	88.4	45.8	94.4	8.5
Cabrero	95.5	76.7	38.3	90.1	7.3
Romeral	95.5	73.4	52.9	88.9	7.1
Curacautin	95.7	92.3	39.5	92.3	8.1
Laja	95.9	73.6	35.4	90.5	8.4
Andacollo	96.1	92.9	38.7	91.7	7.5
Quirihue	96.1	85.2	40.9	89.7	8.0
Hijuelas	96.2	72.3	48.6	91.0	7.3
Yerbas Buenas	96.3	69.4	48.2	88.0	6.7
Cartagena	96.4	93.8	40.4	96.0	8.5
Molina	96.8	83.5	45.0	90.8	7.8
Algarrobo	96.8	74.7	46.2	93.0	7.9
La Ligua	97.0	91.0	47.8	92.7	8.3
Negrete	97.3	78.3	37.6	88.9	7.2
Chimbarongo	97.4	81.7	46.1	90.6	7.2
Teno	97.5	68.7	48.5	85.8	6.6
Chillan Viejo	97.5	88.0	41.4	93.6	8.7
Cabildo	97.5	95.2	43.2	91.3	7.7
Vallenar	97.6	89.0	41.1	95.2	9.0
Lanco	97.7	69.8	35.6	92.9	8.2
Olmue	97.7	58.6	41.5	95.6	8.5
Mejillones	97.8	97.0	45.8	98.7	9.5
Diego De Almagro	97.8	92.6	44.2	95.4	9.1
Pica	97.8	95.6	49.0	97.7	8.8
Marchigue	97.9	64.5	43.9	87.6	6.9
Renaico	98.3	85.4	34.7	92.0	7.4
La Cruz	98.3	78.4	50.0	96.0	8.4
Villa Alegre	98.4	80.5	41.2	90.4	8.0
Calle Larga	98.4	89.6	44.5	93.4	7.9
Rinconada	98.5	94.6	47.8	92.5	8.1
Llanquihue	98.5	97.5	46.6	93.6	7.4
San Esteban	98.5	86.6	45.1	92.0	8.1
Maria Elena	98.6	99.8	47.4	98.9	10.0
Zapallar	98.6	74.6	47.4	92.9	8.0
Purranque	98.7	88.8	38.7	91.3	7.7
Placilla	98.7	82.6	42.7	89.2	7.3
Putaendo	98.8	91.3	41.8	90.3	8.1
Rio Negro	98.9	100.0	35.3	89.6	8.0
Nancagua	99.0	90.6	47.8	90.7	7.6
Limache	99.0	92.1	44.2	96.0	9.4
Navidad	99.1	47.3	40.2	88.6	7.4
Nogales	99.1	86.1	41.6	94.5	8.4
Santa Maria	99.1	92.1	45.4	91.6	8.0
La Calera	99.2	95.0	45.0	96.1	8.9
Frutillar	99.2	77.8	44.5	93.4	8.1
Papudo	99.3	92.0	44.8	94.6	7.9
El Quisco	99.5	89.5	44.3	96.7	8.5
El Tabo	99.5	85.0	41.4	98.1	9.2
Panquehue	99.7	86.6	46.8	92.0	7.8
Cochrane	99.8	99.5	43.2	87.6	7.5

Table 10: Lower Bound Estimation by Industry using C4

Industry	a	b	α	s	Asymptotic C4%	Number of Obsevations
Hardware stores	-10.26	140.59	2.67	21.82	0.00	965
Candy stores	-9.37	113.16	2.59	31.52	0.01	950
Cold cut stores	-6.91	79.47	2.61	40.31	0.10	1,024
Gas stations	-6.41	105.03	3.20	22.25	0.16	760
Butcher shops	-5.68	61.58	2.94	67.31	0.34	1,142
Clothing stores	-5.60	65.22	2.78	50.95	0.37	943
Home supply stores	-5.35	45.80	1.88	10.53	0.47	1,263
Liquor stores	-5.17	48.44	2.11	16.34	0.56	1,228
Grocery stores	-4.67	33.79	1.71	3.95	0.93	1,335
Greengrocer stores	-4.41	41.48	1.85	11.05	1.20	1,155
Handcraft shops	-3.35	34.27	3.37	211.72	3.40	618
Office supply stores	-2.16	35.80	2.57	23.37	10.33	903
Propane stores	-1.58	24.75	5.20	1393.10	17.13	811
Supermarkets	-1.33	14.86	1.65	6.70	20.99	1,214

Table 11: Regressions of Concentration Ratios (C4) on Market Size

	Panel R.E (over Comunas)	Pooled OLS	Panel R.E. no control Var.	Pooled OLS no control Var.
Home supply stores	-0.213 (0.014)	-0.228 (0.012)	-0.147 (0.010)	-0.182 (0.006)
Office supply stores	-0.049 (0.005)	-0.044 (0.004)	-0.038 (0.004)	-0.035 (0.002)
Clothing stores	-0.066 (0.009)	-0.076 (0.008)	-0.050 (0.007)	-0.068 (0.004)
Grocery stores	-0.149 (0.017)	-0.168 (0.014)	-0.110 (0.012)	-0.162 (0.007)
Cold cut stores	-0.060 (0.011)	-0.064 (0.009)	-0.049 (0.007)	-0.060 (0.004)
Hardware stores	-0.019 (0.003)	-0.019 (0.002)	-0.013 (0.002)	-0.018 (0.001)
Candy stores	-0.054 (0.008)	-0.054 (0.007)	-0.054 (0.006)	-0.060 (0.004)
Gas stations	-0.006** (0.002)	-0.008 (0.001)	-0.004 (0.001)	-0.006 (0.001)
Liquor stores	-0.094 (0.012)	-0.120 (0.010)	-0.067 (0.009)	-0.102 (0.005)
Butcher shops	-0.058 (0.009)	-0.068 (0.007)	-0.034 (0.006)	-0.049 (0.003)
Greengrocer stores	-0.057 (0.012)	-0.079 (0.010)	-0.049 (0.009)	-0.069 (0.005)
Propane stores	-0.008* (0.004)	-0.009+ (0.004)	-0.009 (0.003)	-0.011 (0.002)
Supermarkets	-0.018+ (0.012)	-0.025* (0.009)	-0.019 (0.007)	-0.035 (0.004)

See Table 1.6 for the number of observations.
All Coefficients significant at 1% level.
** Significant at the 5% level.
* Significant at the 10% level.
+ Not statistically significant.

Table 12: Regressions of Concentration Ratios (C4) on Market Size (Logit Transformation)

	Panel R.E (over Comunas)	Pooled OLS	Panel R.E. no control Var.	Pooled OLS no control Var.
Home supply stores	-1.379 (0.086)	-1.296 (0.068)	-1.184 (0.063)	-1.272 (0.038)
Office supply stores	-1.312 (0.113)	-1.329 (0.089)	-0.989 (0.086)	-1.070 (0.048)
Clothing stores	-1.309 (0.122)	-1.404 (0.096)	-1.049 (0.092)	-1.224 (0.053)
Grocery stores	-0.529 (0.049)	-0.584 (0.040)	-0.243 (0.041)	-0.752 (0.025)
Cold cut stores	-1.086 (0.126)	-1.115 (0.102)	-0.962 (0.090)	-1.087 (0.057)
Hardware stores	-0.860 (0.097)	-0.961 (0.078)	-0.583 (0.070)	-0.890 (0.042)
Candy stores	-1.199 (0.107)	-1.234 (0.089)	-1.157 (0.084)	-1.306 (0.055)
Gas stations	-0.415 (0.072)	-0.548 (0.058)	-0.246 (0.049)	-0.404 (0.029)
Liquor stores	-0.994 (0.100)	-1.338 (0.078)	-0.767 (0.077)	-1.177 (0.047)
Butcher shops	-0.934 (0.116)	-1.165 (0.094)	-0.650 (0.079)	-0.871 (0.047)
Greengrocer stores	-0.734 (0.144)	-0.901 (0.114)	-0.693 (0.106)	-0.908 (0.062)
Propane stores	-0.353 (0.103)	-0.453 (0.091)	-0.288 (0.077)	-0.392 (0.044)
Supermarkets	-0.491 (0.123)	-0.458 (0.099)	-0.430 (0.077)	-0.600 (0.051)

See Table 1.6 for the number of observations.
All Coefficients significant at 1% level.