ONLINE APPENDIX
Entry Regulations, Product Differentiation and Determinants of Market Structure

Florin Maican* and Matilda Orth†

July 23, 2014

The online appendix consists of nine sections. Appendix A provides additional information about entry regulation in Sweden. Appendix B presents additional information about data sources. Appendix C provides additional details about the model. Appendix D provides details about the construction of the transition probabilities. Appendix E provides details about the estimation. Appendix F reports additional results based on sell-off values and the counterfactuals. Appendix G provides an alternative approach to constructing operating profits. Appendix H reports results using alternative measures of regulation. Appendix I extends the dynamic model to include spatial product differentiation.

Appendix A: Entry regulation (PBA)

On July 1, 1987, a new regulation was imposed in Sweden, the Plan and Building Act (PBA). Compared to the previous legislation, the decision process for market entry become decentralized, giving local governments power over entry in their municipality and citizens a right to appeal the

*Research Institute of Industrial Economics (IFN) and University of Gothenburg, Box 640, SE-405 30, Göteborg, Sweden, Phone +46-31-786 4866, Fax +46-31-786 4154, E-mail: florin.maican@economics.gu.se

†Research Institute of Industrial Economics (IFN), Box 55665, SE-102 15, Stockholm, Sweden, Phone +46-8-665 4531, Fax +46-8-665 4599, E-mail: matilda.orth@ifn.se

decisions. Since 1987, only minor changes have been made to the PBA. From April 1, 1992, to December 31, 1996, the PBA was slightly different, prohibiting the use of buildings from counteracting efficient competition. Since 1997, the PBA has been more or less the same as it was prior to 1992. Long time lags in the planning process make it impossible to directly evaluate the impact of decisions. In practice, differences due to policy changes seem small (Swedish Competition Authority, 2001:4). Nevertheless, the PBA is considered to be one of the major entry barriers, resulting in different outcomes, e.g., price levels, across municipalities (Swedish Competition Authority, 2001:4; Swedish Competition Authority, 2004:2). Municipalities are then, through the PBA, able to put pressure on prices. Those that constrain entry have less sales per capita, while those where large and discount stores have a higher market share also have lower prices.

Appendix B: Data sources

The DELFI data. DELFI Marknadspartner AB collects daily data on retail food stores from a variety of channels: (1) public registers, the trade press, and daily press; (2) the Swedish retailers association (SSLF); (3) Kuponginlösen AB (which handles rebate coupons collected by local stores); (4) the chains' headquarters; (5) matching customer registers from suppliers; (6) telephone interviews; (7) yearly surveys; and (8) the Swedish Retail Institute (HUI). Location, store type, owner, and chain affiliation are double checked in corporate annual reports.

Each store has an identification number that is linked to its geographical location (address). The twelve store types, based on size, location, product assortment, and so forth, are hypermarkets, department stores, large supermarkets, large grocery stores, other stores, small supermarkets, small grocery stores, convenience stores, gas station stores, mini markets, seasonal stores, and stores under construction. We drop gas station stores from the data since these stores are located in special places and offer a limited assortment of groceries and a different product bundle than ordinary stores. There are about 1,300 gas stations in the data every year: 1,317 (2001) and 1,298 (2008).

Advantages of the data are that they are collected yearly and include the total population of stores. Sales (including VAT) and sales space are collected via yearly surveys. Owing to the survey collection, a number of missing values are substituted with the median of other stores of the same type in the same local market.

Additional descriptive statistics. Table B.1 shows that the distributions of sales space and sales are surprisingly similar across stores that belong to different firms. The median store size is 350-450 square meters for stores that the belong to the three major firms. Stores without an affiliation to the main firms are substantially smaller and have lower sales.

The majority of entrants and exits are small stores (Table B.2). Among small entrants, between 25 and 75 percent were not affiliated with any of the main four firms during the 2001-2008 period (higher at the beginning of the period). In comparison, the share of large entrants without an affiliation to any of the main firms varies between 14 and 21 percent. Regarding exits, up to half of the small stores do not belong to one of the main firms, whereas up to 20 percent is found for large. Sales space and sales are surprisingly similar across stores that belong to different firms.

Figure 1 shows that the substantial outflow of stores consists of mainly stores affiliated to ICA, Axfood, Coop, and Others, i.e., well established players in the market. Hard discounters and small stores that are owned by Others dominate entry, together with Axfood. Note, however, that these observations concern only the number of stores and not capacity (size/type of store).

Figures 2 and 3 show that the average entry and exit rates share similar trends for national chains, whereas the entry rate is very high for hard discounters, and the mean exit rate is high for Others.

Table B.1: Distribution of store characteristics by firm 2001-2008

	ICA		Axfood		Coop		Others	
	Space (m^2)	Sales	Space (m^2)	Sales	Space (m^2)	Sales	Space (m^2)	Sales
Minimum	20	250	10	20	40	1,500	10	40
10th percentile	130	4,500	100	2,500	198	9,000	55	1,500
25th percentile	235	12,500	150	4,500	310	17,500	80	2,500
50th percentile	450	22,500	350	12,500	400	27,500	116	3,500
75th percentile	858	55,000	1,000	55,000	900	45,000	235	9,000
90th percentile	1,650	110,000	1,800	100,500	1,820	87,500	500	17,500
Maximum	10,000	600,000	11,000	500,000	11,00	580,000	15,000	750,000
Mean	713	46,566	698	38,848	800	44,454	301	12,902
Std. deviation	792	66,716	820	55,283	875	57,080,	772	41,701
No. of obs.	12,857		7,101		6,813		11,678	

NOTE: This table shows the distribution of number of square meters and sales of stores that belong to different firms during the period 2001-2008. Sales (incl. 12% VAT) is measured in thousands of 2001 SEK (1 USD=9.39 SEK, 1 EUR=8.34 SEK).

Table B.2: Entry and exit by store type and firm affiliation

	All	Small stores		Large stores	
		number	share not affiliated to the main firms	number	share not affiliated to the main firms
A. Entrants					
2001					
2002	71	60	0.783	11	0.000
2003	113	93	0.612	20	0.150
2004	128	118	0.305	10	0.200
2005	167	153	0.301	14	0.143
2006	126	96	0.344	30	0.167
2007	123	95	0.316	28	0.214
2008	102	80	0.250	22	0.000
B. Exits					
2001	385	366	0.511	19	0.053
2002	157	142	0.387	15	0.200
2003	240	218	0.408	22	0.091
2004	257	240	0.500	17	0.176
2005	242	209	0.478	33	0.181
2006	198	181	0.530	17	0.059
2007	193	171	0.544	22	0.181
2008					

NOTE: Large entrants and exiters are defined as the five largest store types in the DELFI data (hypermarkets, department stores, large supermarkets, large grocery stores, and other stores). The main firms are ICA, Coop, Axfood, and Bergendahls.

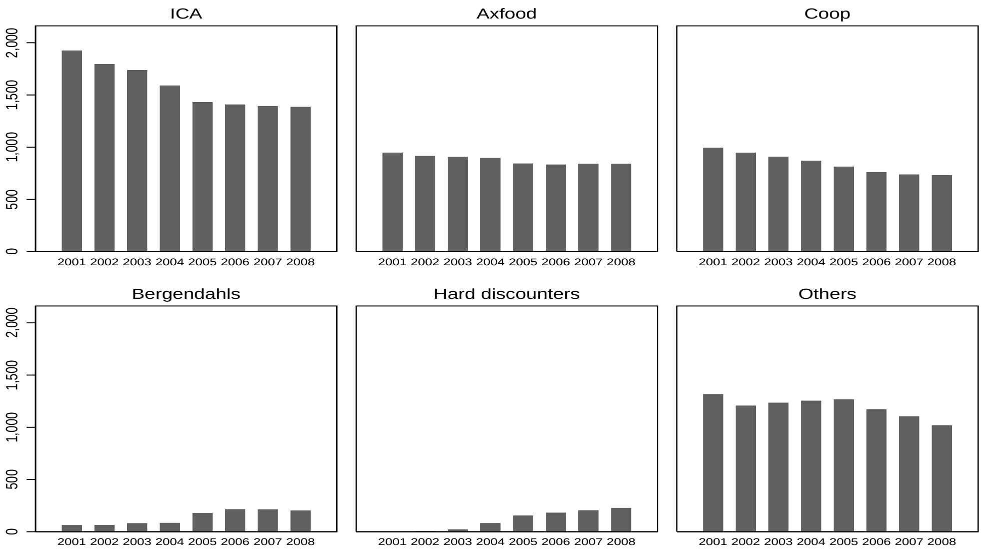

Figure 1: Total number of stores by firm affiliation 2001-2008.

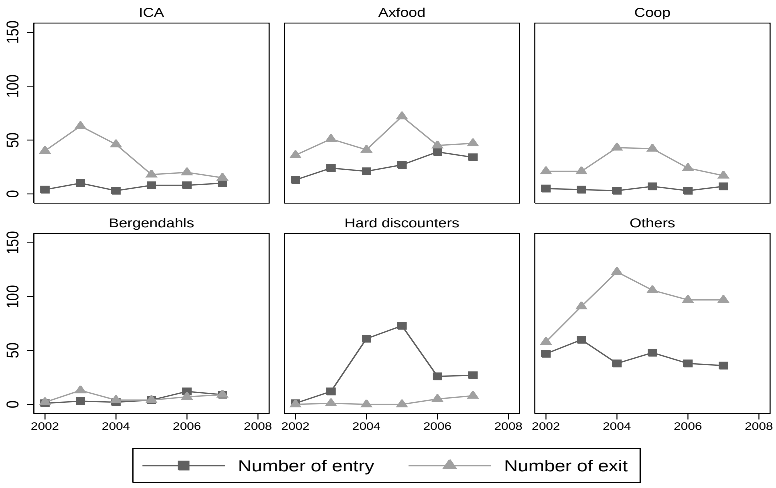

Figure 2: Total number of entries and exits by firm affiliation 2002-2007.

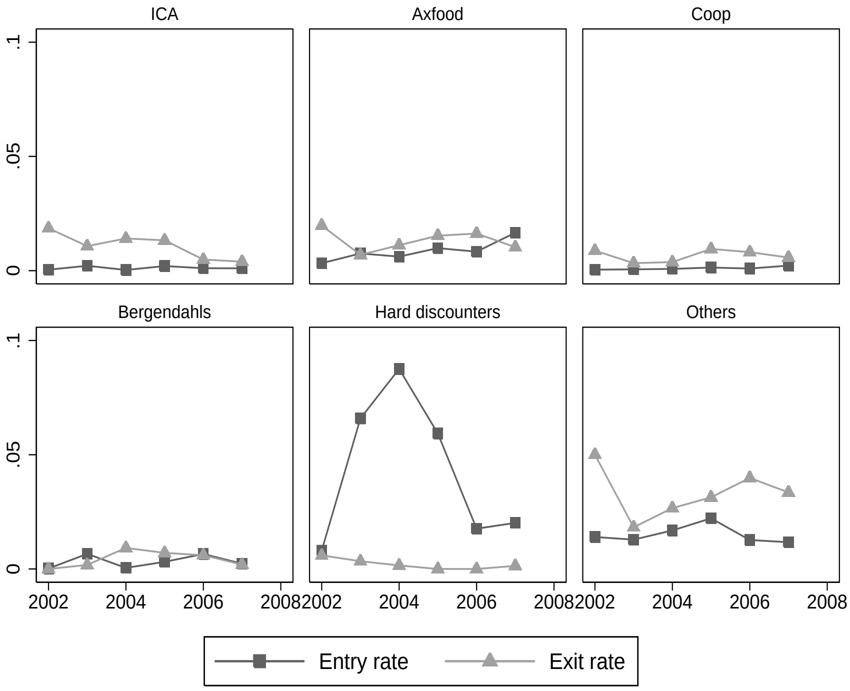

Figure 3: Mean entry and exit rates by firm affiliation and local markets 2002-2007.

Price data. The data on prices are collected by the Swedish National Organization of Pensioners (PRO) and contain yearly price information for approximately 30 products in about 1,000 stores during the 2003-2008 period.[1] The sample thus covers roughly 20 percent of the total number of stores. Stores of different sizes, formats and firms are investigated across the entire country. The "regular price", i.e., the price is without temporary promotions or discount campaigns (due to, for example, loyalty cards) is collected for each product. We form a product basket by selecting eleven products that are available in all stores and do not change their characteristics and package size. These products are as follows: sugar (Strosocker Dansukker 2 kg); cereals (Havregryn fiber AXA 800 g); mashed potatoes (Potatismos Felix); macaroni (Snabbmakaroner Kungsornen 1 kg); coffee (Gevalia mellan brygg 500 g); chocolate milk (O'boy Kraft 500 g); bread (Husman Wasabrod 500 g); biscuits (Guldmarie Goteborgskex 200 g); breakfast cereals (Familjemusli orig Finax); margarine (Bregott 600 g); caviar (Kalle kaviar Abba 190 g). Table B.3 shows the summary statistics of the price of a basket that contains one package of each of these eleven products. Large stores offer a cheaper price than small ones for the basket. For both store types, the difference between the 75th and the 25th percentile is about 30 SEK. Table B.4 presents the distribution of the basket prices for small and large stores belonging to main firms. First, for all firms, large stores offer lower prices. Second, Bergendahls offers a lower median price for our selected basket than other firms. Third, the difference between the median price from a large store and from a small store is less than 10 SEK. Fourth, ICA offers the minimum prices among the main 4 firms. The figures show that we have price variation across store types and

[1] Because our store data cover the 2001-2008 period, we compute price predictions in 2001 and 2002. We model the price as an AR(1) process with exogenous controls such us local market demand shifters. This is not restrictive since we only need predicted prices for 2 years. In addition, our demand estimates are robust to the sample choice (2001-2008 or 2003-2008). We prefer to use the full sample (2001-2008) because we use this sample when computing transition matrices in the dynamic setting.

firms.

Table B.3: Descriptive statistics of the basket price by store type, 2001-2008

Store type	Minimum	Q25	Q50	Q75	Maximum
Small	98.50	192.72	211.90	222.83	327.30
Large	152.80	188.15	203.85	215.50	278.50

NOTE: The price is in 2001 SEK (1 USD=9.39 SEK, 1 EUR=8.34 SEK). The basket consists of eleven products.

Table B.4: Descriptive statistics of the basket price by firm and store type, 2001-2008

Store type	Minimum	Q25	Q50	Q75	Maximum
Panel A: ICA					
Small	159.00	191.85	210.83	221.25	268.80
Large	152.80	187.37	203.90	215.05	266.90
Panel B: Axfood					
Small	170.20	192.53	213.18	224.03	304.10
Large	165.39	192.30	204.30	215.68	278.50
Panel C: Bergendahls					
Small	166.80	190.07	201.00	220.63	263.70
Large	164.23	186.25	196.39	210.62	262.90
Panel D: Coop					
Small	168.60	195.40	213.90	225.80	327.30
Large	164.23	188.06	204.49	216.39	266.90
Panel E: Others					
Small	98.50	192.72	213.05	222.37	275.30
Large	163.90	186.72	206.68	219.29	263.70

NOTE: The price is in 2001 SEK (1 USD=9.39 SEK, 1 EUR=8.34 SEK). The basket consists of eleven products.

Appendix C: Model: Continuation values, entry values and equilibrium

Incumbents and sell-off value. Section 3 in the paper presents the model using fixed-costs. The model can be rewritten to estimate sell-off values instead of fixed costs. The value function of an incumbent store of type z is given by the Bellman equation

$$\begin{aligned} V_z(n_z, n_{-z}, \mathbf{y}, \phi_z; \boldsymbol{\theta}) = \; & max\{\pi_z(n_z, n_{-z}, \mathbf{y}; \boldsymbol{\theta}) + \beta\phi_z, \pi_z(n_z, n_{-z}, \mathbf{y}; \boldsymbol{\theta}) + \\ & \beta VC_z(n_z, n_{-z}, \mathbf{y}; \boldsymbol{\theta})\}, \end{aligned} \tag{C-1}$$

where $\pi_z(\cdot)$ is the profit function; $VC_z(\cdot)$ is the continuation value; ϕ_z is the sell-off value; and $0 < \beta < 1$ is the discount factor. Incumbents know their scrap value ϕ_z but not the number of entrants and exits, prior to making their decision.

Incumbents perceptions. The continuation value, $VC_z(\cdot)$, is obtained by taking the expectation over the number of entrants, exits, and possible values of the profit shifters

$$\begin{aligned} VC_z(n_z, n_{-z}, \mathbf{y}; \boldsymbol{\theta}) = \; & \textstyle\sum_{e_z, e_{-z}, x_z, x_{-z}, \mathbf{y}} \int_{\phi'_z} V_z(n_z + e_z - x_z, n_{-z} + e_{-z} - x_{-z}, \\ & \mathbf{y}, \phi'_z; \boldsymbol{\theta}) p^c_z(e_z, e_{-z}, x_z, x_{-z} | n_z, n_{-z}, \mathbf{y}, \lambda^c_z = 1) \\ & p(\mathbf{y}'|\mathbf{y}) p(d\phi'_z), \end{aligned} \tag{C-2}$$

where $p^c_z(\cdot)$ is a z - incumbent's perception of the rivals' type decisions $(e_z, e_{-z}, x_z, x_{-z})$ conditional on itself continuing, i.e., $\lambda^c_z = 1$. The optimal policy for an incumbent is to exit if the draw of the fixed-cost (or sell-off value) is larger than the value of continuing in the market, which gives the probability of exit $Pr(\phi_z > VC_z(n_z, n_{-z}, \mathbf{y}; \boldsymbol{\theta})) = 1 - F^{\phi_z}(VC_z(n_z, n_{-z}, \mathbf{y}; \boldsymbol{\theta}))$.

Entrants perceptions. Potential entrants maximize the expected discounted future profits and enter if they can cover their sunk costs. They start to operate in the next period. The value of entry is

$$VE_z(n_z, n_{-z}, \mathbf{y}; \boldsymbol{\theta}) = \sum_{e_z, e_{-z}, x_z, x_{-z}, \mathbf{y}} \int_{\phi'_z} V_z(n_z + e_z - x_z, n_{-z} + e_{-z} - x_{-z}, \mathbf{y}, \phi'_z; \boldsymbol{\theta}) p^e_z(e_z, e_{-z}, x_z, x_{-z} | n_z, n_{-z}, \mathbf{y}, \lambda^e_z = 1) p(\mathbf{y}'|\mathbf{y}) p(d\phi'_z), \tag{C-3}$$

where $p^e_z(\cdot)$ is a potential entrant's perceptions of the number of entrants and exits of each type conditional on entering the market. Entry occurs if the draw from the distribution of sunk costs is smaller than the value of entry, which results in the probability of entry being $Pr(\kappa_z < VE_z(n_z, n_{-z}, \mathbf{y}; \boldsymbol{\theta})) = F^{\kappa_z}(VE_z(n_z, n_{-z}, \mathbf{y}; \boldsymbol{\theta}))$. Potential entrants choose to operate a store of type z if the expected profits are higher than those for all other types and the outside option. Hence, first, we have the condition that the entry value needs to be larger than the draw of the entry cost. Then, we have that the type (location) decision needs to give the highest expected discounted future profits among all type alternatives:

$$VE_z(n_z, n_{-z}, \mathbf{y}; \boldsymbol{\theta}) \geq \kappa_z \tag{C-4}$$

$$\beta VE_z(n_z, n_{-z}, \mathbf{y}; \boldsymbol{\theta}) \geq \beta VE_{-z}(n_z, n_{-z}, \mathbf{y}; \boldsymbol{\theta}). \tag{C-5}$$

Equilibrium. Incumbents and potential entrants make simultaneous moves, and they both form the perceptions of entry and exit among rivals. In equilibrium, these perceptions need to be consistent with stores' actual behavior. The incumbents' perceptions of rival incumbents' behavior need to be the same for all rivals of the same type. That is, all incumbents of a given type have the same probability of exit, which is the probability that the draw of the exit cost is larger than the value of continuing. Similarly, all potential entrants have the same probability of entering with a given type, i.e., they have the same probability that the draw of the entry cost is smaller than the value of entry. Thus, again the perceptions are the same for all rivals of the same store type.

For incumbents, we need to construct the perceptions of p^c_z in equation

(C-2). Conditional on a z-incumbent continuing, we have to compute the perceived probabilities of facing a particular number of entrants and exits of each type $p_z^c(e_z, e_{-z}, x_z,\ x_{-z}|n_z, n_{-z}, \mathbf{y}, \lambda_z^c = 1)$. That is, the probability that the exit draw is larger than the type-location continuation value $\phi_z > VC_z(n_z, n_{-z}, \mathbf{y}; \boldsymbol{\theta})$ is

$$p_z^c(e_z, e_{-z}, x_z, x_{-z}|n_z, n_{-z}, \mathbf{y}, \lambda_z^c = 1) = \begin{array}{l} p_z^c(e_z, e_{-z}|n_z, n_{-z}, \mathbf{y}, \lambda_z^e = 1) \\ g_z^c(x_z, n_z - 1|n_z, n_{-z}, \mathbf{y}) \\ g_{-z}^c(x_{-z}, n_{-z}|n_z, n_{-z}, \mathbf{y}). \end{array} \tag{C-6}$$

The perceptions of entry conditional on that they enter $p_z^c(\cdot)$ and the perceptions of exit of the same type $g_z^c(\cdot)$ and of the rival type $g_{-z}^c(\cdot)$ all need to be consistent with the equilibrium behavior. The assumption that competitors are identical in type implies that incumbents' perceptions of competitors' exit from each type are given by the multinomial logit probabilities in the case of more than two choices and by the binomial distribution in the case of two choices.

Potential entrants of each type are identical up to the draw of the sunk cost, so in equilibrium, all potential entrants of each type need to have the same probability of entry. The perceptions are given by

$$p_z^e(e_z, e_{-z}, x_z, x_{-z}|n_z, n_{-z}, \mathbf{y}, \lambda_z^e = 1) = \begin{array}{l} p_z^e(e_z, e_{-z}|n_z, n_{-z}, \mathbf{y}, \lambda_z^e = 1) \\ g_z^e(x_z, n_z|n_z, n_{-z}, \mathbf{y}) \\ g_{-z}^e(x_{-z}, n_{-z}|n_z, n_{-z}, \mathbf{y}), \end{array} \tag{C-7}$$

where $p_z^e(\cdot)$ are the perceptions of the entrants conditional on that they enter, while $g_z^e(\cdot)$ and $g_{-z}^e(\cdot)$ are the perceptions of exit of the same and rival types.

The solution concept is a Markov Perfect Equilibrium. Yet, there might exist more than one equilibrium. As in POB, it is guaranteed that in the recurrent class, there is only one profile of equilibrium policies that is consistent with a given data-generating process. The data will thus select the equilibrium that is played. As POB argue, the correct equilibrium will be selected if samples are large enough. For this purpose, the present paper takes advantage of the detailed data that we have access to, covering the total population of stores in Sweden for a long period of time.

Appendix D: Transition probabilities

Incumbents and sell-off value. An incumbent that continues will get the continuation value

$$VC_z(\mathbf{s};\boldsymbol{\theta}) = E^c_{\mathbf{s}'}[\pi_z(\mathbf{s}';\boldsymbol{\theta}) + \beta E_{\phi'_z}(\max\{VC_z(\mathbf{s}';\boldsymbol{\theta}), \phi'_z\}\,|\mathbf{s}')], \tag{D-8}$$

where $\mathbf{s} = (n_z, n_{-z}, \mathbf{y})$ and $\mathbf{s}' = (n'_z, n'_{-z}, \mathbf{y}')$. An incumbent will exit if the draw of the sell-off value is larger than the continuation value in a given state $\mathbf{s}$, i.e., $p^x_z(\mathbf{s}) = Pr(\phi'_z > VC_z(\mathbf{s}';\boldsymbol{\theta}))$. Thus,

$$E_{\phi'_z}(\max\{VC_z(\mathbf{s}';\boldsymbol{\theta}), \phi'_z\}\,|\mathbf{s}') = (1-p^x_z)VC_z(\mathbf{s}';\boldsymbol{\theta}) + p^x_z E[\phi'_z|\phi'_z > VC_z(\mathbf{s}';\boldsymbol{\theta})]. \tag{D-9}$$

If we assume that ϕ_z has an exponential distribution, we get $E[\phi'_z|\phi'_z > VC_z(\mathbf{s}';\boldsymbol{\theta})] = VC_z(\mathbf{s}') + \sigma_z$, which we substitute into (D-9). Using (D-8), we then get

$$VC_z(\mathbf{s};\boldsymbol{\theta}) = E^c_{\mathbf{s}'}[\pi_z(\mathbf{s}';\boldsymbol{\theta}) + \beta E_{\phi'_z}(\max\{(1-p^x_z)VC_z(\mathbf{s}';\boldsymbol{\theta}) + p^x_z(VC_z(\mathbf{s}';\boldsymbol{\theta}) + \sigma_z)\})], \tag{D-10}$$

where σ_z is a parameter in the exponential distribution that represents the inverse of the mean. We now define the continuation values, profits, and exit probabilities as vectors, i.e., $\boldsymbol{VC}_z(\cdot)$, $\boldsymbol{\pi}_z$, and $\boldsymbol{p}^x_z$. Furthermore, we define a matrix of transition probabilities $\boldsymbol{W}^c_z$ that indicates the transition from state $\mathbf{s} = (n_z, n_{-z}, \mathbf{y})$ to state $\mathbf{s}' \neq \mathbf{s}$ for type z

$$\boldsymbol{VC}_z(\cdot) = \boldsymbol{W}^c_z[\boldsymbol{\pi}_z + \beta\boldsymbol{VC}_z(\cdot) + \beta\sigma_z\boldsymbol{p}^x_z]. \tag{D-11}$$

There is no dependence over time in the transition probabilities.[2]

Incumbents: Empirical transition probabilities. To compute the continuation value, we need to calculate the expected discounted future profits that the store would gain in alternative future states. We then take weighted averages for those stores that actually continued from state $\mathbf{s}$. The idea is to use average discounted profits that are actually earned by stores that continue from state $\mathbf{s}$, i.e., to insert consistent estimates of $\boldsymbol{W}_z^c$ and $\boldsymbol{p}_z^x$ into (D-11) in order to get consistent estimates of $\boldsymbol{VC}_z(\cdot)$.

We average over the states in the recurrent class. Let R be the set of periods in state $\mathbf{s} = (n_z, n_{-z}, \mathbf{y})$:

$$R(\mathbf{s}) = \{r : \mathbf{s}_r = \mathbf{s}\},$$

where $\mathbf{s}_r = (n_{r,z}, n_{r,-z}, \mathbf{y}_r)$. Using the Markov property and summing over the independent draws of the probability of exit, we obtain consistent estimates of exit probabilities:

$$\tilde{p}_z^x(\mathbf{s}) = \frac{1}{\#R(\mathbf{s})} \sum_{r \in R(\mathbf{s})} \frac{x_{r,z}}{n_z}.$$

Let $W_{\mathbf{s},\mathbf{s}'}^c$ be the probability that an incumbent transitions to $\mathbf{s}' = (n'_z, n'_{-z}, \mathbf{y}')$ conditional on continuing in $\mathbf{s} = (n_z, n_{-z}, \mathbf{y})$. Consistent estimates for incumbents' transition probability from state $\mathbf{s}$ to $\mathbf{s}'$ are given by

$$\tilde{W}_{\mathbf{s},\mathbf{s}'}^c = \frac{\sum_{r \in R(\mathbf{s})} (n_z - x_{r,z}) \mathbf{1}_{\mathbf{s}_{r+1}=\mathbf{s}'}}{\sum_{r \in R(\mathbf{s})} (n_z - x_{r,z})}. \tag{D-12}$$

Both $\tilde{p}_z^x(\mathbf{s})$ and $\tilde{W}_{\mathbf{s},\mathbf{s}'}^c$ will converge in probability to $p_z^x(\mathbf{s})$ and $W_{\mathbf{s},\mathbf{s}'}^c$ as $R(\mathbf{s}) \to \infty$. The transitions are weighted by the number of incumbents that continue in order to capture the fact that incumbents' calculations are conditional on continuing. Now, we use equation (D-11) to get estimates

[2]The presence of serially correlated unobservables is discussed in detail in the empirical implementation in Section 4.

of $\boldsymbol{VC}_z(\cdot)$ as a function of $\boldsymbol{\pi}_z$, $\tilde{\boldsymbol{p}}_z^x$ and $\tilde{\boldsymbol{W}}_z^c$ when modeling sell-off value:

$$\widehat{\boldsymbol{VC}}_z(\cdot) = [I - \beta \tilde{\boldsymbol{W}}_z^c]^{-1} \tilde{\boldsymbol{W}}_z^c [\boldsymbol{\pi}_z + \beta \sigma_z \tilde{\boldsymbol{p}}_z^x], \tag{D-13}$$

where I is the identity matrix. Modeling fixed-costs, we have (see Section 3)

$$\widehat{\boldsymbol{VC}}_z(\cdot) = [I - \beta \tilde{\boldsymbol{W}}_z^c]^{-1} \tilde{\boldsymbol{W}}_z^c [\boldsymbol{\pi}_z - \beta \sigma_z (1 - \tilde{\boldsymbol{p}}_z^x)]. \tag{D-14}$$

The calculation of the continuation values includes inversion of the transition matrix. $\widehat{\boldsymbol{VC}}_z(\cdot)$ is the mean of the discounted values of the actual returns by players, creating a direct link to the data. Since $\tilde{\boldsymbol{W}}_z^c$ and $\tilde{\boldsymbol{p}}_z^x$ are independent of the parameters (for a known β), they only need to be constructed once. The computational burden decreases because the transitions are only constructed in the beginning of the estimation routine. The burden increases, on the other hand, in the number of states, mainly due to the inversion of the transition matrix.[3]

Entrants: Empirical transition probabilities. We follow the same approach for entrants as for incumbents and define $\boldsymbol{W}_z^e$ as the transition matrix that gives the probability that an entrant starts operating at $\mathbf{s}'$ conditional on continuing in $\mathbf{s}$:

$$\tilde{W}^e_{\mathbf{s},\mathbf{s}'} = \frac{1}{\#R(\mathbf{s})} \frac{\sum_{r \in R(\mathbf{s})} (e_{r,z}) \mathbf{1}_{\mathbf{s}_{r+1}=\mathbf{s}'}}{\sum_{r \in R(\mathbf{s})} (e_{r,z})}. \tag{D-15}$$

The expected value of entry is then

$$\begin{aligned} \widehat{\boldsymbol{VE}}_z(\cdot) = & \left[\tilde{\boldsymbol{W}}_z^e + \beta \tilde{\boldsymbol{W}}_z^e [I - \beta \tilde{\boldsymbol{W}}_z^c]^{-1} \tilde{\boldsymbol{W}}_z^c\right] \boldsymbol{\pi}_z \\ & + \left[\beta \tilde{\boldsymbol{W}}_z^e \beta \tilde{\boldsymbol{W}}_z^c [I - \beta \tilde{\boldsymbol{W}}_z^c]^{-1} \tilde{\mathbf{p}}_z^x + \beta \tilde{\boldsymbol{W}}_z^e \tilde{\mathbf{p}}_z^x\right] \sigma_z. \end{aligned} \tag{D-16}$$

[3]The number of states depends directly on the number of types/locations and on the way in which we discretize the exogenous demand and cost shifters.

Appendix E: Details on estimation

The empirical transition probability matrices used in the estimation are sparse. To compute the value functions for the states that are not observed in the data, we use a "smoothing" technique as suggested by Pakes et al. (2007). POB use kernel estimator. This paper uses b-splines and ordinary least square estimator. To estimate cost parameters, we use two different GMM estimators, i.e., an indirect inference estimator and an minimum distance estimator. The cost estimates are robust to the estimator choice.

Indirect inference: In case of indirect inference, we run ordinary least square regression on entry and exit probabilities from the data and from the model, i.e. $\mathbf{p} = \mathbf{s}\boldsymbol{\rho}$, and save the estimated coefficients $\boldsymbol{\rho}$ (data) and $\boldsymbol{\rho}(\boldsymbol{\theta})$ (model). The criterion function minimizes the distance between the regression coefficients:

$$\hat{\boldsymbol{\theta}} = \arg\max_{\boldsymbol{\theta}} [\hat{\boldsymbol{\rho}} - \hat{\boldsymbol{\rho}}(\boldsymbol{\theta})]' \mathbf{A}_R [\hat{\boldsymbol{\rho}} - \hat{\boldsymbol{\rho}}(\boldsymbol{\theta})], \tag{E-17}$$

where $\mathbf{A}_R$ is the weighting matrix, i.e., identity matrix or $Var[\boldsymbol{\rho}]^{-1}$.

Minimum distance estimator: Let $\hat{\mathbf{p}}$ be the vector of exit and entry probabilities that are observed in the data for each type and that are, therefore, used to estimate the transition matrices. The vector of theoretical probabilities $\hat{\mathbf{q}}$ is obtained from the assumed cost distributions and computed value functions. The minimum distance estimator is defined as

$$\hat{\boldsymbol{\theta}} = \arg\max_{\boldsymbol{\theta}} [\hat{\mathbf{p}} - \hat{\mathbf{q}}(\boldsymbol{\theta})]' \mathbf{A}_R [\hat{\mathbf{p}} - \hat{\mathbf{q}}(\boldsymbol{\theta})], \tag{E-18}$$

where $\mathbf{A}_R$ is the weighting matrix that is defined by the following blocks

$$\mathbf{A}_R(j,j) = \begin{bmatrix} \frac{\#R(\mathbf{s}_1)^2}{R^2} & \frac{2\#R(\mathbf{s}_1)\#R(\mathbf{s}_2)}{R^2} & \cdots & \frac{2\#R(\mathbf{s}_1)\#R(\mathbf{s}_S)}{R^2} \\ \vdots & \vdots & \vdots & \vdots \\ \frac{\#R(\mathbf{s}_S)\#R(\mathbf{s}_1)}{R^2} & \frac{2\#R(\mathbf{s}_S)\#R(\mathbf{s}_2)}{R^2} & \cdots & \frac{\#R(\mathbf{s}_S)^2}{R^2} \end{bmatrix}$$

where $\#R(\mathbf{s})$ is the number of observations in state $\mathbf{s}$ and R is the total number of observations. The matrix $\mathbf{A}_R$ reduces the fine bias, but is not the asymptotic optimal matrix.

Appendix F: Cost estimates and counterfactuals using sell-off values

Table F.1 presents parameter estimates for the distributions of sell-off value and entry costs for each store type (panel A) and the average sell-off value and entry costs in monetary units, i.e., Swedish kronor (panel B).[4] We estimate the entry cost parameters for markets with restrictive and liberal entry regulations. The estimates are obtained using a minimum distance estimator, as presented in the previous section.

We present results for the four different profit function specifications. As expected, large stores have higher sell-off values and entry costs than small stores. This result is robust across all specifications. For expositional simplicity and because the differences across markets are fairly similar, we focus on the most complex specification, $\mathcal{M}_4$. Our findings indicate that the average sell-off value is about 10 times higher for large than for small stores. Small stores have entry costs of SEK 12.11 and 13.56 million in liberal and restrictive markets. The entry costs for small stores are thus 10 percent lower in liberal than in restrictive markets. For large stores, the corresponding entry costs are SEK 110.9 and 136.5 million, i.e., the entry costs for large stores are 18 percent lower in liberal than in restrictive markets.

Store values, probability of exit, and probability of entry. We use the estimated parameters to evaluate the value of an incumbent store continuing in operation (VC_z), the value of a potential entrant (VE_z), and the probabilities of exit (p_z^x) and entry (p_z^e) for small and large stores. As noted, we assume that the sell-off value follows an exponential distribution and that the entry costs follow a unimodal distribution. The value functions are

[4] The mean values in panel B are in millions of 2001 SEK (1 USD=9.39 SEK, 1 EUR=8.34 SEK).

computed for each state and are expressed in millions of 2001 SEK. VE_z does not depend on the estimated parameter of the entry cost distribution. However, lower entry rates imply larger entry costs. The implications of differences in entry costs are explored in the counterfactual analysis. The slopes of the profit function show the toughness of short-run competition, and entry and exit have a long-run impact on store profits.

Table F.2 shows the distribution of the value functions (VC_z, VE_z) for small and large incumbents and entrants in markets with restrictive and liberal regulations. These descriptive statistics are computed using all observed states in the data. For both store types, the average VC_z and VE_z are lower in liberal than in restrictive markets. For incumbents, all distribution measures of VC_z are lower in liberal than in restrictive markets. The lower percentiles of VE_z (below median) are higher in liberal markets than in restrictive markets.

Table F.3 shows the continuation values (VC_z) and entry values (VE_z) for a selection of states. Both the continuation and the entry values increase with the exogenous market index y_{mt}. This includes profit shifters and accounts for unobserved market heterogeneity. Increasing the market index from 1 to 2 (high profit regime) in liberal (restrictive) markets, with 4 small and 3 large stores, increases VC_{small} from SEK 5 to 32 (13 to 18) million and VC_{large} from SEK 36 to 261 (121 to 163) million. The values of entry in liberal (restrictive) markets also increases: VE_{small} increases from SEK 0.8 to 5.4 (1.7 to 9.9) million and VE_{large} increases from SEK 6 to 44 (15 to 81) million. Additional large stores decrease the continuation and entry values, conditional on the index variable and the number of small stores. For example, in a market with 32 small stores and a market index of 4, the continuation and entry values in restrictive markets decrease from SEK 7.7 to 5.6 million for small stores, and from SEK 73 to 51 for large stores. For several states, an increase in exogenous profit shifters (part of market index y_{mt}) outweighs more intense competition. The net effect of increasing the number of large stores from 2 to 3 and increasing the market index from 1 to 2 in a market with 4 small stores, for example, is an increase in continuation values. These findings highlight the complexity of the market dynamics when two store types are used and local market heterogeneity is allowed for.

Considering store type differentiation allows us to analyze the trade-offs between large and small stores and to investigate the relative importance of each store type for long-run profits and market structure. For example, in liberal markets, an additional large store decreases the continuation values to a greater degree than two additional small stores in a low profit regime market ($y_{mt} = 1$) with 9 small and, 2 large stores: $VC_{small}(9, 2, 1) = 7.07$, $VC_{small}(9, 3, 1) = 5.56$, and $VC_{small}(11, 2, 1) = 5.81$. The unique possibilities that we have to evaluate these trade-offs across states clearly highlights the richness of our proposed dynamic framework and how it can be used to improve our understanding of industry dynamics.

Since considering several store types makes the presentation by individual states quite complex, we also run reduced-form regressions (OLS estimator) to summarize the impact of changes in the state space variables on VC_z, VE_z, p^e_z and p^x_z. Table F.4 shows the average marginal effects of an additional store.[5] On average, long-run profits decrease when the number of rivals increases. The decrease in long-run profits from an additional large store is about three times greater than that from an additional small store. Moreover, the reduction in long-run profits is greater for small than for large incumbents. These findings are consistent with our profit generating function estimates, and emphasize asymmetric competition between store types. In addition, the impact of an additional store on long-run profits is about 1-2 percentage points larger in restrictive than in liberal markets. The greater effects on competition on average in restrictive compared with liberal markets may suggest that restrictive markets fail to attract sufficient additional demand due to insufficient product differentiation. This result might also be explained by the fact that the marginal effect of an additional store on long-run profits is 3-4 percentage points lower for entrants (VE)

[5]We also compute the whole distribution of the marginal effects. While analyzing the entire distribution provides rich information about competition effects, the average values of marginal effects provide a consistent summary of these effects.

than for incumbents (VC). Another explanation for this result is that restrictive markets tend to consist of fewer stores, and thus, we would expect the continuation values to decrease to a greater extent. The probability of exit increases, for both small and large incumbents, when an additional small store enters in the market.

More intense competition from stores decreases the probability of entry for potential entrants. An additional large store decreases the probability of entry to a greater degree than an additional small store. However, the competitive effects on the entry values and probability of entry are similar in restrictive and liberal markets.

Counterfactual results. Our main goal is to evaluate how entry regulations influence long-run profits and market structure. Therefore, we evaluate differences in the determinants of the market structure in local markets with liberal and restrictive regulations. In this counterfactual exercise, we focus on local markets with a restrictive implementation of the regulation (Dunne et al., 2013). In these markets, we replace the parameter estimates of the entry cost distributions for each store type by those that we obtain in the liberal markets. We assume that there is no change in the regulatory environment or in how the local authorities apply the regulation. Based on the new entry cost parameters, i.e., if the restrictive markets had liberal regulations, we compute the new equilibrium values for small and large stores. This computation yields new values of incumbent stores continuing in operation (VC_z^{cf}), values of potential entrants (VE_z^{cf}), and probabilities of exit ($p_z^{x,cf}$) and entry ($p_z^{e,cf}$) for small and large stores. We then evaluate the change in long-run profits and market structure that is due to restrictive regulations. For each store type in restrictive markets, we compute the difference between the predicted long-run profits based on the new entry costs (from liberal markets) and our long-run profits obtained from the estimated entry costs in restrictive markets. Our structural estimates thus allow us to quantify how more liberal regulations change store values, entry values, long-run profits, probabilities of entry and exit, and net changes in the number of small and large stores. In contrast to previous work, we quantify the consequences of entry regulations in light of trade-offs between small and large stores.

Table F.5 shows the changes in the value functions (VC_z and VE_z) and the exit and entry probabilities (p_z^x and p_z^e) when the cost of entry in restrictive markets is reduced to be equal to the cost of entry in liberal markets for both small and large stores. In other words, we reduce the entry costs by 10 percent, i.e., from SEK 13.56 million to SEK 12.11 million for small stores. For large stores, we reduce the entry costs by 18 percent, i.e., from SEK 136.5 million to SEK 110.9 million (Table H.2).

The reduction in entry costs induces an average decrease in the continuation value VC_{small} by 0.5 percent in markets with a low profit regime (low index y). In these markets, the changes in VC_{small} varies between -4 percent and +2 percent. While we observe large variation in changes in VC_z across the states, the sum of the changes ($VC_z^{cf} - VC_z$) across the observed states is negative for both small and large stores. On the aggregate, this result suggests that there is an increase in competitive pressure from new entrants that induces a decrease in store value. The change in the probability of exit is very small, suggesting that an even higher increase in the competitive pressure would be needed to increase the exit rate for both small and large stores.[6] The reduction in entry costs in restrictive markets induces an increase of 3 percentage points in the average probability of entry. In the upper part of the distribution, the increase is as high as 13.5 percentage points. For potential entrants, the average value function of small stores (VE_{small}) increases by 9.2 percent and 8 percent in low and high profit regime markets, respectively. However, we observe large dispersion in VE_{small}, e.g., a reduction by about 4 percent for some states and an increase of up to 53.5 percent for other states. This result is not surprising because competition from the entry of large stores increases as a result of the lower entry costs for large stores. Overall, increasing the likelihood of entry for small stores without inducing the exit of other small

[6]These results are confirmed by using the profit specification $\mathcal{M}_1$. This specification implies a larger reduction in entry costs for both small and large stores, which results in a more substantial increase in the probability of exit. The results are available from the authors upon request.

stores benefits consumers because of the increased product differentiation and decreased transportation costs (travel distance) for buying food.

For large stores, the reduction in entry costs decreases the average store value function (VC_{large}) by about 15 percent. The reduction is larger in states with low profit regime, where the increase in the probability of exit is somewhat larger than in a high profit regime markets. For the observed states in the data, the sum of cumulated changes in VC_{large} is negative, suggesting that competition increases in the long run because of new entrants of both store types. By reducing the entry costs of small and large stores, the median reduction in VE_{large} is about 7 percent in low profit markets. The largest reduction is about 30 percent in low profit regime markets and about 9 percent in high profit regime markets. The complexity of the dynamics when the entry costs of two store types are reduced increases the value of entry in some states (with a larger increase in high profit markets). The reductions in entry costs in restrictive markets induce an average increase in the probability of entry by 1.8-2.8 percentage points for small stores and by 3.1-3.5 percentage points for large stores. In the upper part of the distribution, the increase is as high as 10-14 percentage points. Hence, because the policy of decreasing entry costs in restrictive markets induces a non-trivial increase in entry rates, the markets with high profit regimes have relatively higher entry rates than markets with low profit regimes.

In sum, by reducing the entry costs of both small and large stores, we find an increase in long-run competition in restrictive markets. First, competition among incumbents is more intense in restrictive markets with a low rather than a high profit regime. Second, it is important to consider the trade-off between the store types. Differentiating between the cost reductions for the two store types plays a crucial role in successfully increasing entry, which in turn leads to lower continuation values for incumbents. In addition, the policy changes concerning entry costs should account for exogenous features that drive the profitability of the market since we observe large dispersion in the long-run profits within the store type.

Decrease in entry costs for small stores. Because the traveling distance for customers to buy food has increased, the main Swedish retail firms aimed on reinventing small store formats in 2011. Using the structural estimates, we evaluate the impact of a 20 percent decrease in the entry costs for small stores on long-run profits for small and large stores in various market configurations. The difference between this counterfactual and the previous one is that the entry costs of large stores remain unchanged but we reduce the cost of small stores in all markets. In other words, we want to encourage the entry of small stores. Aggregate estimates indicate a median decrease in VC_{small} by 0.1 percent in liberal and restrictive markets. Decreasing entry costs leads to an increase in the probability of exit by about 4 percentage points for small stores and by 3 percentage points for large stores in liberal markets. The average entry value for new small stores (VE_{small}) increases by about 4 percent (0.2 percent) in restrictive (liberal) markets. The decrease in entry costs increases the probability of entry for small stores by 5 percentage points (average across states) in liberal markets and by 8 percentage points in restrictive markets. Since we aim to encourage the entry of small stores, we find a decrease by 7 percent (median value) in the value of entry for large stores in liberal markets. The long-run profits of small stores decrease by about 1 percent (3 percent) when a small (large) store enters the market.[7] These marginal effects are not sensitive to the degree of regulation in the market.

The findings show the complexity of various effects on the dynamics of the market structure as a result of changes in entry costs of different store types.[8] In sum, our counterfactual results show that there is a trade-off in changes in entry costs between small and large stores when policy aims to increase the number of small stores in a local market. Only reducing the cost of small stores in all markets increases competition between small

[7] These marginal effects are computed by regressing VC_{small} on a linear combination of the state variables (see Table F.4).

[8] Our theoretical framework relies on a good measure of profits. The otherwise detailed data from DELFI has the limitation that it lacks a measure of profits. It is therefore important to recognize potential changes in the results when using observed profits.

stores. As a result, we observe increases in both the entry and the exit of small stores, but the net effect is a greater number of stores (net entry). While the local demand conditions are important factors for entry decisions, understanding the cost differences between several store types in markets with different degrees of regulation is important for designing policies that favor the entry of small stores.

Table F.1: Estimation results of structural parameters

	Small stores				Large stores			
	$\mathcal{M}_1$	$\mathcal{M}_2$	$\mathcal{M}_3$	$\mathcal{M}_4$	$\mathcal{M}_1$	$\mathcal{M}_2$	$\mathcal{M}_3$	$\mathcal{M}_4$
A. Estimated parameters								
Sell-off value (σ)	1.639	48.511	23.786	38.255	0.167	4.812	4.850	2.759
	(0.673)	(2.023)	(1.956)	(1.572)	(0.561)	(0.682)	(0.620)	(0.618)
Entry cost restrictive markets (a)	0.214	0.222	0.223	0.221	0.021	0.024	0.024	0.024
	(0.023)	(0.023)	(0.024)	(0.027)	(0.008)	(0.007)	(0.007)	(0.007)
Entry cost liberal markets (a)	0.272	0.248	0.248	0.247	0.031	0.033	0.029	0.030
	(0.033)	(0.040)	(0.041)	(0.041)	(0.010)	(0.011)	(0.011)	(0.011)
B. Mean of sell-off value and entry cost								
Sell-off value (ϕ)	0.610	0.021	0.042	0.026	6.000	0.207	0.206	0.362
Entry cost restrictive markets (κ)	14.00	13.48	13.43	13.56	158.0	135.82	135.46	136.51
Entry cost liberal markets (κ)	11.00	12.10	12.10	12.11	109.0	102.69	116.66	110.99

NOTE: Standard errors in parentheses. $\mathcal{M}_1 - \mathcal{M}_4$ are different specification of the profit generating function (see Table H.1). Large stores are defined as the five largest store types in DELFI (hypermarkets, department stores, large supermarkets, large grocery stores, and other stores). Municipalities are defined to have restrictive (liberal) regulations if the regulation index, defined in section 3, is below (above) the median. Sell-off value of exit follows an exponential distribution. Entry cost for small stores (κ_{small}) follows a unimodal distribution with parameter a_{small}. For large stores, we estimate the parameter of μ where k_{large}=k_{small} + μ, where μ follows a unimodal distribution with parameter a_{large}. The mean values in panel B are in millions of 2001 SEK (1 USD=9.39 SEK, 1 EUR=8.34 SEK).

Table F.2: Descriptive statistics of long-run profits for incumbents and entrants by store-size and regulation

	Small stores		Large stores	
	Restrictive Markets	Liberal Markets	Restrictive Markets	Liberal Markets
A. Value function of incumbents				
Minimum	0.123	0.012	1.052	0.287
10th percentile	1.112	1.080	8.907	10.158
25th percentile	3.516	3.095	28.698	30.314
50th percentile	12.952	9.528	110.120	78.457
75th percentile	25.682	21.022	206.256	169.943
90th percentile	57.301	41.885	467.575	295.145
Maximum	200.659	92.566	1532.847	709.536
Mean	19.774	14.947	160.897	121.584
B. Value function of entrants				
Minimum	0.110	0.010	0.766	0.082
10th percentile	0.655	1.026	5.310	9.604
25th percentile	1.637	2.349	14.558	20.730
50th percentile	4.645	5.040	39.264	47.705
75th percentile	12.896	12.295	105.474	117.036
90th percentile	34.679	24.611	277.776	218.119
Maximum	100.329	117.986	766.423	1019.193
Mean	12.242	10.280	99.086	92.873

NOTE: Value functions are computed using the estimated parameters for exit and entry distributions and the most complex profit generating function specification ($\mathcal{M}_4$). Only observed local markets configurations are included. Municipalities are defined to have restrictive (liberal) regulations if the regulation index, defined in section 3, is below (above) the median. Numbers are reported in millions of 2001 SEK.

Table F.3: Predicted value of dynamic benefits (VC, VE)

Regulation	No. small stores	No. large stores	Market index	Small: VC for incumbents	Small: VE for potential entrants	Large: VC for incumbents	Large: VE for potential entrants
Liberal	4	2	2	35.7615	2.4713	284.0939	21.8547
Restrictive	4	2	2	27.1464	3.1285	228.0202	25.3365
Liberal	4	3	1	4.9464	0.8368	36.3578	6.0592
Restrictive	4	3	1	13.8529	1.7317	121.3900	15.1759
Liberal	4	3	2	32.4546	5.4598	261.9207	44.2216
Restrictive	4	3	2	18.3948	9.9998	163.4181	81.6881
Liberal	9	2	1	7.0755	0.7993	63.7712	7.0874
Restrictive	9	2	1	6.6893	0.7708	55.9924	7.9986
Liberal	9	3	1	5.5633	1.0837	45.8437	9.1689
Restrictive	9	3	1	8.8128	2.9406	79.1162	26.3689
Liberal	11	2	1	5.8128	1.4569	52.9324	13.2308
Restrictive	11	2	1	0.8027	0.4100	6.8217	2.7650
Liberal	32	8	4	7.7899	7.7885	73.7521	73.7780
Restrictive	32	8	4	1.6271	0.5430	13.9804	4.7757
Liberal	32	10	4	5.6536	5.6521	51.8410	51.7837
Restrictive	32	10	4	2.7220	1.3574	24.8102	11.3837

NOTE: The sell-off value follows an exponential distribution. Entry cost follows a unimodal distribution that allows for store type correlation. Municipalities are defined to have restrictive (liberal) regulations if the regulation index, defined in section 3, is below (above) the median. Market index groups the exogenous variables (population, income, and distance to the distribution center) at the local market level: 1 and 2 correspond to markets below the median of this index, and 3 and 4 are for markets above the median. The value functions are expressed in millions of 2001 SEK.

Table F.4: Estimation of the long-run competition effects on VC, p^x, VE, p^e

	VC				px				VE				pe			
	Small		Large		Small		Large		Small		Large		Small		Large	
	Restr.	Lib.	Restr.	Lib.	Restr.	Lib.	Restr.	Lib.	Restr.	Lib.	Restr.	Lib.	Restr.	Lib.	Restr.	Lib.
A. Small stores																
	-0.079	-0.059	-0.279	-0.259	0.0006	0.001	-0.002	-0.001	-0.049	-0.026	-0.214	-0.191	-0.005	-0.002	-0.044	-0.041
	(0.005)	(0.007)	(0.032)	(0.027)	(0.0001)	(0.0006)	(0.0016)	(0.001)	(0.004)	(0.010)	(0.034)	(0.028)	(0.002)	(0.002)	(0.009)	(0.007)
R^2	0.477				0.088				0.407				0.276			
B. Large stores																
	-0.076	-0.053	-0.267	-0.244	0.0005	0.001	-0.001	-0.001	-0.047	-0.023	-0.199	-0.175	-0.003	-0.001	-0.037	-0.034
	(0.005)	(0.009)	(0.031)	(0.026)	(0.0001)	(0.0005)	(0.001)	(0.001)	(0.004)	(0.010)	(0.033)	(0.028)	(0.002)	(0.002)	(0.008)	(0.007)
R^2	0.467				0.096				0.394				0.268			

NOTE: The marginal effects show the change in small and large stores' VC, p^x, VE, and p^e (row) of one additional small or large store in restrictive and liberal markets (column). Standard errors are in parentheses. The estimated marginal effects are obtained using average number of observed stores and the following regression specification: ln(y)=$\beta_0 + \beta_1 n_{small} + \beta_2 n_{large} + \beta_3$MarketIndex $+ \beta_4$Regulation $+ \beta_5 n_{small} \times$ Regulation $+ \beta_6 n_{large} \times$ Regulation $+ \beta_7 n_{small} \times n_{large} + u$, where $y = \{VC, p^x, VE, p^e\}$, n_{small} is the number of small stores in a local market, n_{large} is the number of large stores in a market, *Regulation* is a dummy variable that indicates type of the market, i.e., liberal or restrictive.

Table F.5: Counterfactuals: Changes in VC, p^x, VE, p^e when entry costs in liberal and regulated markets are the same

Statistic	Regulation	Growth VC		Change p^x		Growth VE		Change p^e	
		Small	Large	Small	Large	Small	Large	Small	Large
A. Below median aggregated market index									
10th percentile	Restrictive	-0.039	-0.402	0.000	0.000	-0.041	-0.305	0.000	0.000
25th percentile	Restrictive	-0.002	-0.199	0.000	0.000	-0.002	-0.163	0.000	0.000
50th percentile	Restrictive	-0.001	-0.142	0.000	0.000	-0.001	-0.073	0.000	0.000
75th percentile	Restrictive	0.001	-0.034	0.000	0.000	0.030	0.020	0.000	0.001
90th percentile	Restrictive	0.013	0.001	0.000	0.000	0.535	0.470	0.135	0.009
Mean	Restrictive	-0.005	-0.159	-1.46E-9	-2.66E-7	0.092	-0.021	0.031	0.018
Sum of changes		-9.194	-2163.134	-1.26E-7	-2.342	120.055	228.471	2.544	2.735
B. Above median aggregated market index									
10th percentile	Restrictive	-0.003	-0.025	0.000	0.000	-0.001	-0.009	0.000	-8.95E-4
25th percentile	Restrictive	-6.95E-4	-0.003	0.000	0.000	0.001	-0.003	0.000	0.000
50th percentile	Restrictive	0.001	-0.003	0.000	0.000	0.011	0.006	0.000	0.000
75th percentile	Restrictive	0.014	0.002	0.000	0.000	0.075	0.097	0.002	0.005
90th percentile	Restrictive	0.061	0.023	0.000	0.000	0.346	0.336	0.106	0.129
Mean	Restrictive	0.010	-0.005	-2.67E-10	-3.18E-8	0.080	0.088	0.035	0.028
Sum of changes		26.139	-249.796	-3.58E-8	-1.851	120.961	844.110	4.068	3.680

NOTE: Profit generating specification $\mathcal{M}_4$ is used in the counterfactual. Large stores are defined as the five largest store types in DELFI (hypermarkets, department stores, large supermarkets, large grocery stores, and other stores). Municipalities are defined to have restrictive regulations if the regulation index, defined in section 3, is below the median. The value of exit follows an exponential distribution. Entry cost follows a unimodal distribution that allows for type correlation.

Appendix G: Alternative approach to constructing operating profits

Our structural framework requires a good measure of profits. Although DELFI is a very rich store-level data set, a direct measure of profits is not provided. As an alternative approach to demand estimation, we exploit the fact that DELFI contains detailed data on a wide range of variables for each store, which provide good opportunities to construct a profit measure. First, the data include sales at the store level. Second, we assume that stores of the same type have identical costs. Third, a wide range of cost measures at the store level helps us to construct the total costs for each type.

The primary costs of retail chains include rent (cost of buildings), wages (cost of labor), distribution (logistics), product stocks, machinery/equipment, and other costs, such as marketing and promotion costs. Most of these costs enter as variable costs in the profit function, and we divide them into two groups: (i) costs that vary across both store types and markets, and (ii) costs that only vary across store types and are constant across markets. Rent, wages, and distribution costs all vary across both store types and markets because they, apart from store size, depend on the geographic location of the store. The remaining costs might only vary across store types, and we therefore assume that they are proportional to store size (in square meters and sales).

Having the sales and the variable costs for each type, we first construct the operating profits for each type and market (Holmes, 2011). Operating profits are defined as he difference between the gross profit margin and costs of rent and wages. In the estimation, we use a gross profit margin of 17 percent. Constructing Walmart's operating profits, Holmes (2011) uses a gross profit margin of 24 percent, from which he takes out 7 percent to account for the cost of running the distribution system, the fixed cost of running the central administration, and other costs. These costs are not considered variable costs.[9]

The average price per square meter for houses sold times the median number of square meters of each store type is a reasonable approximation for the cost of buildings. We assume that stores pay a rent of 12 percent of the total cost of buildings. The cost of labor is measured as average wages in the municipality times the size of the store. Number of employees, rather than number of square meters, is considered a measure of store size.[10] The total cost of labor is then calculated as wages times three employees for small stores and times five employees for large stores. Relying on these assumptions, we calculate a measure of operating profits $\tilde{\pi}_z$.

Results: estimation of the alternative profit function. Table G.1 shows the estimates of our alternative profit-generating function, without Specification (1) and with Specification (2) market fixed effects. The dependent variable is the logarithm of mean operating profits for each store type in different geographical markets. The covariates are the number of small stores, the number of large stores, the number of small and large stores squared, a store type dummy, the store type dummy interacted with the number of small and large stores, the population, the population interacted with store type, and year-market fixed effects. The estimation is done using OLS with robust standard errors.

The coefficient for the number of small stores is negative and statistically significant at the 1 percent level in both specifications. Hence, on average, an additional small competitor decreases the profits of a small store by about 2 percent (Column (1)). When we control for market heterogeneity (Column (2)), the non-linearity in the number of small stores becomes important. In this specification, the marginal effect of the number of small stores on the profits of small stores becomes positive (under 1 percent) for an average market. However, the effect is still negative for small

[9]The paper accounts for distribution costs in the main specification (Section 4). The minimum distance from each location to the nearest distribution center for each store type will be used as an approximation of distribution costs.

[10]The number of employees is taken from Statistics Sweden.

markets. In other words, the competition effect of an additional small store is smaller in large markets (with a high number of small stores). One possible explanation for this result is that stores might choose their location to avoid competition (spatial differentiation effect) in large markets.

As for small stores, the coefficients for the number of large stores and the marginal effect of the number of large stores on profits are negative. Large stores have higher profits than small stores, as indicated by the positive and significant coefficient for the dummy for large stores. The coefficient for the number of large stores squared is statistically significant at conventional levels in Specification (1) but not in Specification (2). This result might be observed because of the high prevalence of large stores over time, which in fact corresponds to local market fixed effects. An additional large store decreases the profits of small stores by about 6 percent, on average. Turning to the interactions of the number of small/large competitors and the dummy for large stores, we find clear evidence of store type competition. The profits of a large store decrease by about 9 percent due to entry of an additional large store. That is, large competitors decrease profits to a greater extent for large stores than for small ones. These findings are consistent with results reported in the static entry literature (Mazzeo, 2002) and hold for both specifications.

The coefficient for population is positive and significant at the 1 percent level in Specification (1) but negative when we control for market fixed effects in Specification (2). Small changes in population over time may have led to this result, i.e., the population is absorbed in the local market fixed effects. Furthermore, the population does not seem to influence the profits of large and small stores differently. Apart from market fixed effects, the lack of controls for spatial differentiation and differences in market size by store type is a possible explanation for this unexpected finding.

Table G.1: Profit-generating function estimates

	(1)	(2)
Number of small stores	-0.027	-0.060
	(0.006)	(0.021)
Number of small stores × Large type	0.011	0.021
	(0.003)	(0.004)
Number of small stores squared	-0.0003	0.0007
	(0.0001)	(0.0003)
Number of large stores	-0.074	-0.118
	(0.022)	(0.103)
Number of large stores × Large type	-0.036	-0.062
	(0.014)	(0.015)
Number of large stores squared	0.003	0.006
	(0.001)	(0.006)
Population	0.386	-2.355
	(0.099)	(0.985)
Population × Large type	-0.044	-0.041
	(0.079)	(0.084)
Large type	2.547	2.941
	(0.747)	(0.794)
Intercept	2.008	32.85
	(0.563)	(10.26)
Year fixed effects	yes	yes
Market fixed effects	no	yes
Adjusted R^2	0.897	0.896
Root of mean squared errors	0.347	0.443
Absolute mean errors	0.121	0.196
Number of observations	1,240	1,240

NOTE: The dependent variable is the log of estimated profits. Standard errors are presented in parentheses. Large stores are defined as the five largest store types in DELFI (hypermarkets, department stores, large supermarkets, large grocery stores, and other stores). *Large type* is a dummy variable indicating whether the store type is large.

Appendix H: Results using alternative measures of regulation

Table H.1: Profit-generating function estimates

	Model specification			
	$\mathcal{M}_1$	$\mathcal{M}_2$	$\mathcal{M}_3$	$\mathcal{M}_4$
Number of small stores	-0.068	-0.110	-0.103	-0.102
	(0.005)	(0.009)	(0.009)	(0.009)
Number of small stores × Large type	0.018	0.018	0.018	0.018
	(0.005)	(0.004)	(0.004)	(0.004)
Number of small stores squared	0.0006	0.001	0.0009	0.0009
	(0.0001)	(0.0002)	(0.0002)	(0.0002)
Number of large stores	-0.318	-0.366	-0.370	-0.373
	(0.029)	(0.043)	(0.043)	(0.043)
Number of large stores × Large type	-0.069	-0.071	-0.071	-0.071
	(0.019)	(0.014)	(0.014)	(0.014)
Number of large stores squared	0.012	0.015	0.016	0.016
	(0.001)	(0.002)	(0.002)	(0.002)
Log of population	-5.553	-22.322	-21.280	-20.808
	(0.582)	(4.776)	(6.117)	(6.107)
Log of population squared	0.314	1.146	1.125	1.100
	(0.029)	(0.224)	(0.287)	(0.287)
Log of distance to DC	-0.854	-1.181	-1.181	-1.181
	(0.221)	(0.259)	(0.259)	(0.259)
Log of distance to DC squared	0.040	0.056	0.056	0.056
	(0.010)	(0.012)	(0.012)	(0.012)
Log of income			0.794	0.791
			(0.470)	(0.470)
Log of income squared			-0.054	-0.054
	No	No	(0.029)	(0.029)
Large type	2.356	2.350	2.350	2.350
	(0.053)	(0.040)	(0.040)	(0.040)
Regulation				0.358
				(0.322)
Market fixed effects	No	Yes	Yes	Yes
Adjusted R^2	0.683	0.802	0.802	0.802
Root of mean squared errors	0.806	0.618	0.617	0.617
Absolute mean errors	0.651	0.382	0.381	0.381
Number of observations	3,820	3,820	3,820	3,820

NOTE: The dependent variable is the log of estimated average profits by store type, local market and year. OLS estimator is used. Robust standard errors in parentheses. The intercept is included. Large stores are defined as the five largest store types in DELFI (hypermarkets, department stores, large supermarkets, large grocery stores, and other stores). *Large type* is a dummy variable indicating whether the store type is large. Distance to the distribution center (DC) is defined as the median (by store type and market) of the minimum distance to the nearest distribution center for each store and firm/owner. The index defined in Section 3 is used to measure the degree of regulation in each local market.

Table H.2: Estimation results of structural parameters

	Small stores				Large stores			
	$\mathcal{M}_1$	$\mathcal{M}_2$	$\mathcal{M}_3$	$\mathcal{M}_4$	$\mathcal{M}_1$	$\mathcal{M}_2$	$\mathcal{M}_3$	$\mathcal{M}_4$
A. Estimated parameters								
Entry cost restrictive markets (a)	0.224	0.253	0.238	0.237	0.024	0.031	0.029	0.029
	(0.023)	(0.023)	(0.024)	(0.027)	(0.008)	(0.007)	(0.007)	(0.007)
Entry cost liberal markets (a)	0.305	0.345	0.336	0.340	0.030	0.036	0.035	0.036
	(0.033)	(0.040)	(0.041)	(0.041)	(0.010)	(0.011)	(0.011)	(0.011)
B. Mean of fixed cost and entry cost								
Fixed cost (ϕ)	0.072	0.008	0.009	0.009	0.651	0.076	0.084	0.079
Entry cost restrictive markets (κ)	13.37	11.83	12.56	12.61	133.99	106.77	113.25	113.14
Entry cost liberal markets (κ)	9.83	8.69	8.92	8.81	109.19	90.99	92.40	91.53

NOTE: Standard errors in parentheses. $\mathcal{M}_1 - \mathcal{M}_4$ are different specification of the profit generating function (see Table H.1). Large stores are defined as the five largest store types in DELFI (hypermarkets, department stores, large supermarkets, large grocery stores, and other stores). Municipalities are defined to have restrictive (liberal) regulations if they have a socialist (non-socialist) local government, defined in section 3. Fixed cost follows an exponential distribution. Entry cost for small stores (κ_{small}) follows a unimodal distribution with parameter a_{small}. For large stores, we estimate the parameter of μ where k_{large}=k_{small} + μ, where μ follows a unimodal distribution with parameter a_{large}. The mean values in panel B are in millions of 2001 SEK (1 USD=9.39 SEK, 1 EUR=8.34 SEK).

Appendix I: Extended model: locations

We divide each market using five-digit zip codes that provide us with a number of locations that share borders in line those used with Seim (2006), who uses census tracts. The zip codes are irregular areas that vary in size. The advantage of using zip codes is that they are constructed for mail delivery and therefore consider geographical characteristics such as main roads, waterways, and forested areas. Hence, we believe that zip codes are an appropriate way to divide markets. In order to calculate distances between cells, we place all stores at the population-weighted midpoint of the zip code. Based on the idea of distance bands in Seim (2006), we calculate a radius from the midpoint of each zip code, which gives us distance bands within a certain distance from each cell. The splitting of markets into locations (cells) is illustrated in Figure 7. The general idea of spatial differentiation is that stores that are located in the first neighboring cell (cell 1) compete most intensely with competitors in the same cell. The intensity of competition declines for competitors in the second neighboring cells (cells 2, 5, and 4), followed by even lower intensity in the third (cells 3, 6, 9, 8, and 7).[11] Thus, we expect the competition intensity to be strongest in the first neighboring cell and then to decrease as we move to further away from the actual location.[12]

Empirical implementation: locations. The present model can be extended by including differentiation in location. This new model has three main dimensions: store, location, and type. To account for spatial differ-

[11]Following Seim (2006), distances between zip codes are computed using the Haversine formula. Based on latitude-longitude coordinate data, the distance d between two points A and B is given by

$$d_{A,B} = 2\text{Rarcsin}\left[\min\left((\sin(0.5(x_B - x_A)))^2 + \cos(x_A)\cos(x_B)(\sin(0.5(y_B - y_A)))^2\right)^{0.5}, 1\right]$$

where R = 6,373 kilometers denotes the radius of the earth, x_A is longitude and x_B latitude.

[12]Descriptive statistics show that for 85 (95) percent of all Swedish consumers, the nearest store was within 5 (10) kilometers in 2001, whereas the corresponding figure is 83 (94) percent in 2008.

entiation in detail, we use a large number of locations. Grouping locations based on distance reduces the dimensionality of the competition parameters. Adding the following assumption reduces the competition parameter space: a store faces competition not from the stores in each location of the market but from neighboring locations, which are defined by the distance between locations (Seim, 2006). For example, three distance bands specification is the most commonly used in the empirical literature (Figure 7). In this case, the profit function can then be specified as

$$\begin{aligned}\tilde{\pi}_{zlt} = \ & \gamma_0 + \gamma_{zl} n_{zlt} + n_{zlt}\mathbf{dm}_{zl}\boldsymbol{\gamma}_{zl} + \textstyle\sum_{k \in L} n_{zkt}\gamma_{zk} + \\ & \mathbf{n}_{-zlt}\boldsymbol{\gamma}_{-zl} + \mathbf{n}_{-zlt}\mathbf{dm}_{zl}\boldsymbol{\gamma}_{-zld} + \textstyle\sum_{k \in L} \mathbf{n}_{-zkt}\boldsymbol{\gamma}_{-zk} + \\ & \mathbf{dm}_{zl}\boldsymbol{\gamma}_d + \mathbf{y}_{lt}\boldsymbol{\gamma}_y + \xi_l + \tau_t + \epsilon_{zlt},\end{aligned} \tag{I-19}$$

where n_{zlt} and $\mathbf{n}_{-zlt}$ are the number of stores of own and rival types in location l; $\mathbf{dm}_{zl}$ is a dummy matrix for types in location l; n_{zkt} and $\mathbf{n}_{-zkt}$ are own and rival store types within the distance band k from location l; L is the number of locations in a market; $\mathbf{y}_{lt}$ represents exogenous state variables; and ϵ_{zlt} is an i.i.d. error term.

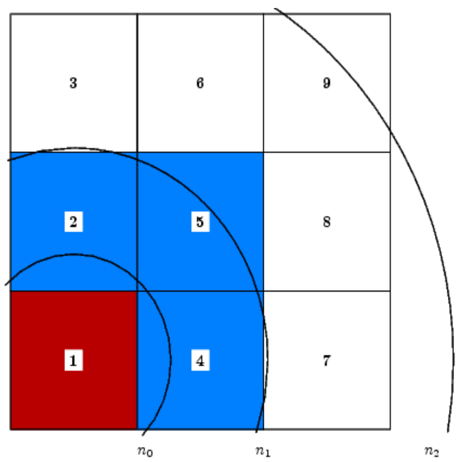

Figure 4: Illustration of distance bands

References

Dunne, T., S. Klimek, M. Roberts, and Y. Xu (2013): "Entry, Exit and the Determinants of Market Structure," *The RAND Journal of Economics (*forthcoming*)*.

Holmes, T. (2011): "The Diffusion of Wal-Mart and Economies of Density," *Econometrica*, 79(1), 253–302.

Mazzeo, M. (2002): "Product Choice and Oligopoly Market Structure," *The RAND Journal of Economics*, 33, 221–242.

Pakes, A., M. Ostrovsky, and S. Berry (2007): "Simple Estimators for the Parameters of Discrete Dynamic Games (with Entry/Exit Examples)," *The RAND Journal of Economics*, 38(2), 373–399.

Seim, K. (2006): "An Empirical Model Of Firm Entry with Endogenous Product-Type Choices," *The RAND Journal of Economics*, 37(3), 619–640.

Swedish Competition Authority (2001:4): "Kan Kommunerna Pressa Matpriserna? (Can the Municipalities Put Pressure on Prices?)," Technical Report 4, Stockholm.

——— (2004:2): "Konsumenterna, Matpriserna och Konkurrensen (Consumers, Retail Food Prices, and Competition)," Technical Report 2, Stockholm.