ENTRY REGULATIONS, WELFARE AND DETERMINANTS OF MARKET STRUCTURE*

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Welfare effects of entry regulations are theoretically ambiguous in differentiated product markets. We use a dynamic oligopoly model of entry and exit with store-type differentiation and static price setting to evaluate how entry regulations affect long-run profitability, market structure and welfare. Based on unique data for all retail food stores in Sweden, we estimate demand, recover variable profits, and estimate entry costs and fixed costs by store type. Counterfactual policy experiments show that welfare increases when competition is enhanced by lower entry costs. Protecting small stores by imposing licensing fees on large stores is not welfare enhancing.

Keywords: Imperfect competition; product differentiation; retail markets; entry; exit; sunk costs; welfare.

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1. INTRODUCTION

Entry regulations are common in retail markets and are frequently debated among policymakers.[2] The welfare effects of such regulations in differentiated product markets are theoretically ambiguous. Entry leads to more intense competition affecting future decisions regarding pricing, entry and exit. Consumers can benefit from lower prices, higher quality and variety. Social welfare, however, can decrease because more stores have to pay sunk costs and fixed costs and because entrants take market share from incumbents. The net change in welfare is an empirical question that depends on how consumers substitute between different types of stores in addition to the nature of asymmetric competition between store types over time. This paper quantifies the impact of entry regulations on long-run profits, the evolution of market structure, and welfare.

We use a dynamic oligopoly model of entry and exit with store-type differentiation and static price setting to evaluate entry regulations in retail. The model is applied to unique data on store characteristics, prices, local markets and regulations in Sweden during the 2001-2008 period. First, we estimate a discrete choice demand model to analyze how consumers choose stores. We use the demand estimates to calculate variable profits in all possible states using the Nash-Bertrand equilibrium assumption together with a marginal cost function. Second, we use the dynamic game of entry and exit to recover entry costs and fixed costs. By matching the observed entry and exit rates in the data to those predicted by the dynamic model, we estimate the parameters of entry cost and fixed cost distributions for small and large stores in local markets with liberal and restrictive entry regulations. Third, we use the structural estimates to re-compute equilibrium outcomes and welfare under a number of alternative entry regulation regimes that are frequently debated among policymakers.

Entry regulations are common in OECD countries. While countries like the U.K. and France explicitly regulate large entrants, more flexible zoning laws exist, for instance, in the U.S. Each store seeking entry into retail markets is typically required to file a formal application with the local government. Local governments approve or reject applications after evaluating the potential impact of the store's entry on aspects like price, market share and concentration. Entry regulations affect store costs because stores require a physical location to operate and buildings constitute a major portion of capital expenses. Municipal administrative processes also contribute to regulatory costs. By influencing store costs, entry regulations affect the intensity of competition and can have anti-competitive effects (Pozzi and Schivardi, 2016).

[2] See, e.g., European Competition Network (2011); European Commission (2012).

We further develop the framework of Pakes, Ostrovsky, Berry (2007) [POB] to account for demand, entry and exit in differentiated product markets. The main advantage of our model is that we can calculate welfare measures (consumer and producer surplus) under different regulatory regimes. Our counterfactual experiments exploit the role of dynamics in long-run changes in profitability, market structure and welfare under alternative entry regulations. A dynamic approach for differentiated products is crucial to accurately assess how changes in entry regulations induce tradeoffs between responses in demand and the supply of stores. In retail, modeling the supply of store types is challenging because of the nonlinear nature of important supply-side characteristics such as entry and exit. There is a strong trend toward larger but fewer stores in food retailing. In Sweden, for instance, large stores represent only 20 percent of the total number of stores but over 60 percent of aggregate sales and sales space (Table 1).[3] Food consumption represents a large share of private consumption, and the welfare implications of various policies are likely to be substantial.[4]

Our paper contributes to the literature on estimation of dynamic oligopoly models based on Ericson and Pakes (1995).[5] We add to the few papers that combine a demand model of differentiated products with a dynamic game of entry and exit to evaluate the importance of dynamics for welfare (e.g., Gowrisankaran and Town, 1997; Benkard, 2004; Ryan, 2012; Collard-Wexler, 2013; Sweeting, 2013; Fowlie et al., 2016). In particular, we contribute to recent applications of POB, i.e., Dunne et al. (2013), who model identical firms, and Fan and Xiao (2015), who allow for heterogeneous option values of waiting. To the best of our knowledge, no study has combined a dynamic oligopoly model of demand, entry and exit for differentiated products with detailed store-level data to evaluate the effects of regulations on welfare in the retail industry. Our dynamic framework deviates from previous works on optimal entry that use static models of entry and demand by emphasizing the role of dynamics and entry regulation for market structure.[6] Finally, we contribute to recent work

[3]In Sweden, all stores (not only large stores) are affected by entry regulations. Swedish food retailers operate well-defined store types, are highly independent and determine their own prices, thus reducing the influence of national firms.

[4]Total annual food expenditures in the US exceed USD 1,100 billion; the average household purchases groceries every week and spends as much as an hour per trip. Food consumption represents approximately 10 percent of private consumption in the US and up to 20 percent of private consumption in most European countries.

[5]See Aguirregabiria and Mira (2007); Bajari et al. (2007); Pakes et al. (2007); Pesendorfer and Schmidt-Dengler (2008). Ackerberg et al. (2007) and Doraszelski and Pakes (2007) provide surveys.

[6]For contributions considering a static entry game with demand, see Berry and Waldfogel (1999), Gowrisankaran and Krainer (2011), Maruyama (2011), and Berry et al. (2016). Our study also relates to the literature on retail: chain expansion (e.g., Holmes, 2011 and Basker et al., 2012); static models that account for store location (e.g., Seim, 2006; Jia, 2008; Ellickson et al., 2013; Nishida, 2014); and dynamic models of multiple stores (e.g., Aguirregabiria and

on the effects of entry regulations (e.g., Suzuki, 2013; Turner et al., 2014; Maican and Orth, 2015).

The results show differences in own- and cross-price elasticities as well as asymmetric competition across store types. Under the current regulation, entry costs for large stores are lower and average welfare is higher in local markets with liberal rather than restrictive regulation. The discounted producer surplus is on average four times larger than the discounted consumer surplus. The consumer surplus increases by 3-4 percent from an additional large store and by 1 percent from an additional small store. In contrast, an additional large store decreases producer surplus by on average three times more than a small store. The relative magnitudes of these two countervailing forces underlie the welfare tradeoffs.

Counterfactual experiments show that lower entry costs are welfare enhancing, i.e., either for small stores (by 15 percent) or policies for large stores that are the equivalent in monetary terms to the government. Average discounted producer surplus decreases slightly more when the entry of large stores is promoted rather than small stores, while the increase in average discounted consumer surplus is similar. The average drop in producer surplus in restrictive markets is double that in liberal markets. Our cost reduction of small stores results in 10 percent more small stores per restrictive market and 13 percent per liberal market, whereas the number of large stores is almost unchanged. Our cost reduction of large stores leads to 18 percent more large stores per market on average. Encouraging large entrants also results in 8 percent (1 percent) fewer small stores in liberal (restrictive) markets, implying that small stores can operate despite lower profits in restrictive markets. Average welfare per market increases by 7-9 percent when encouraging small entrants and by 6-8 percent when encouraging large entrants. Welfare improvements are primarily driven by medium and large markets. Aggregate industry-level welfare is maximized from encouraging small entrants in liberal markets and large entrants in restrictive markets.

Protecting small stores either by imposing a licensing fee (i.e., 5 percent tax on variable profits) or higher entry costs for large stores is not welfare improving, in particular in markets with restrictive regulation. A licensing fee increases consumer surplus and the number of small stores more than higher entry costs. However, higher entry costs are better for welfare because producer surplus drops less than under the licensing fee. This is because short- and long-run profits of all large incumbents decrease by the fee, whereas higher entry costs target potential entrants that in turn affect incumbents' profits. We conclude that it is crucial to account for endogenous entry, exit and demand for differentiated products to correctly evaluate welfare from alternative regulations.

Vicentini, 2016; Igami and Yang, 2016).

The next section presents the data and market. Section 3 presents the model, and Section 4 the empirical implementation. Section 5 discusses the results, Section 6 the counterfactual exercises, Section 7 robustness, and Section 8 concludes.

2. DATA AND CHARACTERISTICS OF THE SWEDISH RETAIL FOOD MARKET

Many retail food markets in OECD countries consist of firms that operate uniformly designed store types. In Sweden, the food market consists of stores that, to a large extent, operate as independent or franchise units. Importantly, stores have independent pricing strategies. This is in contrast to national pricing, which exists, for example, in the UK. Centralized decision making - and thus the concern regarding national strategies - in the Swedish retail food market is thus less pronounced than in many other countries. Firms primarily act as wholesale providers, and the degree of centralization varies somewhat across firms. One firm, ICA, consists of independently owned stores that traditionally collaborate on wholesale provision and logistics. Two firms, Axfood and Bergendahls, each have a combination of franchises and centrally owned stores, the latter of which are primarily located in the south and southwest of Sweden. Coop consists of centralized cooperatives, and decisions are made at the national or local level. In 2011, approximately 90 percent of all stores were connected to one of four firms: ICA (49 percent), Coop (22 percent), Axfood (15 percent), and Bergendahls (7 percent). Various independent owners comprise the remaining 7 percent market share. International firms with hard discount formats entered the Swedish market in 2002 (Netto) and 2003 (Lidl).

Data. Three data sets are used in our empirical application. The first and primary data set includes all retail food stores in the Swedish market during the 2001-2008 period and is collected by Delfi Marknadsparter AB (DELFI). A unit of observation is a store based on its geographical location, i.e., its physical address. We have information on each store's geographic location (geo-coordinates), store type, firm affiliation, sales, sales space (in square meters), wholesaler and location (geo-coordinates). The store type classification (12 different) depends on size, location, product assortment, and so forth. Store types are similar for stores that are affiliated with different firms, and we jointly analyze several store types in the dynamic analysis. We define the five largest types (hypermarkets, department stores, large supermarkets, large grocery stores, and others) as "large" and four other types (small supermarkets, small grocery stores, convenience stores, and mini-markets) as "small."[7] We believe that these types are representative of small and large stores in the Swedish retail food market. Due to the complexity of defining the output and the variety of product assortments across stores, as is common in studies on the retail food market, we do not have information on the quantity sold for each product.

The second data set contains demographic information from Statistics Sweden (SCB), i.e., population, population density, average income, distribution of income across age groups, and political preferences. The third data set is collected by the Swedish National Organization of Pensioners (PRO) and contains annual price information for approximately 30 products in approximately 1,000 stores during the 2003-2008 period. The data set is rich and covers stores of different sizes, formats and firms across all counties in Sweden. The surveyed products cover a wide range of frequently purchased items of well-defined brands and pack sizes.[8] Because the empirical implementation of our model relies on all stores, we define a product basket for which we construct a price index by store type, firm, local market and year. In the empirical application, we consider a basket that contains 11 products. Online Appendix B provides details regarding the components of the product basket and descriptive statistics of the price. Section 7 and online Appendix G discuss the estimation results using separate product baskets for small and large stores.

Local markets. Food products fulfill daily needs and are often relatively perishable. Thus, stores are generally located near consumers; the travel distances are relatively short (unless prices are sufficiently low), and proximity to home or work is therefore a key concern for consumers. The size of the local market of each store depends on its type. Large stores attract consumers from a wider area than do small stores, but the size of the local market also depends on the distance between stores. We assume that retail markets are isolated geographic units, in which stores in one market only competitively interact with other stores in the same local market. The 21 counties in Sweden are clearly too large to be considered local markets for our purposes, while the 1,534 postal areas are likely too small, especially for large stores. Two intermediate choices are the 88 local labor markets or the 290 municipalities. Local labor markets take into account commuting patterns, which are important for the largest stores, such as hypermarkets and department stores, while municipalities

[7]Gas stations, seasonal stores, and stores under construction are excluded from the analysis. Stores classified as "other" stores are large and located outside cities.

[8]PRO is divided into a number of geographic districts, approximately corresponding to the 21 counties, which are each responsible for the survey in their geographic area. See Asplund and Friberg (2002) for previous work using the same data source. Based on the names and addresses of the stores in DELFI, we identify the stores that are included in the PRO survey.

appear more suitable for large supermarkets. As discussed below, local government decisions regarding new entrants are made at the municipal level. We therefore use municipalities as local markets.

Entry, exit and market shares. We define an entrant in year t as a store that operates in year t but not in $t-1$. We define an exit in year t as a store that operates in year $t-1$ but not in t. The variables e_{mt} and x_{mt} measure the number of entrants and exits in market m in year t. The total number of stores in the beginning of period $t+1$, n'_{mt+1}, is given by $n'_{mt+1} = n_{mt} + e_{mt} - x_{mt}$, where n_{mt} is the number of incumbent stores in period t. We only consider physical entry and exit as these are the relevant considerations for estimating sunk and fixed costs. Thus, we do not include stores that change owners but continue to operate at the same address.

To construct market share, we use store sales and the price of a large product basket to derive the quantity of product baskets a store sells in year t. Market share is defined as the quantity of product baskets sold divided by the total quantity in each local market and year (Section 4.1).

Entry regulation. The Swedish Plan and Building Act (PBA) regulates the use of land, water and buildings. The regulation contains a comprehensive plan that covers and guides the use of the entire municipality and detailed development plans that cover only a fraction of the municipality. The detailed development plans divide municipalities into smaller areas for which limits on use and design are set, i.e., construction rights for real estate and whether areas can be used for work places, housing, schools, parks etc.

The right to open and operate a retail food store is addressed in the detailed development plan. Each store seeking to enter the market is required to file a formal application with the local government. The application has to describe the purpose of the activity and what it contains, i.e., a new building, wholesale provision with trucks, parking places, etc. For the entry to occur, the municipality can accept a new detailed development plan or make changes to an existing one. The municipality evaluates the consequences for market structure, consumers, traffic, environmental issues and so forth. This is to ensure each consumer in the municipality has access to different types of stores, a broad product assortment and reasonable prices. Online Appendix A describes the PBA in greater detail.

Because there is no single ideal measure of regulatory stringency in local markets, we follow previous work and use several measures.[9] We access data on political preferences, i.e., the share of non-socialist seats in the local government (Bertrand and Kramarz, 2002; Schivardi and Viviano,

[9]See, e.g., Bertrand and Kramarz (2002), Schivardi and Viviano (2011), Suzuki (2013), Turner et al. (2014), Maican and Orth (2015), Maican and Orth (2016).

2011). The exogeneity of political preferences relies on the assumption that land-use issues do not determine the outcomes of local elections. Swedish municipalities have numerous responsibilities with childcare, schooling and elderly care being the spending areas likely to have a greater influence on voter decisions. We expect that non-socialist local governments are more liberal regarding new entry in Sweden, which is confirmed by reduced-form regressions.[10] In addition, we have data on the number of the applications approved (PBA) by local authorities for each municipality and year (Swedish Mapping, Cadastral and Land Registration Authority). This includes applications to change land-use plans and the total number of existing land-use plans.[11] Municipalities with a non-socialist majority approve more PBA applications. The correlation between non-socialist seats and the number of approved PBA applications in local markets is 0.6.[12]

To measure local market regulation, we use the share of political seats alone and index variables (Suzuki, 2013; Turner et al., 2014; Maican and Orth, 2015). Specifically, we use an index in which half the weight is the share of non-socialist seats in local governments, one quarter is the number of approved applications over the total number of stores and one quarter is the number of approved applications over the number of existing land-use plans. By construction, the index variables are not sensitive to the size of the local market. The higher the index is, the more the liberal regulations are. The index ranges from 0.032 to 1.28 with a median (standard deviation) of 0.28 (0.14). We define municipalities as having restrictive (liberal) regulations if the index is below (above) the median. We report results using one index definition and refer to robustness for alternative measures of regulation.

[10]The Social Democratic Party collaborates with the Left Party and the Green Party. The non-socialist group consists of the Moderate Party, most often together with the Liberal Party, Christian Democrats, and the Center Party. The Center Party is traditionally strong in rural areas and is not expected to be more liberal towards entry of new stores. For our purposes, we therefore only consider the Moderate Party, the Liberal Party and Christian Democrats in the non-socialist group.

[11]In addition, we have data on the number of approved PBA applications permitting the entry of retail stores. A high number of approved applications that allow retail stores to enter the market indicates a more liberal application of the PBA. The data are collected by surveys of 163 of the 290 municipalities and are available for three time periods: 1987-1992, 1992-1996, and 1997-2000 (Swedish Competition Authority, 2001:4). The survey was unfortunately not performed during our study period, i.e., 2001-2008. Importantly, the correlation between the number of approved applications for retail stores and the total number of approved applications is as high as 0.83.

[12]Overall, 117 of the 290 municipalities have had a non-socialist local government for at least one of the years in our study period. In local government (municipal) elections, there are two shifts in the number of seats during the study period. The number of markets with a non-socialist local government increases over time: 57 (2001-2002), 104 (2003-2006), and 102 (2007-2008).

Descriptive statistics. Table 1 shows aggregate statistics for the 2001-2008 period. The total number of stores decreases by 16 percent to 5,240 at the end of the period. While total sales increase by more than 24 percent, the total number of square meters increases by only about 10 percent. The share of large stores increases by 3.5 percentage points to nearly 22 percent in 2008. Large stores account for the majority of the sales and sales space. Their sales increase by 3.8 percentage points to 61.8 percent in 2008, whereas their sales space increases by 2.7 percentage points to 60.5 percent. The total number of entrants is fairly constant over time, with the number of exits being slightly less than twice the number of entrants. Moreover, the majority of entrants and exits are small stores (online Appendix B).

Figure 1a shows that the total number of entrants increases until 2005 and then declines, whereas the number of stores that exit peaks in 2004. Figure 1b shows that the entry and exit rates are correlated over time. The overall correlation between the entry and exit rates is 0.04, whereas the correlation between the number of entrants and the number of exits is 0.43. The positive correlation between entry and exit supports our approach of using a dynamic model.

Table 2 shows that the number of stores, store turnover, population and income are higher in liberal markets and big markets. The exit rate is three times higher than the entry rate. The mean exit rate varies between 0.042 and 0.054, and the mean entry rate ranges from 0.010 to 0.022. A medium sized market has on average 9 small stores and 3 large stores. That a median large store sells as much as ten times more than a median small store emphasizes the importance of estimating costs separately for small and large stores.

3. A DYNAMIC OLIGOPOLY MODEL

To evaluate the impact of entry regulation on market structure dynamics and welfare, we build a dynamic game model based on Pakes et al. (2007) that accounts for product differentiation in store type/location and incorporates a discrete choice demand model. The players in a local market consist of a finite set of incumbent stores $\mathbf{J}^c$ and a finite set of potential entrant stores $\mathbf{J}^e$. A specific player is denoted $j^c \in \mathbf{J}^c$ for incumbents and $j^e \in \mathbf{J}^e$ for potential entrants. We consider a dynamic game of entry and exit in discrete time ($t = 1, 2, ..., \infty$) in a market $m \in \mathcal{M}$, where $\mathcal{M}$ is a finite set of local markets. In the beginning of each period, incumbents and potential entrants choose their actions (whether to exit and whether to enter). Next, the stores that decide to operate simultaneously choose prices. Finally, consumers choose where to shop. In this section, we discuss stores' dynamic entry and exit decisions. Section 4.1 discusses consumers' decisions. In what follows, we describe the events taking place in every period in a local market. For notational simplicity, the presentation omits the market index m.

States. A player is described by a vector of state variables $\mathbf{s}_t = (n_{zt}, \mathbf{n}_{-zt}, \mathbf{y}_t)$ that consists of the number of active stores of each type in a local market, $(n_{zt}, \mathbf{n}_{-zt})$, $z \in \mathcal{Z} = \{1, \cdots, Z\}$, and exogenous profit shifters that are specific to each type $\mathbf{y}_t$. The vector $\mathbf{n}_{-zt}$ includes the number of each store type except z, i.e., $\mathbf{n}_{-zt} = \{n_1, \cdots, n_{z-1}, n_{z+1}, \cdots, n_Z\}$. For example, in the case of two types (small and large), the state space is $\mathbf{s} = (n_{small}, n_{large}, \mathbf{y})$, where n_{small} and n_{large} are the number of small and large stores, respectively. The state variables $\mathbf{s}_t$ are commonly observed by all players and the econometrician. The profit shifters $\mathbf{y}_t$ have finite support, and the states $\mathbf{s}_t$ are bounded. Players also receive privately observed payoff shocks. In every period, each incumbent j^c of type z receives a draw of the fixed cost ϕ^c_{jzt} from the common distribution F^{ϕ_z}. In every period, each potential entrant j^e of type z, receives a draw of the entry cost κ^e_{jzt} from the common distribution F^{κ_z}. Fixed costs and sunk costs are drawn from known distributions that are observed by all players. Fixed costs and sunk costs are i.i.d. across both players and time periods. All stores of type z are identical up to the draw of the fixed cost and entry fee. All parameters of the distributions of fixed costs F^{ϕ_z} and sunk costs F^{κ_z} are collected in $\boldsymbol{\theta}$.

Actions. Players simultaneously decide their actions in the beginning of each period. Actions are taken after players observe the commonly known state variables and the private cost shocks. Each incumbent j^c chooses whether to continue to operate with store type (or in location) $z \in \mathcal{Z}$ or exit. Incumbents pay their fixed cost in the next period if they continue. Each potential entrant j^e decides whether to enter a store of type $z \in \mathcal{Z}$.

The set of potential entrants are short-lived, and they will be replaced with a new set of potential entrants once they decide not to enter the market. Entrants' decisions are made one period ahead of the start of operation, which implies that we can obtain continuation and entry values that do not depend on entry costs. All incumbents and potential entrants form beliefs of the entry and exit of their rivals.

State transition. The number of stores of type z evolves endogenously over time according to $n_{zt+1} = n_{zt} + e_{zt} - x_{zt}$, where n_{zt} is the number of incumbents and e_{zt} and x_{zt} are the number of entrants and exits. The exogenous profit shifters that include both demand and variable costs are public information to firms and evolve exogenously according to a first-order Markov process $\mathbb{P}(\mathbf{y}_{t+1}|\mathbf{y}_t)$.

Per-period profits. Each store's per-period variable profit $\pi_z(\mathbf{s}_t; \boldsymbol{\theta})$ is commonly observed at the end of each period after all actions are taken, where $\pi_z(\cdot)$ is bounded and converges to zero as the numbers of incumbents grows. Section 4.1 discusses the computation of per-period profits $\pi_z(\cdot)$ using a discrete choice demand system, a marginal cost function specification, and an equilibrium assumption.

Local markets. We assume that local markets are independent, i.e., a separate game is played in each local market. This assumption implies that there is no interdependence between entry decisions across local markets. Hence, entry and exit decisions in one market do not depend on entry and exit decisions in any other market. It does not matter whether two municipalities are neighbors. For instance, stores of the same owner are not allowed to benefit from economies of scale, scope or density across local markets (e.g., joint benefits from logistics and advertising). The main reason for using this assumption is to simplify estimation of the dynamic game.[13]

Equilibrium. Incumbents and potential entrants make simultaneous moves and form expectations of the entry and exit of their rivals. In equilibrium, these expectations must be consistent with the stores' actual behavior. The incumbents' expectations of rival incumbents' behavior are identical for all rivals of the same type. Similarly, all potential entrants have the same probability of entering with a given type. The solution concept is a Markov Perfect Equilibrium. We assume that the same equilibrium is played in all local markets. This assumption allows us to compute conditional choice probabilities and transition matrices using a pooled sample from different markets. However, more than one equilibrium might exist. We acknowledge that the assumption of a single equilibrium in the data, which is commonly used in empirical applications, is restrictive.[14] Inference on multiple equilibria for this class of dynamic games has, however, not yet been addressed in the literature.[15]

We assume that players' strategies are pure Markovian. The action of one player can thus be expressed as a function of only the privately observed payoff shocks and the commonly observed state variables. Because we focus on stationary Markov strategies, we do not consider the time

[13]There are a few papers that account for entry into multiple markets, e.g., Jia (2008) and Holmes (2011). A common characteristic of these studies is that they only consider two to three players.

[14]Pakes et al. (2007) claim that the correct equilibrium will be selected in sufficiently large samples. The model requires consistent transition probabilities to be constructed only once based on what is observed in the data. In markets with various structural changes over time, we might not obtain consistent transition probabilities if the period is not sufficiently long.

[15]For details and explanations, see Pakes et al. (2007); Otsuy et al. (2016).

index t in what follows.[16]

Incumbents. The value function of an incumbent store of type z is given by the Bellman equation

$$V_z(\mathbf{s}, \phi_z; \boldsymbol{\theta}) = \pi_z(\mathbf{s}; \boldsymbol{\theta}) + max\{\beta VC_z(\mathbf{s}; \boldsymbol{\theta}) - \beta\phi_z, 0\}, \tag{1}$$

where $\pi_z(\cdot)$ is the profit function; $VC_z(\cdot)$ is the continuation value; ϕ_z is the fixed cost; and $0 < \beta < 1$ is the discount factor. Incumbents know their fixed cost ϕ_z but not the number of entrants and exits prior to making their decisions. The optimal policy for an incumbent is to exit if the draw of the fixed cost is larger than the expected future profits, which yields the probability of exit $p_z^x(\mathbf{s}) = Pr(\phi_z > VC_z(\mathbf{s}; \boldsymbol{\theta})) = 1 - F^{\phi_z}(VC_z(\mathbf{s}; \boldsymbol{\theta}))$. Incumbents that continue obtain the continuation value

$$\begin{aligned} VC_z(\mathbf{s}; \theta) = \;& E^c_{\mathbf{s}'}[\pi_z(\mathbf{s}'; \boldsymbol{\theta}) + E_{\phi'_z}[\max\{\beta VC_z(\mathbf{s}'; \boldsymbol{\theta}) - \beta\phi'_z, 0\}]] \\ = \;& E^c_{\mathbf{s}'}[\pi_z(\mathbf{s}'; \boldsymbol{\theta}) + \beta(1 - p_z^x(\mathbf{s}'))(VC_z(\mathbf{s}'; \boldsymbol{\theta}) \\ - \;& E[\phi'_z | \phi'_z \leq VC_z(\mathbf{s}'; \boldsymbol{\theta})])], \end{aligned} \tag{2}$$

where $\mathbf{s}' = (n'_z, \mathbf{n}'_{-z}, \mathbf{y}')$ and the expectation $E^c_{\mathbf{s}'}[\cdot]$ uses the continuing stores' perceptions of the future values of the state variables. If we assume that ϕ_z follows an exponential distribution, we obtain $E[\phi'_z | \phi'_z \leq VC_z(\mathbf{s}'; \boldsymbol{\theta})] = \sigma_z - VC_z(\mathbf{s}')[p_z^x(\mathbf{s}')/(1 - p_z^x(\mathbf{s}'))]$. Substituting this into (2), we obtain

$$VC_z(\mathbf{s}; \boldsymbol{\theta}) = E^c_{\mathbf{s}'}[\pi_z(\mathbf{s}'; \boldsymbol{\theta}) + \beta VC_z(\mathbf{s}'; \boldsymbol{\theta}) - \beta\sigma_z(1 - p_z^x(\mathbf{s}'))], \tag{3}$$

where σ_z is a parameter in the exponential distribution that represents the inverse of the mean.

Entrants. 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

$$VE_z(\mathbf{s}; \boldsymbol{\theta}) = E^e_{\mathbf{s}'}[\pi_z(\mathbf{s}'; \boldsymbol{\theta}) + \beta VC_z(\mathbf{s}'; \boldsymbol{\theta}) - \beta\sigma_z(1 - p_z^x(\mathbf{s}'))], \tag{4}$$

where $p_z^x(\mathbf{s}')$ is a potential entrant's perceptions of the exit probability of each type of incumbents and $E^e_{\mathbf{s}'}[\cdot]$ indicates the entrants' expectations of future state variables. 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 $Pr(\kappa_z < \beta VE_z(\mathbf{s}; \boldsymbol{\theta})) = F^{\kappa_z}(\beta VE_z(\mathbf{s}; \boldsymbol{\theta}))$.

[16] We do not allow stores to invest or change owners or formats. That store concepts in retail are rather uniform justifies this assumption.

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. Thus, first, the entry value must be larger than the draw of the entry cost. In addition, the type decision must yield the highest expected discounted future profits among all type alternatives:

$$\beta VE_z(\mathbf{s};\boldsymbol{\theta}) \geq \kappa_z \quad \text{and} \quad \beta VE_z(\mathbf{s};\boldsymbol{\theta}) - \kappa_z \geq \beta VE_{z'}(\mathbf{s};\boldsymbol{\theta}) - \kappa_{z'} \tag{5}$$

for all $z' \in \mathcal{Z}$. We assume that entry costs follow a unimodal distribution with the general density function given by

$$f(\kappa = \mu) = a^2(\mu - \frac{1}{a})exp(-a(\mu - \frac{1}{a})),$$

for $\mu \in (1/a, \infty)$, where the parameter a ($a > 0$) defines the boundary support for the entry cost κ. Because of the boundary support, there is no entry if the number of incumbents is very large. The entry costs for small (κ_{small}) and large stores (κ_{large}) in a local market are assumed to be independent, where κ_{small} and κ_{large} follow unimodal distributions with parameters a_1 ($a_1 > 0$) and a_2 ($a_2 > 0$), respectively. We expect higher entry costs for large stores because they require more land and building permissions and influence the traffic and the environment, i.e., $\kappa_{large} > \kappa_{small}$.[17] The parameters a_1 and a_2 are estimated in the second stage together with σ_z.

We now define the continuation values, profits, and exit probabilities as vectors and define a matrix of transition probabilities $\boldsymbol{W}_z^c$ that indicates the transition from state $\mathbf{s}$ to state $\mathbf{s}' \neq \mathbf{s}$ for type z, $\boldsymbol{VC}_z(\boldsymbol{\theta}) = \boldsymbol{W}_z^c[\boldsymbol{\pi}_z + \beta \boldsymbol{VC}_z(\boldsymbol{\theta}) - \beta\sigma_z(1 - \boldsymbol{p}_z^x)]$, which implies that

$$\boldsymbol{VC}_z(\boldsymbol{\theta}) = [I - \beta \boldsymbol{W}_z^c]^{-1}\boldsymbol{W}_z^c[\boldsymbol{\pi}_z - \beta\sigma_z(1 - \boldsymbol{p}_z^x)], \tag{6}$$

where I is the identity matrix. Using nonparametric estimates of $\boldsymbol{W}_z^c$ and $\boldsymbol{p}_z^x$ from the data, we can obtain an estimate of the value function at each state. There is no dependence over time in the

[17] Previous versions of the paper allowed for a correlation in entry costs, i.e., $\kappa_{large} = \kappa_{small} + \mu$, where κ_{small} and μ follow unimodal distributions with parameters a_1 ($a_1 > 0$) and a_2 ($a_2 > 0$), respectively. The main benefit of allowing for a correlation in entry costs is that by construction $\kappa_{large} > \kappa_{small}$. However, our empirical results are not dependent on this assumption.

transition probabilities.[18] For potential entrants, the value of entry is

$$\boldsymbol{VE}_z(\boldsymbol{\theta}) = \boldsymbol{W}_z^e[\boldsymbol{\pi}_z + \beta \boldsymbol{VC}_z(\boldsymbol{\theta}) - \beta\sigma_z(1 - \boldsymbol{p}_z^x)], \tag{7}$$

where $\boldsymbol{W}_z^e$ is the transition matrix that yields the probability that an entrant starts operating at $\mathbf{s}'$ conditional on entering in state $\mathbf{s}$. Online Appendix D provides details regarding the construction of the transition matrices.

Comparisons to alternative approaches: static and dynamic. Our model differs from previous work based on the POB framework in the following ways: First, we account for heterogeneous stores. Second, we use a demand system and data on store-level prices to recover variable profits and welfare measures for each state, which allows us to understand the dynamic implications of entry regulation for welfare.

Static entry models cannot explain the descriptive patterns of entry and exit that we observe in our data and require the market structure to be in long-run equilibrium (Mazzeo, 2002; Seim, 2006; Berry and Reiss, 2007). Our model differs from the static models of heterogeneous firms in the following ways: First, we distinguish short-run profits from long-run profits (continuation and entry values). Second, we separately identify sunk costs and fixed costs. Third, we allow for transitions in the market structure over time and let the prior market structure and the number of stores influence the future market structure. In summary, a dynamic model is necessary if one wishes to quantify the impact of entry policies on profitability, market structure, and welfare changes.

There are recent studies that combine static entry models with a static demand system (e.g., Gowrisankaran and Krainer, 2011) and use dynamic models of demand (e.g., Gowrisankaran and Rysman, 2012). We contribute to this literature by jointly considering a dynamic entry and exit setting with a static demand framework.

4. IDENTIFICATION AND ESTIMATION

The empirical implementation proceeds in four steps: First, we estimate a static discrete choice demand model that is used to construct variable profits for each store. We believe it is reasonable to assume a static demand system for retail food because consumers purchase food products, which

[18] While we add various market controls when computing variable profits using a discrete choice demand system, it is difficult to control for the possible presence of serially correlated unobservables in our dynamic framework. See Takahashi (2015) for a dynamic model of exit that controls for correlated unobservables.

are of limited durability, on a frequent basis. We use the Nash price equilibrium system from the demand system together with predicted values for marginal cost to compute variable profits for each store type for all possible states. The main advantage of this approach is that we are able to compute counterfactual prices, profits, and welfare measures. Second, we estimate the transition probabilities, which are used to compute the continuation and entry value functions. Third, we estimate the cost distributions (fixed and sunk) for each store type in liberal and restrictive markets. Fourth, we calculate welfare measures and evaluate equilibrium outcomes under a number of alternative entry regulation regimes.

4.1. Demand and variable profits. We adopt a nested logit demand model with correlation τ across stores that belong to the same group of store type $z \in \mathcal{Z}$. The arguments for using store types as nests rely on the assumption that store type likely influences consumer choice. Consumers acknowledge that stores differ and perceive similar store types to be closer substitutes. This allows preferences to be correlated across stores of a certain type. In accordance with Berry (1994), the utility of consumer i of store j in local market m is given by

$$u_{ijmt} = \delta_{jmt} + \zeta_{izmt} + (1-\tau)\epsilon_{ijmt}, \tag{8}$$

where ϵ_{ijmt} is identically and independently distributed extreme value, ζ_{izmt} is common to all stores in group z and has a distribution function such that if ϵ_{ijmt} is a random variable, $[\zeta + (1-\tau)\epsilon]$ is extreme value distributed with $\tau \in [0,1]$ measuring the within-group correlation in idiosyncratic preferences.[19] Let $\delta_{jmt} = \mathbf{x}_{jmt}\beta - \alpha p_{jmt} + \eta_f + \eta_t + \xi_{jmt}$, where $\mathbf{x}_{jmt}$ are control variables such as the log of store size (m^2), average local market income, and income squared; p_{jmt} is the price of the product basket; η_f are dummies for the main firms (ICA, Axfood, Coop, and Bergendahls); and η_t are year fixed effects. The remaining demand shocks ξ_{jmt} are not correlated across store types and markets and could include a store's local advertising, for example. Integrating out over the idiosyncratic preferences yields the estimable demand equation

$$ln(s_{jmt}) - ln(s_{0mt}) = \mathbf{x}_{jmt}\beta - \alpha p_{jmt} + \tau ln(s_{jmt|z}) + \eta_f + \eta_t + \xi_{jmt}, \tag{9}$$

[19] Although the nested logit demand model allows preferences to be correlated across stores within a group (small or large), it assumes symmetric cross-price elasticities within a group (Berry, 1994; Grigolon and Verboven, 2014). Berry et al. (1995) provide rich discrete choice frameworks to model demand.

where s_{jmt} is the market share of store j constructed using the quantity of a product basket that a store sells in year t in market m, i.e., $q_{jmt} = sales_{jmt}/p_{jmt}$ and $s_{jmt} = q_{jmt}/\sum_k q_{kmt}$. $s_{jmt|z}$ is the within-group share of store j in group z in market m, and s_{0mt} is the market share of the outside option, which is defined as buying food from stores not affiliated with the four main firms. We form moment conditions on ξ_{jmt} to identify α, β and τ.

Store profits. The variable profits of store j are given by

$$\pi_{jmt} = (p_{jmt} - mc_{jmt})M_t s_{jmt}(\mathbf{p}, \mathbf{x}; \boldsymbol{\psi}), \tag{10}$$

where mc_{jmt} is the marginal cost of store j in market m; M_t is the total market size, i.e., the number of consumers that purchase the food product (our product basket); $\mathbf{p}$ is the price vector; $\mathbf{x}$ is the store characteristics matrix; and $\boldsymbol{\psi} = (\alpha, \beta, \tau)$ represents the parameters to be estimated.[20]

We assume that stores compete in prices, which determine the basket price, and that p_{jmt} is the result of a pure strategy Nash equilibrium. The fact that individual stores determine their own prices in Sweden supports this assumption. In the standard nested logit specification derived in Berry (1994), the price minus marginal cost takes a simple analytical form

$$p_{jmt} - mc_{jmt} = \left[\frac{(1-\tau)}{\alpha} / [1 - \tau s_{jmt|z} - (1-\tau)s_{jmt}]\right]. \tag{11}$$

Identification. To estimate equation (9), we require instruments for the endogenous variables price p_{jmt} and the within-group share $s_{jmt|z}$. There is variation in prices across store types, firms, markets and years. As instruments for p_{jmt}, we use the main cost shifters for retail food stores ($\mathbf{w}_{jmt}$), which are the labor and logistics costs. We proxy for these costs using average wages and the distance to the nearest distribution center for each store type, firm and market. These instruments are correlated with the store's price because of the service production costs, and they do not include store-specific demand shocks.[21] The within-store-type (group) share is correlated with the number of stores of each type in a market. Because the assumption that demand shocks ξ_{jmt} are not correlated with number of stores in a market is restrictive when ξ_{jmt} is first-order Markov, we use the average

[20] Using quantity, the variable profits can also be computed as $\pi_{jmt} = (p_{jmt} - mc_{jmt})q_{jmt}(\mathbf{p}, \mathbf{x}; \boldsymbol{\psi})$, where q_{jmt} is the quantity of food product baskets sold by store j.

[21] The average prices of stores of the same type in other local markets can also be used as an instrument for p_{jmt} (Hausman, 1997; Nevo, 2001).

number of stores of each type in other local markets as an instrument for $s_{jmt|z}$.[22] This instrument is correlated with $s_{jmt|z}$ because it reflects the service costs of operating different store types across local markets, and it is valid if there are no national demand shocks. Moreover, any function of these variables is a valid instrument. The parameters β are identified using moment conditions on $\mathbf{x}_{jmt}$. Section 7 discusses the robustness results using additional identification strategies for the demand equation.

Equilibrium prices. We use the Nash equilibrium condition (first-order condition of (10)) together with the estimated information about the marginal cost mc_{jmt} to compute equilibrium prices. The price p_{jmt} and market share s_{jmt} are not observed for potential (hypothetical) entrants, but they can be computed using extrapolated marginal cost mc_{jmt} from the linear specification $mc_{jmt} = \mathbf{x}^{'}_{jmt}\boldsymbol{\gamma} + \epsilon_{jmt}$, where the vector $\mathbf{x}^{'}_{jmt}$ includes store-type dummies, market fixed effects, and average wage that are likely to be exogenous or predetermined (online Appendix F). The fitted values are $\hat{mc}_{jmt} = \hat{mc}_{j'mt}$ if stores j and j' belong to the same store type z (i.e., small or large). The equilibrium prices in a given state (market configuration) are computed by numerical iteration using the first-order condition and fitted values of marginal cost:

$$p^{l+1}_{jmt} = -s_{jmt}(\mathbf{p}^l, \mathbf{x}; \boldsymbol{\psi}) \left(\frac{\partial s_{jmt}(\mathbf{p}^l, \mathbf{x}; \boldsymbol{\psi})}{\partial p_{jmt}} \right)^{-1} + \hat{mc}_{jmt}, \tag{12}$$

where p^l is the price at iteration l and $l = 0, 1, 2, \cdots$. We use the observed values of price as the initial values of p^l_{jmt}.[23] The recovered information about equilibrium prices and marginal costs allows us to compute the variables profits for each state in the state space.

4.2. Value functions and transitions between states. To compute the continuation values for incumbents ($\boldsymbol{VC}_z$) and entrants ($\boldsymbol{VE}_z$), we need to calculate the expected discounted future profits that the store would obtain from counterfactual future states. The transition probability matrices ($\boldsymbol{W}^c_z$) and ($\boldsymbol{W}^e_z$) are computed for each store type and local markets with different degrees of entry regulation using the empirical transition probabilities. As explained in Section 2, we define municipalities as having a restrictive (liberal) implementation of the PBA if the regulation index is below (above) the median. The grouping of local markets is considered exogenous to the stores, and

[22] Recent work on dynamic demand models allows ξ_{jmt} to be correlated over time, which plays a key role in understanding consumer heterogeneity (see, e.g., Gowrisankaran and Rysman, 2012).

[23] We obtain $\hat{\xi}_{jmt}$ for stores that are observed in the data and use the average value for stores that are not observed in the data. We find that numerical iteration converges rapidly.

we consequently do not attempt to model expected changes in regulations over time (Dunne et al., 2013).

We estimate the transition probabilities using municipalities in Sweden over 8 years with a population of fewer than 200,000; i.e., large cities, such as Stockholm, Gothenburg, and Malmö, are excluded. The number of small store types in each market varies between 2 and 55, and there are between 2 and 19 large stores in each market. To simplify the computation of the static Nash-Bertrand equilibrium given the state space, we use only market size as the third state in the state space. However, other exogenous demand and cost shifters (e.g., wages) are still part of the state space because they enter in the computation of fitted values for the marginal cost at each state. Market size is continuous and part of the state space, and we discretize it in three groups (small, medium, large) based on quantiles to reduce dimensionality of the state space. The dimensionality of the generated state space is 1,911 states in markets with restrictive entry regulations and 2,916 states in markets with liberal entry regulations.[24] Online Appendix E presents additional technical details used to construct the empirical transition matrices and value functions.

4.3. Estimation of entry and fixed costs. The final stage involves parameter estimation of sunk costs (κ_z) and fixed costs (ϕ_z) for each store type in local markets with restrictive and liberal regulation.[25] The continuation value is computed for each state and is known up to the parameter of the distribution of fixed costs F^{ϕ_z}. The value of entering depends on the entry cost draw from the distribution F^{κ_z}. A minimum distance estimator or indirect inference estimator can be used to estimate the cost parameters. Both estimators yield similar estimates in our application, which is unsurprising because indirect inference is also a GMM estimator. In the case of indirect inference, we use ordinary least squares (OLS) to regress entry and exit probabilities from the data and the model, respectively, on the state variables, i.e., $\mathbf{p} = \mathbf{s}\boldsymbol{\rho}$. We save the estimated coefficients $\boldsymbol{\rho}$ (data) and $\boldsymbol{\rho}(\boldsymbol{\theta})$ (model), where the vector $\boldsymbol{\theta}$ contains the parameters of the cost distributions. The criterion

[24] After the transition matrices are computed, they are retained in memory to increase computational efficiency. Calculating the inverses of the transition matrices is the most demanding computational task. Our Java code uses sparse matrices and parallel computing. For two types, it takes less than one minute to compute all matrices necessary to evaluate the value functions on an ordinary laptop with a dual-core processor.

[25] The magnitude of entry costs captures the restrictiveness of entry regulation in our model. To estimate entry cost to depend on current market structure would severely complicate the estimation because a store will face a different entry cost in any state in the future. It would also require to redefine the equilibrium assumptions.

function minimizes the distance between the regression coefficients:

$$\hat{\boldsymbol{\theta}} = \arg\max_{\boldsymbol{\theta}}[\hat{\boldsymbol{\rho}} - \hat{\boldsymbol{\rho}}(\boldsymbol{\theta})]'\mathbf{A}_R[\hat{\boldsymbol{\rho}} - \hat{\boldsymbol{\rho}}(\boldsymbol{\theta})], \tag{13}$$

where $\mathbf{A}_R$ is the weighting matrix. The variance-covariance matrix is estimated using a parametric bootstrap, which is easy to apply because we can use the model to simulate new data and then use it to estimate new values for parameters. Online Appendix E describes details regarding the estimation and alternative estimators.

4.4. Welfare measures. The welfare in each state, i.e., market configuration, is computed as the discounted sum of profits minus costs plus the consumer surplus, i.e., $W_t(n_z, \mathbf{n}_z, \mathbf{y}) = CS_t(n_z, \mathbf{n}_{-z}, y) + PS_t(n_z, \mathbf{n}_{-z}, y)$. The estimation of the demand system allows us to compute the static consumer surplus for each state. The static consumer surplus $CS_t(\cdot)$ in the nested logit model is given by (Small and Rosen, 1981)

$$CS_{mt} = \frac{1}{\alpha} M \ln \left[1 + \sum_z n_{zmt} exp(\frac{\delta_{zmt}}{1-\tau}) \right], \tag{14}$$

where δ_{zmt} and n_{zmt} are the mean utility provided by store type z and the number of stores of type z in market m in period t, respectively. Because our model is complete, to obtain discounted consumer surplus, we use numerical simulation. For each state, we simulate the model T periods and obtain the path of consumer surplus starting with the given state (e.g., $T = 100$ years). This allows us to compute discounted consumer surplus in a given state. Then, we repeat the simulations and report the average of discounted consumer surplus. The producer surplus $PS_t(\cdot)$ is defined as the sum of discounted surplus for incumbents and entrants.[26] To compute the welfare the industry level in the empirical application, we sum the welfare $W_t(n_z, \mathbf{n}_z, \mathbf{y})$ for the states observed in the data.

[26]The computation of producer surplus is straightforward because it translates to already computed value functions VC and VE. The producer surplus for potential entrants might be biased because some of the potential entrants will never enter (Collard-Wexler (2013) also discusses this aspect). Given that there are only a few entrants in each state, ignoring producer surplus from entrants has only a minor impact on the overall producer surplus.

5. RESULTS

This section discusses the results for the demand estimation, static Nash equilibrium outcome, cost parameters, long-run profits and the welfare measures of current regulation.

5.1. Demand estimates. Table 3 reports the estimates of demand equation (9) using OLS and two-stage least squares (2SLS). The control variables are store size(m^2), average local market income, income squared, and dummies for the main firms (ICA, Axfood, Coop, and Bergendahls). The price coefficient (α) is positive and significant in both specifications.[27] As expected, the coefficient is smaller after we control for the endogeneity of price and local market characteristics that shift demand. In the OLS specification, the coefficient of the within-store-type (group) share (τ) is 0.971. An estimate of τ close to 1 suggests strong "business stealing" within the store type. However, τ decreases to 0.637 when instrumenting within-type share, which is consistent with the existence of demand shocks that affect both total demand and the within-type share. For both p_{jmt} and $s_{jmt|z}$, the F-tests reject the joint hypothesis that the coefficients on the instruments are all zero in the first stage. The coefficients for store size and the dummies for major firms are positive, as anticipated. The 2SLS specification is used to compute the counterfactual profits in the dynamic part.

Table 4 presents the unweighted average own- and cross-price elasticities for small and large stores, reporting cross elasticities both within and between store types. Because the average estimated price elasticities are functions of the estimated demand parameters, we use the bootstrap method to compute the standard errors for the reported averages. The average own-price elasticity is -3.871 for a small store and -3.001 for a large store. The average cross-price elasticity for the same store type is 0.125 for small stores and 0.841 for large stores. These findings indicate that asymmetric competition exists within store types, i.e., the own-price elasticities are larger (in absolute terms) than the cross-price elasticities. Among the cross-price elasticities for the rival store type, the impact of increasing the prices of small stores on the market shares of large stores (0.031) is smaller than that of increasing the prices of large stores on the market shares of small stores (0.221). Small stores gain more than large stores when the price of the rival store type increases. In other words, consumers prefer large stores if prices are sufficiently low to compensate for transportation costs.

Nash-Bertrand equilibrium outcome. Using the demand estimates, we recalculate the Nash price equilibrium and construct price-cost margins, variable profits and the static consumer surplus

[27] Note that price enters demand equation (9) with a negative sign.

and producer surplus for each state of the state space. Table 5 presents the summary of these measures for small and large stores. Prices are on average lower in large stores than in small stores. Prices for small stores are lower in liberal markets than in restrictive markets. Predicted prices are close to the observed prices, confirming that prices are lower in large stores and in liberal markets. The average price-cost margin for large stores is approximately 10 percent, which is consistent with previous findings (Aguirregabiria and Vicentini, 2016). Small stores have a smaller average price-cost margin in liberal markets than in restrictive markets, i.e., 8 percent and 10 percent, respectively. The large standard deviation in the price-cost margin for small stores indicates large heterogeneity across markets and the importance of dynamics for market structure and welfare.

Variable profits. Large stores have, on average, about ten times higher variable profits than small stores. The average variable profit is also higher in restrictive markets than in liberal markets. The averages of the variable profits for small stores across the generated state space are about SEK 1.20 million in restrictive markets and SEK 1.13 million in liberal markets. For large stores, the corresponding averages are SEK 13.34 million in restrictive markets and SEK 12.56 million in liberal markets. We calculate operating profits by subtracting the estimated average fixed cost from the second stage (Section 5.2) from our variable profit estimates. Overall, our predicted operating profits are good approximations of the annual operating profits reported by Statistics Sweden, i.e., average values 2001-2010: SEK 1.08 million for small stores and SEK 12.18 million for large stores.

Static welfare. The total static consumer surplus is higher in markets with a liberal regulation (Table 5). Average static consumer surplus is SEK 21.7 million with a standard deviation of SEK 14.41 million. The corresponding average in restrictive markets is SEK 13.43 million with a standard deviation of SEK 9.2 million. The static producer surplus is substantially higher than the consumer surplus, which suggests that substantial changes in the store mix (dynamics) in a market are needed to obtain a positive welfare change after a policy that decreases producer surplus. Producer surplus is SEK 113.5 million in restrictive markets and SEK 108.6 million in liberal markets.[28]

5.2. Structural parameter estimates. We estimate the entry cost parameters for markets with restrictive and liberal entry regulations. Table 6 presents the parameter estimates for the distributions (in millions of 2001 Swedish kronor) of fixed costs and entry costs for each store type (1 USD=9.39 SEK, 1 EUR=8.34 SEK). The average entry cost for small stores is SEK 10.7 million in restrictive markets and SEK 11.4 million in liberal markets. For large stores, entry costs are SEK 179.6 million

[28]Online Appendix J presents additional information about the static asymmetric competition between store types.

in restrictive and SEK 118.6 million in liberal markets. The estimated average fixed costs are SEK 1.2 million for small and SEK 10.2 million for large stores.

To evaluate the extent to which our average entry cost estimates are reasonable, we compare them to publicly available investment costs for new stores. The reported cost, including land, buildings, and equipment, is 8.5 million for a small Coop store in a small market (Årjäng), 80 million for a relatively large ICA store in a big market (Malmö), and 123 million for the largest ICA store in a big market (Västerås). Our estimates of sunk entry costs include other costs such as those related to the regulatory process and, therefore, are larger than the accounting costs. Nevertheless, the range of our cost estimates appears empirically reasonable when assessing the magnitude of our implied value functions.

Table 7 presents a summary of the model prediction of the market structure using observed states in the data in 2001 as starting values for simulation. The simulated model makes accurate predictions for the number of large stores in all types of markets. The average prediction of the number of small stores is 1-2 more stores than in the observed data, but given the complexity of the market and large heterogeneity across observed markets, the estimated model does a good job in explaining the number of stores in the data. Most importantly, the results show that the model accurately predicts the shares of small/large stores.

Long-run competition and welfare under current regulation. To summarize the nonlinear and asymmetric store type competition and its welfare impact under the current regulation, we show average marginal effects of an additional store (small or large) on VC_z, VE_z, p_z^x, p_z^e, CS_t, and PS_t using polynomial expansions in the number of small and large stores and the OLS estimator. Table 8 shows store-type competition in liberal markets; i.e., small stores compete more intensely with other small stores than with large stores.[29] Large stores compete fiercely with all incumbents in restrictive markets. An additional large store decreases incumbents' long-run profits by about 1 percentage point more and increases the probability of exiting by 2-3 percentage points more in restrictive than in liberal markets. Product differentiation and the fact that liberal markets are on average larger than restrictive markets in our sample can explain these differences. Potential entrants' long-run profits and the likelihood of entry decrease substantially more from a large competitor than from a small.

Under the current regulation (our base case), welfare is higher in liberal than in restrictive mar-

[29] F-tests reject the null hypothesis that the coefficients of the number of stores terms are zero in nonlinear regressions (online Appendix J).

kets, i.e., averages of SEK 1,350 million (liberal) and SEK 538 million (restrictive). Discounted producer surplus is on average about four times larger than consumer surplus. Average discounted consumer surplus is SEK 193 million in liberal markets and SEK 99 million in restrictive markets. The corresponding averages for producer surplus is SEK 1,141 million in liberal and SEK 429 million in restrictive markets. Unlike in the case of a static framework, our welfare measures account for endogenous entry and exit and short-run price competition between heterogeneous stores. Consumer and producer surplus depend on the store-type mix in a local market, own- and cross price elasticities, and the asymmetric long-run store type competition (i.e., non-linearity in state variables). Table 8 shows that consumer surplus increases by 3-4 percent from an additional large store and by 1 percent from an additional small store. This confirms that discounted consumer surplus is increasing with the number of stores. The corresponding relationship for producer surplus might, however, be non-monotonic. On average, an additional large store decreases producer surplus three times more than a small store, and the marginal effects are 1 percentage point higher in liberal than in restrictive markets.

Computing the Markov Perfect Equilibrium. To compute counterfactuals, we recalculate the Markov perfect equilibrium, i.e., (VC_z, VE_z, p_z^e), where p_z^e is the probability of entry with store type z. When changing the cost parameters, we recalculate transition matrices for incumbents and entrants of each store type in markets with different regulations (Pakes et al., 2007). We assume that the potential entrants for small and large stores follow a Poisson distribution.[30] The equilibrium solves the system of equations (2), (4), and (5). The computation algorithm is as follows. *Step 0:* start with an initial probability to enter for each state, $\mathbf{p}_{z,0}^e$; *Step 1:* recalculate transition probabilities, and use them to update VC_z^0 and VE_z^0; *Step 2:* update $\mathbf{p}_{z,1}^e$ using VC_z^0 and VE_z^0; *Step 3:* if

[30] There are alternatives to implement the Poisson distribution for potential entrants in our dynamic setting. In the end, these methods choose the means of the distributions that fit the observed data. First, we can treat the pool of potential entrants as infinite and model entry as proposed in Weintraub et al. (2008) and Dunne et al. (2013), which implies the estimation of the mean of the Poisson variable that depends on the state $(n_z, \mathbf{n}_{-z}, \mathbf{y})$ (see Hausman et al., 1984). It might be unreasonable, however, to assume that there is an infinite (or very large) number of potential entrants in the retail food industry, where the number of stores decreases over time and demand is local. The second alternative is to choose the parameters of these Poisson distributions to fit observed data by simulating the model with estimated cost parameters. For example, using the mean of Poisson distribution equal to 9 for both small and large stores fits the Swedish data well. Another option for the mean of the Poisson distribution is to use the highest number of PBL applications (which is lower than 9) for retail food in one year-market as the mean of the distribution. However, our repeated simulations show that increasing the number of the potential entrants does not affect the quality of the results, but it is more computationally intensive (a large number of combinations is required to compute the value of an element in the transition matrices).

$\| \mathbf{p}^e_{z,1} - \mathbf{p}^e_{z,0} \| < error$, then stop; otherwise, go to *Step 1*.[31]

6. COUNTERFACTUAL POLICY EXPERIMENTS

The estimated parameters of the model are used to evaluate counterfactual policy experiments that resemble commonly and recently debated aspects of entry regulations. The proposed policy regimes mimic realistic policies that regulators can easily assess, which simplifies the practical implementation. We exploit heterogeneity across store size and local markets both in the design of the policy and the outcomes. We first protect small incumbents by imposing licensing fees and higher entry costs for large stores (Table 9) (Mankiw and Whinston, 1986; Berry and Waldfogel, 1999). Then, we consider more liberal policies that promote competition by lowering the entry costs for small or large entrants (Table 10).

Our policies primarily target large stores because entry of large stores is one of the most frequently debated questions among retail policy makers in both US and Europe. Large store entrants are the main driver of structural change in the last few decades (e.g., Walmart, Carrefour, Metro, Schwartz, and Tesco), and they are expected to influence market structure and, thus, the planning process substantially. They also represent the majority of total sales but for a minor share of the number of stores. Entry of large stores is explicitly regulated in, for instance, the UK and France, which restrict entry of stores with sales space above 2,500 and 1,000 square meters, respectively.[32]

Each policy experiment is compared to the current regulation (base case). After a policy change, we recalculate the new equilibrium as described in Section 5.2. We focus on the observed market configurations in the data and present the average and aggregate changes in the long-run profit (VC_z and VE_z), entry and exit probabilities (p^x_z and p^e_z), the number of small and large stores, discounted consumer and producer surplus, and total welfare (Section 4.4).[33] We discuss the changes due to each policy in markets with different degrees of regulation and size.

The changes in welfare measures depend on two countervailing forces. First, more stores increase consumer surplus, which is affected by consumers' substitutability between small and large stores and short-run price competition. Second, asymmetric store-type competition (i.e., how small and large competitors influence long-run profits) and endogenous entry and exit determine producer surplus. For instance, more stores result in tougher competition, lower continuation values, and

[31] One way to avoid multiple equilibria is to use different starting values.

[32] The policy in the UK was implemented in 1996, and in France in 2008.

[33] The value functions and welfare measures are in millions of 2001 SEK.

changes in entry and exit. The relative magnitude of these complex changes depends on the store-type configurations.

6.1. Protecting small incumbents by regulating large stores. Table 9 summarizes the first set of policies that are easy to compare because they are equivalent in monetary terms for the government. **Licensing fees for large stores in all markets.** To protect small incumbents, we implement a licensing fee for large stores by taxing their variable profits by 5 percent in all markets (CF_1 in Table 9). Long-run profits decrease and the probability of exiting increases for large stores. It also becomes less attractive to enter as shown by a lower probability to enter for large stores. There is a net decrease in the number of large stores. Because large stores survive to a greater extent despite lower profits in liberal markets, the number of large stores falls more in restrictive markets (-1.385) than in liberal markets (-0.074) on average. Fewer large stores induce profit reallocation to small stores that obtain higher continuation and entry values and become more likely to enter and less likely to exit. As a result, the number of small stores increases by on average 1.591 in restrictive markets and 0.135 in liberal markets. The magnitudes of these changes might appear small at first, but given that a medium sized market has only three large stores and nine small stores, the changes are more substantial.

Consumer surplus increases because consumers benefit from new store-type configurations where more small stores stay in operation, i.e., on average, by SEK 24.7 million in restrictive and SEK 63.7 million in liberal markets. Producer surplus decreases, i.e., the reduction in long-run profits for large stores outweighs the increase in long-run profits for small stores. Total welfare decreases because producer surplus falls considerably as the licensing fee is paid by all large stores. Welfare decreases more in restrictive markets (SEK -46.4 millions) than in liberal markets (SEK -20.4 millions). In addition, on average, licensing fees generate revenues to local governments of SEK 15 million in restrictive markets and SEK 60 million in liberal markets. In sum, the gains to consumers are not enough to compensate for the loss in stores' long-run profits, particularly in local markets that already have restrictive regulation.

Licensing fees for large stores in big cities only. To protect small stores in big markets where more consumers shop, we implement the licensing fee only in big markets (cities) (CF_2 in Table 9). A licensing fee that provides the same total revenues to the government as the 5 percent tax of large stores in all markets is a 7.1 percent tax on large stores in big cities only.[34]

The results are similar to those under CF_1, but the magnitudes are different. The value functions for large incumbents and entrants decrease, and there are fewer large stores (i.e., averages of -0.906 in restrictive and -0.103 in liberal). On the contrary, long-run profits of small stores increase and there is a net increase in the number of small stores in restrictive (0.396) and in liberal (0.299) markets. Compared to CF_1, the results in CF_2 give fewer large stores and more small stores in liberal markets; it may reflect that more big markets have liberal rather than restrictive regulation.

Consumer surplus increases, and the increase is higher in liberal markets. In restrictive markets, on average, a licensing fee in big cities only results in a higher increase in consumer surplus than does a licensing fee in all markets (i.e., SEK 31.7 million in CF_2 vs SEK 24.7 million in CF_1). Welfare decreases by on average SEK 9 million in restrictive markets and by SEK 19.3 million in liberal markets. The total change in welfare is negative due to the drop in producer surplus. The overall outcome of policy CF_2 is a small drop in total welfare, especially in restrictive markets (SEK -9 million in CF_2 vs SEK -46 million in CF_1).

Higher entry costs for large stores. The third experiment increases the entry costs of large stores to protect small stores from large entrants (CF_3 in Table 9). This policy mimics a more strict regulation of entry of large stores, which is frequently debated among policymakers, e.g., Walmart's expansion in the US, hypermarket entrants in Europe, and especially the restriction of large entrants in the UK and France. We implement this policy such that the total increase in entry costs is the same as the government's total tax revenues under the licensing fee policies (CF_1 and CF_2), i.e., an increase in entry costs of large stores by SEK 1 million. We assume that there is no additional cost for local governments to be stricter against large stores.

The presence of fewer large store entrants reduces business stealing, increases incumbents' long-run profits, and implies less exit on the part of both store types. The average changes in long-run profits, however, are small, but dispersion is high. Moreover, long-run profits for large stores increase more in liberal markets than in restrictive markets. While the number of large stores remains almost unchanged, there is a net increase on average in the number of small stores in restrictive (0.914) and in liberal (0.622) markets.

There are important differences in the mechanisms for how a licensing fee on large stores and higher entry costs for large stores influence market structure and profitability for incumbents and

[34] Big cities are defined based on our sample of markets for which we exclude the metropolitan areas Stockholm, Göteborg and Malmö.

entrants. A licensing fee makes large incumbents worse off and protects small stores by increasing their long-run profits. On the contrary, higher entry costs for large stores restrict new entrants and decrease their pressure on small stores.

Consumer surplus increases and producer surplus decreases, although the magnitudes are substantially lower than under the licensing fee policy.[35] Producer surplus, which is nonlinear in the number of stores, decreases on average by SEK 6.6 million in restrictive markets and by SEK 2.1 million in liberal markets. The total welfare change is negative in restrictive markets (i.e., SEK -4.2 million) and positive but small in liberal markets (i.e., SEK 7.2 million). In sum, the welfare results from policies that restrict large stores suggest that it is preferable to increase the entry cost (CF_3) rather than introduce licensing fees (CF_1 and CF_2).

6.2. More liberal entry policies. The second set of policies encourage entry. We first decrease the entry cost of small stores by 15 percent (CF_4). Then we decrease the entry cost for large stores (CF_5) such that the total entry cost reduction is the same as in CF_4. As before, we assume that there are no additional costs for local governments to allow more small or large stores to enter.

Lower entry cost for small stores. The direct effect of lower entry costs for small stores is an increase in the probability to enter and lower entry values for small stores (CF_4 in Table 10). The long-run profits for small stores decrease, and their probability of exit increases in liberal markets. Long-run profits for large stores also decrease, and there is slightly more entry and exit. While there is a net increase in the number of small stores in both restrictive (0.946) and liberal (1.541) markets, there are modest changes in the number of large stores (0.052 in restrictive and 0.089 in liberal markets). The number of small stores per market thus increases by 10 percent in restrictive markets and by 13 percent in liberal markets, on average. That small entrants do not force large stores to exit highlights the importance of analyzing the long-run asymmetries between store types as well as the fact that there is room for more stores than under the current regulation.

Consumer surplus increases by on average SEK 30.9 million in restrictive markets and by SEK 71.4 million in liberal markets; consumers access more small stores, and large incumbents continue to operate. Because small entrants do not compete fiercely with large incumbents, the loss in producer surplus is lower than under the policy regimes that target large stores to protect small incumbents (CF_1-CF_3). Total welfare increases in both restrictive (by SEK 36.2 million) and liberal (by SEK

[35]The high dispersion in the changes in the continuation values suggests that the average change in producer surplus is positive in several market configurations.

91.1 million) markets.

Lower entry cost for large stores. The fifth experiment decreases entry costs of large stores (CF_5 in Table 10).[36] The presence of more large store entrants intensifies competition and reduces the long-run profits of small and large entrants and incumbents. Large store entry is more likely in liberal markets. Long-run profits of large entrants decrease about five times more in liberal than in restrictive markets. Long-run profits for small incumbents decrease about ten times more in liberal than in restrictive markets. At the same time, small stores are less likely to enter. Because of more intense competition, both more small stores and large stores exit. The net change in market structure is, on average, more large stores (1.072 in restrictive and 1.131 in liberal markets) and fewer small stores (-0.062 in restrictive and -1.359 in liberal markets). This implies 18 percent more large stores per market and 8 percent (1 percent) fewer small stores in liberal (restrictive) markets, on average.

Consumer surplus increases primarily because more large stores operate in the market. Strong competition from new large stores transfers into lower prices and better quality and variety. As the continuation values of both large and small incumbents decrease, producer surplus falls. The increase in consumer surplus off-sets the reduction in producer surplus and total welfare increases. The average local market welfare increases by 7-9 percent by encouraging small stores (CF_4) and 6-8 percent by encouraging large stores (CF_5).

We conclude that the more liberal policies yield welfare improvements. Although the policies that protect small stores (CF_1-CF_3) produce governmental revenues, these are not enough to compensate for the losses in producer surplus generated by such policies. Aggregate industry-level welfare is maximized based on discriminatory policy applied across markets in various degrees of regulatory stringency, i.e., to stimulate small entrants in liberal markets (SEK 21,676 million) and large entrants in restrictive markets (SEK 19,632 million).

The dynamic implications captured in the counterfactual policy experiments cannot be summarized by a static model. Policies that target entrants or incumbents of a specific store type affect market structure dynamics differently through channels such as consumer substitutability and asymmetric store type competition. Our findings show that it is crucial to use a dynamic model of endogenous entry, exit and demand for differentiated products to correctly evaluate long-run market outcomes and welfare from alternative policy environments.

[36] Because of the different magnitudes of policy changes, the decrease in entry cost of large stores in CF_5 does not exactly mirror the increase in entry cost of large stores in CF_3.

6.3. Heterogeneity across local markets. To highlight heterogeneity across local markets, Table 11 shows welfare differences among restrictive and liberal markets across three market sizes (small, medium, big). Higher entry costs for large stores (CF_3) implies welfare improvements in small and medium markets. In the case of both restrictive and liberal markets, welfare decreases in big markets. In smaller markets, the benefits to consumers outweigh the losses for stores when entry is restricted. In larger markets, there is enough demand such that consumer surplus does not increase to the extent that the overall effect on welfare is positive. An increase in the entry cost for large stores (CF_3) improves welfare more than a licensing fee policy for large stores in big markets (CF_2) in small markets. The differences are driven by larger losses in producer surplus under the licensing fee. Small markets are affected by the policies imposed in big markets because there are changes in entry and exit strategies in small markets to compensate for the losses in big markets.

Welfare improvements from more liberal entry policies are driven by medium and big markets. A more liberal policy toward the entry of small stores (CF_4) creates larger welfare improvements than does a policy that encourages entry by large stores (CF_5) in medium and big markets. The competition between large stores can bring welfare improvements in small markets because it induces reallocation of market shares from small to large stores and increases product differentiation. High demand prompts more small stores to enter medium and big markets. Small stores can operate effectively in larger markets that are densely populated. Consumers then benefit from lower prices and better quality and variety from more small stores. In summary, the heterogeneity across markets shows that the gain in total welfare comes from medium and big markets.

7. ROBUSTNESS ANALYSIS

Our main findings are robust to alternative measures of regulation and profits, different demand and profit function specifications, and changes in the number of potential entrants. We also highlight possible extensions of the dynamic model.

Regulation measures. Our empirical findings are robust to several regulation measures, including different definitions and cut-off points of the regulation index. Online Appendix H presents results using different weights of the variables in the index, and defining liberal (restrictive) markets as those with a non-socialist (socialist) majority in local governments.

Number of potential entrants. To re-compute the new transition probabilities in the counterfactual policy experiments, we use the number of potential entrants of each store type (Section 5.2). The new transition probabilities for incumbents and entrants are computed using the structural formulas in POB (pp. 383). As discussed in Section 5.2, we checked and confirm the robustness of our counterfactuals with respect to the Poisson distribution specification for the potential entrants using extensive simulations with different values for the mean of the distribution. Assuming a fixed number of potential entrants from an internal or external pool may be overly restrictive for retailing because it is difficult to define an external pool and the internal pool is sensitive to changes in local conditions and store type combinations. To relax these restrictions, we assume that the number of potential entrants of each store type comes from a Poisson distribution and that the mean of this distribution is not influenced by changes in the degree of regulation.

A proper model of the endogeneity of potential entrants with respect to regulation is left to future research because it substantially complicates the modeling framework and computations and requires additional assumptions. Changes in regulation might affect entry by changing the number of potential entrants. In our opinion, this is not as pronounced in our application to the Swedish retail food market as in many other industries for at least two reasons. First, there was no structural shift in regulation during the study period. Second, we observe multiple entries of large stores in local markets in two or more consecutive years in the data. Based on discussion with market participants and given that the number of stores decreases over time, it is unreasonable to assume that there are an infinite (or very large) number of potential entrants in the Swedish retail food industry. We observe a constant trend toward larger but fewer stores over time, and the aggregate demand for food products is not likely to change drastically over time.

Demand specification. In the demand analysis, we consider a product basket that contains 11 products (online Appendix B). Our main results are robust to using a small product basket with only three products. The results solely indicate changes in the size of profits and costs; however, the cost ratio for small and large stores remains the same. The profit estimates are robust to using sales instead of quantity to construct market shares in the demand estimation (Section 4.1).[37]

In the main specification, we use a large basket for both store types and controls for sales space, which allows us to compare prices across store types for the same basket. Large stores offer more products than small stores, and it may be important to allow for different baskets for small and large stores. Our main results remain robust when using different product baskets for store types

[37] Demand estimates using market shares based on sales are available from the authors upon request.

(online Appendix G). Using a small basket for small stores and a large basket for large stores, we find somewhat smaller price, cross-price elasticities and own-price elasticities. However, the static findings that drive the dynamics mechanisms remain robust; i.e., (i) the consumer surplus is lower than the producer surplus; and (ii) the consumer surplus is larger in liberal markets. Because the quality of the results does not change, we focus on the estimation that uses the same basket for both store types.

In addition to cost shifters, for robustness, the paper also uses additional instruments to identify the price coefficient: (i) the average prices of stores of the same type in other local markets (Hausman, 1997; Nevo, 2001); (ii) the sum of the sales space of other stores with the same owner and the sum of the sales space of other stores of the same type but with a different owner (BLP instruments) (Berry et al., 1995). Our main findings are robust to the use of these additional instruments. It is important to note that using these instruments requires us to make additional assumptions.

Cost estimates and sell-off values. Our entry costs are closer to those in Table 6 if we estimate sell-off values instead of fixed costs (online Appendix C). The normalization assumption that is used for identification in this case is that fixed costs are zero, whereas the corresponding assumption in the model in Section 3 is that the sell-off value is zero (Aguirregabiria and Suzuki, 2014).

Modeling firm. Because of computational complexity, this paper controls solely for firm/owner in the static component of the model (the discrete choice demand). To investigate whether it is reasonable to abstract from owners, we run reduced-form regressions on owners. We find that the owner dummy variables are not statistically significant in simple store-level probit regressions of entry and exit (online Appendix I). Although this approach has various disadvantages, it confirms that owners do not play an important role in our setting. However, using the framework to understand store dynamics on the basis of the firm/owner is straightforward, e.g., to drop the store type and instead model the number of stores that are affiliated with ICA and Coop. In addition, it is straightforward to extend our model to include differentiation in both type and location. The major constraints are the dimensionality of the state space and computational complexity.

8. CONCLUSIONS

This paper examines store dynamics, cost structures, and welfare in the retail food market using a structural model of demand, entry and exit. The framework, which builds on Pakes et al. (2007), allows for differentiation in store type. We highlight the role of asymmetries between heterogeneous players in industry dynamics, an aspect that is difficult to assess using theory, two-period static entry models or dynamic models with the entry and exit of homogeneous stores. We estimate the sunk entry costs and fixed costs for small and large stores in markets with different degrees of regulation to evaluate the role of regulations in determining industry dynamics and welfare changes. Based on the structural estimates, we perform counterfactual simulations to quantify the impact of entry regulations on long-run profits, market structure and welfare.

Using unique data on all retail food stores in Sweden from 2001 to 2008, we find strong competitive effects of large stores and different cost structures for small and large stores. The estimates of own- and cross-price elasticities, short- and long-run profits, and fixed and entry costs show asymmetries between store types. Under the current regulation, entry costs for large stores are lower and average welfare is higher in local markets with liberal rather than restrictive regulation. The discounted producer surplus is on average about four times larger than the discounted consumer surplus.

The estimated parameters of the dynamic model are used to perform counterfactual policy experiments that mimic frequently debated regulatory regimes in the US and in Europe. First, to protect small stores by imposing a licensing fee or higher entry costs for large stores is not welfare improving, in particular in markets that already face a restrictive regulation. Second, to promote competition by lowering the entry costs for either small or large entrants is welfare enhancing. Average discounted producer surplus decreases slightly more when promoting entry of large stores rather than small stores, whereas the increase in average discounted consumer surplus is similar. On average, local market welfare increases 7-9 percent from encouraging small stores and 6-8 percent from encouraging large stores. Our cost reduction of large stores leads to 18 percent more large stores per market, as well as 8 percent fewer small stores per liberal market and 1 percent fewer stores in restrictive markets, on average. The cost reduction of small stores results in an increase of their type by 13 percent in liberal markets and 10 percent in restrictive markets, along with a minor increase in the number of large stores. Aggregate welfare at the industry level increases the most from lower entry costs for small stores in liberal markets and for large stores in restrictive markets, clearly illustrating that heterogeneity across stores and markets are crucial. Welfare improvements are primarily driven by medium and big markets. To accurately evaluate how alternative entry regulation policies affect welfare, it is crucial to account for the fact that changes in the costs of one store type influence pricing, long-run profitability, and endogenous entry and exit of the rival store type.

In future research, the importance of spatial differentiation and ownership in determining the observed differences in cost structure and welfare could be assessed. The effect of labor costs and new technology on market structure dynamics could also be determined.

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TABLE 1
Characteristics of the Swedish retail food market

Year	No. of stores		No. of	No. of	Sales space (m^2)		Sales	
	total	share large	entrants	exits	total	share large	total	share large
2001	5,240	18.2		385	2,783,921	0.578	155,312,368	0.580
2002	4,926	19.3	71	157	2,704,713	0.579	158,576,880	0.596
2003	4,882	19.6	113	240	2,770,370	0.582	167,942,368	0.601
2004	4,770	19.8	128	257	2,791,441	0.579	172,090,400	0.600
2005	4,680	20.0	167	242	2,885,817	0.576	175,726,624	0.600
2006	4,564	20.5	126	198	2,928,130	0.590	181,214,288	0.611
2007	4,489	21.3	123	193	2,983,612	0.604	188,431,040	0.616
2008	4,398	21.7	102		3,082,295	0.605	193,053,040	0.618

NOTE: DELFI is provided by Delfi Marknadspartner AB and contains all retail food stores based on their geographical location (address). Large stores are defined as the five largest store types in DELFI (hypermarkets, department stores, large supermarkets, large grocery stores, and other stores). Sales (incl. 12 percent VAT) are measured in thousands of 2001 SEK (1 USD=9.39 SEK, 1 EUR=8.34 SEK).

TABLE 2
Aggregate statistics of local markets

	Structure				Demand		Dynamics	
Market type	No. of small	No. of large	Sales small	Sales large	Population	Per-capita income	Entry rate	Exit rate
Small markets								
Restrictive	7.4	2.6	11,439.3	55,640.6	9,304.0	130.7	0.012	0.042
Liberal	6.8	2.6	13,602.6	81,668.0	11,932.0	127.6	0.014	0.045
Medium markets								
Restrictive	9.3	3.4	9,933.7	74,972.0	14,030.0	130.7	0.010	0.045
Liberal	9.4	4.0	10,421.6	94,964.8	23,900.5	139.8	0.015	0.050
Big markets								
Restrictive	20.1	6.3	9,625.8	89,347.3	37,115.0	132.7	0.022	0.054
Liberal	22.5	8.3	11,918.7	111,567.3	60,422.0	142.2	0.018	0.045

NOTE: The figures for number of stores, sales (in thousands SEK), and entry and exit rates represent mean values across local markets and years. The figures for population and income per-capita (in thousands SEK) represent median values across local markets and years.

TABLE 3
Estimated parameters of the demand equation: Nested logit

	OLS		2SLS			
					First-stage	
	Coef.	Std.	Coef.	Std.	F-test	p-value
Price	0.016	0.0009	0.019	0.004	593.75	0.000
Market share (grp)	0.971	0.007	0.637	0.169	748.00	0.000
Log of space(m^2)	0.198	0.021	0.401	0.132		
Log of income	0.672	0.051	1.298	0.300		
Log of income squared	-0.063	0.002	-0.110	0.010		
ICA	1.403	0.058	1.881	0.234		
Axfood	1.312	0.062	1.624	0.129		
Coop	1.272	0.067	1.806	0.223		
Bergendahls	0.968	0.118	1.266	0.215		

NOTE: F-tests report the first-stage F-statistic that the coefficients on the instruments are all zero.

TABLE 4
Average estimated own and cross price elasticities by store type

	Own	Cross same type	Cross rival type
Small	-3.871	0.125	0.221
	(0.423)	(0.138)	(0.051)
Large	-3.001	0.841	0.031
	(0.629)	(0.466)	(0.007)

NOTE: Boostraped standard errors are in parentheses. Cell entries r, c, where r indexes row and c column, give the percentage change in market share of r with 1 percent change in price of c.

TABLE 5
Summary of the Nash-Bertrand equilibrium outcome

Market type	Price				Price-cost margin(%)		Total consumer surplus	Total producer surplus
	Small		Large		Small	Large		
	Estim.	Obs.	Estim.	Obs.				
Restrictive	211.4	209.3	192.01	199.67	10.28	9.77	13.43	113.50
	(4.66)		(4.03)		(1.52)	(0.44)	(9.2)	(56.91)
Liberal	208.65	208.9	193.38	196.7	8.97	10.09	21.73	108.60
	(2.14)		(4.76)		(2.59)	(0.69)	(14.41)	(96.49)

NOTE: The figures represent the mean and standard deviation (in parentheses) of the equilibrium outcomes of generated state space. Price is in SEK (1 USD=9.39 SEK, 1 EUR=8.34 SEK). Total consumer and producer surplus are in millions SEK.

TABLE 6
Estimation results for structural parameters

Store type	Entry cost		Fixed cost
	Restrictive markets	Liberal markets	
Small store	10.700	11.416	1.219
	(1.191)	(1.431)	(0.293)
Large store	179.625	118.618	10.274
	(25.275)	(16.394)	(2.001)

NOTE: Bootstrapped standard errors are presented in parentheses. Fixed cost follows an exponential distribution. The entry costs for small and large stores (κ_{small} and k_{large}) follow a unimodal distribution with parameters a_1 and a_2.

TABLE 7
Comparison between observed data and model prediction

	Restrictive markets		Liberal markets	
	Data	Model	Data	Model
Small markets				
Number of small stores	7.469	5.684	6.808	6.014
Number of large stores	2.638	2.445	2.643	2.610
Share of small stores	0.711	0.641	0.685	0.649
Share of large stores	0.288	0.358	0.314	0.350
Medium markets				
Number of small stores	9.348	9.420	9.360	10.729
Number of large stores	3.411	3.352	4.040	4.770
Share of small stores	0.708	0.712	0.685	0.679
Share of large stores	0.291	0.287	0.314	0.320
Big markets				
Number of small stores	20.069	20.560	22.526	23.245
Number of large stores	6.348	6.550	8.291	9.433
Share of small stores	0.744	0.733	0.713	0.691
Share of large stores	0.255	0.266	0.286	0.308

NOTE: The figures represent the mean values across observed states (2001-2008) and the simulated model states beginning from 2001.

TABLE 8
Dynamic competition and welfare effects: Average marginal effects of an additional store

	Incumbents (VC_z)		Potential entrants (VE_z)		Prob. of exit (p_z^x)		Prob. of entry (p_z^e)		Discounted	
	Small	Large	Small	Large	Small	Large	Small	Large	Consumer surplus	Producer surplus
Restrictive										
No. of small	-0.006	-0.022	-0.016	-0.002	0.001	0.002	-0.008	-0.009	0.012	-0.010
No. of large	-0.028	-0.036	-0.047	-0.029	0.006	0.004	-0.029	-0.115	0.031	-0.035
Liberal										
No. of small	-0.036	-0.012	-0.006	-0.006	0.007	0.000	-0.019	-0.012	0.002	-0.012
No. of large	-0.019	-0.027	-0.068	-0.037	0.004	0.001	-0.046	0.012	0.040	-0.049

NOTE: The figures represent mean values of the marginal effects of one additional store in the market on the log of value functions, entry and exit probabilities, and log of discounted consumer and producer surplus. The value functions, entry and exit probabilities, and consumer and producer surplus are approximated using polynomial expansions in the state variables.

TABLE 9

Policy experiments: Changes in market structure and welfare due to licensing fees and increase in entry cost for large stores

	CF_1: Licensing fee for large in all markets		CF_2: Licensing fee for large in big markets		CF_3: Increase in entry cost for large	
	Restrictive	Liberal	Restrictive	Liberal	Restrictive	Liberal
Panel A: Small stores						
Long-run incumbents' profit (VC)						
Mean	0.10	0.12	0.36	0.11	0.36	0.21
Std.	0.22	0.45	0.60	0.44	0.60	0.74
Probability of exit (p^x)						
Mean	-0.005	-0.020	-0.019	-0.017	-0.019	-0.027
Std.	0.008	0.053	0.017	0.048	0.017	0.061
Long-run entrants' profit (VE)						
Mean	0.12	0.02	0.19	0.06	0.23	0.13
Std.	0.27	0.14	0.31	0.21	0.34	0.75
Probability of entry (p^e)						
Mean	-0.005	-0.003	-0.004	-9e-04	-0.003	-0.001
Std.	0.018	0.015	0.050	0.018	0.042	0.018
Net change in small stores/market						
Mean	1.591	0.135	0.396	0.299	0.914	0.622
Panel B: Large stores						
Long-run incumbents' profit (VC)						
Mean	-13.73	-15.83	-8.83	-12.13	0.25	0.50
Std.	7.78	17.30	11.02	21.28	2.74	12.81
Probability of exit (p^x)						
Mean	0.028	6e-04	0.002	0.001	-0.002	-0.009
Std.	0.040	0.002	0.019	0.004	0.041	0.046
Long-run entrants' profit (VE)						
Mean	-5.50	-15.76	-4.67	-16.05	0.21	0.37
Std.	5.62	12.14	5.62	13.07	1.66	3.44
Probability of entry (p^e)						
Mean	-0.012	-0.015	-0.014	0.002	-0.005	-0.002
Std.	0.033	0.034	0.038	0.020	0.016	0.029
Net change in large stores/market						
Mean	-1.385	-0.074	-0.906	-0.103	0.057	0.018
Panel C: Welfare						
Discounted consumer surplus						
Mean	24.72	63.75	31.79	61.05	15.23	23.53
Std.	28.85	64.44	26.03	62.52	20.31	42.66
Discounted producer surplus						
Mean	-75.14	-86.20	-34.08	-83.54	-6.65	-2.12
Std.	63.32	94.69	74.15	130.61	32.03	51.48
Welfare						
Mean	-46.49	-20.45	-9.06	-19.27	-4.22	7.28
Std.	72.54	128.53	59.49	164.79	43.02	88.81
Percentage change	-10.09	-3.02	-2.27	-4.25	-0.99	3.83
Change at the industry	-11,575.25	-5,480.02	-2,002.46	-5,163.988	-1,761.69	1,514.14

NOTE: The mean and standard deviation are computed based on the observed states in the data. The total welfare is computed as the sum of the discounted consumer and producer surplus. VC, VE, consumer surplus, producer surplus, and welfare are in millions of SEK (1 USD=9.39 SEK, 1 EUR=8.34 SEK). The counterfactuals CF_1, CF_2, and CF_3 are similar, with respect to the total sum collected by the government. CF_1 – licensing fees for large store incumbents in all markets; CF_2 – licensing fees for large store incumbents in large markets; CF_3 – higher entry costs of large stores.

TABLE 10

Policy experiments: Changes in market structure and welfare due to more liberal entry policies

	CF_4: Lower entry cost for small		CF_5: Lower entry cost for large	
	Restrictive	Liberal	Restrictive	Liberal
Panel A: Small stores				
Long-run incumbents' profit (VC)				
Mean	0.29	-0.13	-0.02	-0.23
Std.	0.54	0.70	0.70	1.13
Probability of exit (p^x)				
Mean	-0.031	0.002	0.001	0.001
Std.	0.078	0.072	0.010	0.001
Long-run entrants' profit (VE)				
Mean	-0.02	-0.11	0.41	0.01
Std.	0.21	0.19	0.79	0.56
Probability of entry (p^e)				
Mean	0.008	0.012	-0.004	-0.002
Std.	0.054	0.034	0.048	0.016
Net change in small stores/market				
Mean	0.946	1.541	-0.062	-1.359
Panel B: Large stores				
Long-run incumbents' profit (VC)				
Mean	-3.17	-3.03	-4.34	-3.36
Std.	2.98	7.25	3.17	5.35
Probability of exit (p^x)				
Mean	0.008	9e-04	0.002	6e-04
Std.	0.017	0.010	0.011	0.008
Long-run entrants' profit (VE)				
Mean	-1.42	-10.30	-2.00	-10.33
Std.	2.09	12.63	2.50	12.38
Probability of entry (p^e)				
Mean	3e-04	0.002	2e-04	0.006
Std.	0.002	0.016	0.001	0.022
Net change in large stores/market				
Mean	0.052	0.089	1.072	1.131
Panel C: Welfare				
Discounted consumer surplus				
Mean	30.91	71.45	28.81	68.68
Std.	25.33	71.41	21.85	68.99
Discounted producer surplus				
Mean	-6.44	-2.72	-14.35	-7.38
Std.	26.89	45.34	30.59	40.18
Welfare				
Mean	36.21	91.08	27.16	82.49
Std.	34.14	84.71	33.07	77.09
Percentage change	7.57	8.65	6.17	7.83
Change at the industry	8,001.78	21,676.68	19,632.8	6,002.5

NOTE: The mean and standard deviation are computed based on the observed states in the data. Welfare is computed as the sum of the discounted consumer and producer surplus. VC, VE, consumer surplus, producer surplus, and welfare are in millions of SEK (1 USD=9.39 SEK, 1 EUR=8.34 SEK). The counterfactuals CF_4 and CF_5 are similar, with respect to the total sum collected by the government. CF_4 – 15 percent lower entry cost for small stores; CF_5 – lower entry cost for large stores.

TABLE 11
Policy experiments: Market size and heterogeneity of welfare changes due to policy modifications

	Small markets		Medium markets		Big markets	
	Restr.	Lib.	Restr.	Lib.	Restr.	Lib.
CF_1: Licensing fee for large stores in all markets						
Discounted consumer surplus						
Mean	21.94	24.67	24.95	98.59	26.10	59.48
Std.	0.24	0.95	29.61	63.10	35.70	66.15
Discounted producer surplus						
Mean	-37.16	-35.36	-52.93	-76.75	-112.21	-100.04
Std.	41.77	40.76	41.59	60.64	66.67	108.05
Welfare						
Mean	-15.22	-10.89	-30.60	24.94	-75.22	-40.00
Std.	41.76	41.10	47.90	107.52	88.83	142.94
Change at the industry	-897.99	-381.15	-2,478.24	1,621.35	-8,199.00	-6,720.22
CF_2: Licensing fee for large stores in big markets (equivalent of CF_1)						
Discounted consumer surplus						
Mean	22.13	24.72	33.14	99.10	36.01	55.15
Std.	0.29	0.97	21.45	63.46	33.83	62.54
Discounted producer surplus						
Mean	-5.48	-17.90	-9.06	-20.55	-70.99	-120.39
Std.	10.96	37.04	36.65	55.78	98.47	147.64
Welfare						
Mean	16.65	6.62	8.46	77.93	-41.60	-62.27
Std.	11.05	37.22	33.90	87.13	78.67	185.87
Change at the industry	982.07	231.73	634.39	5,065.36	-3,618.93	-10,461.09
CF_3: Increase in entry cost of large stores (equivalent of CF_1)						
Discounted consumer surplus						
Mean	22.04	24.72	13.28	17.61	12.16	24.37
Std.	0.14	0.97	20.01	34.94	25.82	49.47
Discounted producer surplus						
Mean	-2.42	-0.64	-9.07	-7.45	-7.14	-0.53
Std.	12.38	37.50	30.86	32.45	39.69	58.89
Welfare						
Mean	19.20	15.26	-0.25	39.94	-25.47	-3.16
Std.	11.69	63.91	34.08	66.09	54.04	97.26
Change at industry	1,113.69	549.50	-325.74	1,397.98	-2,549.64	-433.34
CF_4: Decrease in entry cost of small stores						
Discounted consumer surplus						
Mean	22.06	24.73	35.15	98.48	32.52	72.17
Std.	0.30	0.97	25.74	63.63	30.43	77.04
Discounted producer surplus						
Mean	-5.20	0.21	-8.22	-8.78	-5.85	-1.21
Std.	12.52	39.24	17.65	38.34	36.25	48.64
Welfare						
Mean	17.40	30.43	35.94	108.86	48.41	98.67
Std.	11.80	44.15	36.51	67.31	36.47	91.94
Change at the industry	1,008.94	1,065.15	2,587.48	6,205.08	4,405.35	14,406.44
CF_5: Decrease in entry cost of large stores (equivalent of CF_4)						
Discounted consumer surplus						
Mean	22.14	24.72	31.53	98.00	30.38	67.88
Std.	0.34	0.97	22.69	64.67	26.16	73.10
Discounted producer surplus						
Mean	-2.49	2.39	-14.90	-11.15	-20.27	-8.08
Std.	12.28	25.33	20.75	24.92	40.17	46.17
Welfare						
Mean	19.66	30.63	23.54	97.21	35.11	89.47
Std.	12.15	33.93	33.50	62.01	40.07	85.11
Change at the industry	1,159.65	1,102.851	1,718.41	5,735.26	3,124.44	12,794.68

NOTE: The mean and standard deviation are computed based on the observed states in the data (1 USD=9.39 SEK, 1 EUR=8.34 SEK). Welfare is computed as the sum of the discounted consumer and producer surplus.

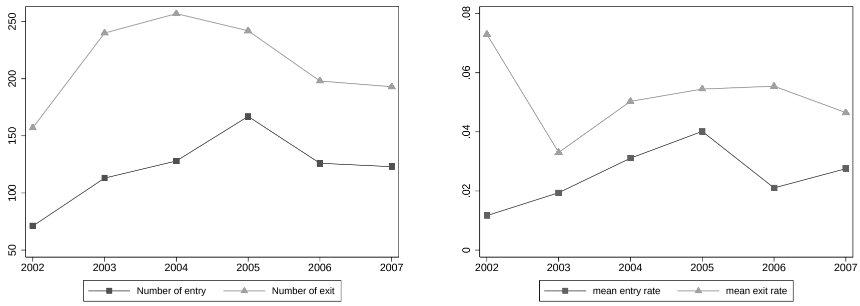

Figure 1
Total number of entries and exits in Sweden, and mean entry and exit rates across local markets 2002-2007