How do 'Big-Box' Entrants Influence the Productivity Distribution in Swedish Food Retailing?*

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Comments are welcome

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Abstract

This paper deals with explanations of large and persistent productivity differences across food retailers by arguing that large ('big-box') entrants in local markets are important for creating the observed productivity differences. To estimate firm productivity, we use a dynamic structural model controlling for large entrants and unobserved prices. How large entrants influence productivity moments in local food retailing are then evaluated using Swedish data. The question posed is of certain interest due to the existing entry regulation in Sweden. The preliminary results indicate that large entrants increase lower-bound and median productivity, and decrease dispersion. We conclude that large entrants play a central role for productivity growth.

Keywords: Retail markets; Imperfect Competition; Industry dynamics; space productivity; TFP; Dynamic structural model

JEL Classification: O3, C24, L11.

1 Introduction

■ Persistent differences in productivity as well as considerable entry and exit of firms are observed phenomena within industries. In the literature, firm dynamics is emphasized to be important for productivity and growth.[1] Although retail markets constitutes for an extensive and increasing share of modern economies, the market has received surprisingly scarce attention in the field of industrial organization. In retail markets, large ('big-box') firms have gained market shares and the total number of firms has decreased during the past decades both in U.S. and many European countries. To a high extent, entry of new establishments are constrained by national entry regulations.[2] The general idea is that the pros and cons of a new entrant should be carefully analyzed before allowing a firm to enter. Sweden is no exception from the just mentioned facts. The potential consequences on competition caused by large chain entrants need to be put forward on the research agenda.[3] The paper examines how large ('big-box) entrants' influence productivity moments of incumbent firms in the Swedish retail food market. First, we estimate firm productivity using a dynamic structural model explicitly incorporating large entrants as well as price- and demand shocks. Second, we evaluate the effect of large entrants on the future productivity distribution in local markets. In addition to estimated firm productivity, we also consider standard benchmark measures of labor productivity and space productivity. The question posed is of policy concern due to the existing planning regulation giving the local governments the power to decide over the use of land and water and, consequently, whether or not a firm is allowed to enter. To our knowledge, this is the first paper analyzing how large entrants affect incumbents' productivity in Swedish food retailing. We contributes to the literature by estimating firm productivity using a dynamic framework suited for retailers and, moreover, by analyzing its distribution in local markets in the light of the entry regulation.

In the first part of the paper, we estimate firm level productivity based on an extension of the structural dynamic framework of Olley and Pakes (1996) (OP). OP uses the implications of a dynamic Markov perfect equilibrium model to recover

[1]See Ericson and Pakes (1995), Hopenhayn (1992) and Jovanovic (1982) for theoretical contributions. See Aghion et al. (2006), Caves (1998) and others for empirical contributions.

[2]The majoriy of OECD countires have entry regulations consisting of local or regional planning. Some countries, e.g. France, Italy, Belgium, Spain and Japan, have specific legislation particularly aimed at the entry of large firms (Pilat (1997)).

[3]The Swedish Competition Authority (2004:2), The Swedish Competition Authority (2001:4)

serially correlated productivity terms. Incumbent firms are assumed to take their decisions in each time period based on their current state variables and market condition information. The advantage of using a dynamic model is that, in contrast to static setups, firms respond to changes in the environment. Hence, we jointly analyze large entrants impact on firms' productivity as well as changes in input and exit decisions. We explicitly model how these choices are being made. The framework allows us to control for selection bias and simultaneity bias when estimating productivity.[4]

We go beyond and extend the OP framework to suit the retail food market. To start with, retail firms are close to consumers and competition is mainly taking place at the local level. In contrast to OP, we therefore consider a number of (independent) local markets. Second, we recover productivity from the firms' optimal choice of labor following Doraszelski and Jaumandreu (2006) i.e. a further difference to OP is that labor has dynamic implications. Third, the effect on productivity caused by large entrants are explicitly incorporated when estimating productivity. We emphasize the importance of large entry on productivity for two reasons: First, large entrants are the core of the ongoing structural development in Swedish food retailing. The national chains have worked out clear firm concepts among which large ('big-box') firms have grown most, a trend that is also present in many other countires (Clark and Waterson (2002)).[5] Second, because local market size differ by firm type, we anticipate large entrants to have a larger impact on the market structure compared to small entrants.[6] Thereby, large entrants need to be extensively evaluated in the planning process (Boverket (1999)). The final difference to OP is that we incorporate that the retail food market is characterized by differentiated products by relaxing the assumption of perfect competition. The estimated production function will capture price and demand shocks that we control for by

[4]See Olley and Pakes (1996) for a detailed discussion. In addition to OP, this line of research also includes contributions by De Loecker (2006), Doraszelski and Jaumandreu (2006), Ackerberg et al. (2005), Levinsohn and Petrin (2003) and a long list of applications.

[5]Large firms have for example greater opportunities to innovate in new technologies that could be applied by smaller firms later. In addition, new buildings are commonly used for large entrants that are externally located.

[6]If a small firm enter, a limited number of consumers are anticipated to purchase in the new firm. On the other hand, if a large firm enter we expect an extensive share of the local market population as potential consumers.

introducing a demand system as in Klette and Griliches (1996).[7] Firms are assumed to take their idiosyncratic (market-specific) demand state into account when they hire inputs. We identify a demand parameter from production data by substituting the inverse demand system for the unobserved prices.

Summarizing our dynamic structural model for estimating productivity we have that firms' decisions to invest and how much to invest in capital and labor depend on the market conditions and the number of large entrants in the market. The unobserved firm productivity can then be expressed as a function of labor, capital, investment, number of large entrants and demand conditions.[8] We have two motivations for not using a fully dynamic model: lack of price information at the firm level and the troublesome work to define potential entrants (due to the entry regulation).[9]

In the second part of the paper, we use the estimated firm productivity from the first part to evaluate the effect of large entrants on the future productivity distribution in local markets. In other words, we relate how the productivity moments, e.g. dispersion, of future productivity are affected by large entrants.[10] Our focus on the distribution of productivity gives a deep understanding how productivity changes as large firms enter. General method of moments are used throughout the estimations of the productivity distribution in order to consider the endogenerity issues. Retailers' definition of output includes the *service* element that vary from very large to very small depending on their focuses. Output depends on the quality of services provided by the labor as well as on adoption of new technology. Therefore, we also examine standard benchmark measures such as labor productivity (value added per

[7] In our data, prices are unobserved and the standard approach has been to use the price index of the industry as a proxy. However, the price index is valid only when all firms sell homogeneous products which is unreasonable in the setting of retail food. De Loecker (2006) and Doraszelski and Jaumandreu (2006) also use the same demand system.

[8] The endogenous productivity model justifies the retention of observations with non-positive investment in the retail sector (few firms invest in capital every year in the retail sector). Without incorporating demand and large entrants, the only unobserved firm-specific state variable (productivity) in the investment function is unlikely to hold when the markets are segmented (Syverson (2004)).

[9] It is not reasonable to assume that the decisions to enter are made simultaneously due to the entry regulation that force firms to propose a formal application to the municipality before they enter.

[10] Adding competition (large entrants) to the productivity analysis, we might expect inefficient firms to be punished harder than efficient ones when competition increases i.e. large firm enters (Boone et. al., 2005).

wages), and space productivity (sales per square meter).[11]

Our research yields several important findings. The empirical results show that TFP, labor productivity and space productivity increase in local markets where large firms enter. Improvements in productivity are found both for the median firm and among the least efficient firms. In addition, productivity dispersion declines. We conclude that large entrants play a central role for productivity growth in food retailing. The results can serve as a basis for policy discussions of the entry regulation in Sweden. They might also be useful in a broader context, especially for countries with similar legislation.

The rest of this preliminary and incomplete version of the paper is organized as follows; Section 2 presents related literature whereas Section 3 gives an overview of the market. Section 4 describes the data and the market definition. Section 5 presents the modeling approach and estimation of firm productivity (TFP). Local market productivity is specified in Section 6 followed by empirical results in Section 7. Finally, Section 8 concludes.

2 Related Literature

The present study is closely connected to two strands of literature. The first relates to productivity and firm dynamics whereas the second links to empirical papers on local markets including entry studies and a growing literature on productivity distribution. Meanwhile, we will also shed light on investigations regarding entry regulation and productivity in the retail sector.

Productivity and its connection to firm entry and exit within industries has been analyzed in the theoretical literature (Ericson and Pakes (1995), Hopenhayn (1992) and Jovanovic (1982)). There is also a long list of empirical productivity studies, mainly on manufacturing, for which Bartelsman and Doms (2000) provide an excellent survey. Moreover, a growing literature on heterogeneity in productivity within industries using dynamic structural models based on investments has developed (Ackerberg et al. (2005), Ackerberg and Pakes (2005), Levinsohn and Petrin (2003), Pavcnik (2002) and Olley and Pakes (1996)). Recent extensions on the OP framework emphasize the importance to control for price and demand shocks when estimating productivity (Jaumandreu (2006), Doraszelski and Jaumandreu (2006), De Loecker (2006), Katayama et al. (2003), Levinsohn and Melitz (2002) and Melitz

[11]See Reynolds et al. (2005) for detailed information about productivity measures in retail markets.

(2000)).

Few studies have examined the distribution of productivity in local markets. Asplund and Nocke (2006) provide testable implications on the distribution of productivities in local markets using a dynamic monopolistic setting. We are only aware of two empirical applications in the area. Syverson (2004) uses a static model and argues that demand explains an extensive part of the persistent productivity dispersion in the concrete industry. In addition, Collard-Wexler (2006) extends the just mentioned study to a dynamic oligopoly framework. The present paper is a contribution to this field of research.

Because retailers are located close to consumers, it is important to analyze local market competition in detail. In particular, the local perspective is essential from a policy point of view. To our knowledge, we are the first to apply the OP framework on local retail markets. A number of studies at the aggregated level found that entry and exit are important for productivity growth in the sector (Aghion et al. (2006), Foster, Haltiwanger and Krizan (2006), Pilat (2005), Haskel and Khawaja (2003), Reynolds et al. (2005)).[12] How large entrants influence local market competition and productivity growth has, anyhow, not been analyzed in detail. Coggins and Senauer (1999) emphasize that large firms increase the competitive pressure on incumbents making innovations, e.g. cost reductions and efficiency improvements, necessary for survival. Therefore, a restrictive entry policy may hit innovations and consequently the productivity of the whole industry. Noteworthy here is also a study by Asplund and Friberg (2002) finding that large firms in Sweden offer lower prices than other firms. We explicitly incorporate the effect of large entrants linking our study to the entry literature.[13] A series of papers use static models to analyze entry and market structure in well defined local markets (Bresnahan and Reiss (1991), Bresnahan and Reiss (1990) and Bresnahan and Reiss (1987)).[14] Until now, we are aware of few studies that develop fully dynamic models for local competition (Beresteanu and Ellickson (2006), Aquirregabiria and Vicentini (2006)

[12]Smith (2007) analyzes welfare effects of changes in firm characteristics such as size, location, brand and additional firms i.e. he can evaluate welfare effects caused by large entrants.

[13]The importance of competition for productivity has also been considered in recent applications of the OP framework (Maican (2006) and Muendler (2005)). Competition has been emphasized earlier in the productivity literature. Boone (2000) shows theoretical explanations for including competition when estimating productivity. There is also an extensive share of empirical studies of competition and productivity using static models, see for example Nickell (1996) and MacDonald (1994).

[14]See Jia (2006), Toivonen and Waterson (2005), Seim (2005), Mazzeo (2002) and Berry (1992) for extensions.

and Dunne et al. (2005)). Beresteanu and Ellickson (2006) examine the competition between supermarket chains using a structural investment model of dynamic oligopoly. They evaluate the impact of entry regulations that prevent growth of supercenters on investment, market structure, and consumer welfare. In addition, there are a couple of other attempts of analyzing the planning regulation in retail markets finding that regulation matter for the market outcome (Pilat (2005), Griffith and Harmgart (2005), Boylaud and Nicoletti (2001) and Hoj et al. (1995)). An important contribution by Bertrand and Kramarz (2002) state that retail markets in France have higher concentration and lower labor growth as a consequence of the regulation.[15]

3 Overview of the Swedish Retail Food Market

■ **The retail food market.** The strategy for retail food firms is to offer products, in each point in time, satisfying the requirements on prices, quality and service level demanded by consumers. Hence, in a setting of retail food markets demand is certainly important. Generally, successful operation of retail food firms include a complex set of requirements. The market is characterized by economies of scale including for example logistics, marketing, purchasing, and price setting. In the need of a common organization, three group of firms started to develop already in the beginning of the 1900s century. In the middle of the 1960s the combination of fridge and freezer and increasing car-use gave possibilities for consumers to purchase less frequently. The latter primarily became a basic condition for the opening of the first hypermarket in the 1960s. Since then the large, often externally located, firms have increased (Kylebäck (2004)). Contemporary to the gain in market shares among large firms, we observe a decline in the total number of firms, more centralized chains and well-defined firm concepts. Investments in information and communication technologies (ICT) is an important characteristic of the market. The introduction of scanner-techniques have given new opportunities to the market. Increasing sales without increasing labor has been possible due to improvements in for example supply chain management and self-scanning by consumers.

Today the Swedish market consists of the three chains; ICA, COOP and Axfood having almost 90 percent of the market shares. ICA, the largest chain with 45 percent of total sales, is historically an organization of independent firms collaborating

[15] Lack of data on the number of formal applications and rejections constraint us to evaluate the entry regulation indirect.

in purchasing and advertising. The centralized decision making has anyhow been put forward over the years. Axfood is also a mix of different firms, either franchising or fully owned. In the end of the 1990s, Axel Johnson and the D-group merged, stating a more centralized decision making and clear firm concepts. Opposite to ICA and Axfood, COOP consists of centralized cooperatives where decision are made at the cooperative level (national or local). Both Axfood and COOP have a market share slightly over 20 percent. In addition to the three national chains, there exist a fourth one, Bergendahls, mainly operating in the south/south-western parts capturing around 4 percent of the market. Finally, firms owned by various independent owners, (labeled Others), incorporates a market share around 8 percent.[16] The present paper will focus on the four chains ICA, Axfood, COOP and Bergendahls that together constitutes for the majority of sales in the market.

■ **Entry regulation.** On July 1st, 1987, a new regulation was imposed in Sweden, the Plan- and Building Act (PBA).[17] Compared to the previous (valid since 1947/1948), PBA had two major implications; First, the decision process was decentralized giving each local government power to decide over the interests in their municipality. The foregoing regulation gave this power to the state. Second, citizens got greater influence through the right to appeal the decisions taken by the local governments at the municipality level. The majority of OECD countries have similar land-use planning regulations i.e. power at the local authority level. Some countries, e.g. France, Italy, Belgium, Spain and Japan, specificly regulate large entarants (Pilat (1997)).[18] For several years there has been a debate in Sweden regarding PBA's impact on market competition. Among economists, entry and exit processes are unarguably necessary to be able to achieve efficient markets that finally are in favor of consumers. In Sweden, PBA is claimed to be one of the major entry barriers to the market resulting in various outcomes, e.g. price levels, in different geographical markets (The Swedish Competition Authority (2004:2) and The Swedish Competition Authority (2001:4)). An investigation by the The Swedish Competition Authority (2001:4) shows that municipalities, through PBA, are able to put pressure on prices. In detail, they find that the square meter per capita is lower in municipalities that restrictively applied PBA. Moreover, municipalities

[16] International owners such as Lidl and Netto entered the Swedish market in 2001 and 2002, respectively.

[17] See The Swedish Competition Authority (2001:4) for a detailed description.

[18] Regulation of opening hours is also present in some countires. In Sweden such a legislation does not exist.

with a higher market share of large- and discount firms were found to have lower price levels. Pilat (2005) claims that, *if* entry and exit of firms drive productivity growth, entry regulations are of severe importance. Planning regulations may affect productivity by preventing entry. For example, it might end up with retail firms operating below minimum efficient scale resulting in low productivity levels. Furthermore, a decrease in competition can slow down the use and adoption of ICT.[19]

Since 1987, only minor changes have been implemented in PBA. During the period April 1st, 1992, and January 1st, 1997, the regulation was slightly different. By then, it was explicit that the use of buildings should not counteract efficient competition. Since 1997, PBA is more or less the same as prior to 1992.[20]

4 Data and the Market Definition

■ **Data.** We use two data sets in the empirical analysis. The primary source of data is a census of Swedish retail food firms employing at least one worker provided by Statistics Sweden(SCB), Financial Statistics(FS) and Regional Labor Statistics(RAMS). The latter provides information on wages whereas FS contains input and output measures. SNI-code 52.1, retail sale in non-specialized stores, is used in order to capture the four chains. The information, available at the individual firm level, covers the time period 1996 to 2002. The FS-RAMS database is used to estimate the firm productivity. A unit of observation is a firm, defined based on organization number. Therefore, a firm in FS-RAMS may contain one or several establishments (stores). The data give opportunities to bring a number of different aspects of productivity relevant for the retail food market. We are able to estimate total factor productivity (TFP) at the firm level. Labor is a key factor in retail so we will also shed light on a benchmark measure of labor productivity (value added per wages). Labor costs depend on both working and opening hours and, moreover,

[19] It is possible that chains adopt similar strategies as their competitors and buy already established firms. As a result, more efficient firms can enter without involvement of PBA and, consequently, the regulation will not work as an entry barrier that potentially affect productivity. Large entrants, however, are often new build firms in external positions making the regulation highly important. Of course, we cannot fully rule out this opportunity.

[20] One can argue that it would be intuitive to analyze the market strucutre effects of this policy change. Long time lags in the planning process makes it, however, impossible to direct evaluate the impact. Furthermore, the differences in practice due to the policy change seem not considerable (The Swedish Competition Authority (2001:4)).

is part time working of importance in retailing. Therefore, wages are the most appropriate choice of labor input. In addition, we connect regional information such as population, age distribution of individuals, total area, average income, distribution of income and political preferences to the individual firm.[21] Appendix A gives more information about the FS data.

The second data set is collected by Delfi Marknadsparter AB (DELFI). Unlike the FS-RAMS data, a unit of observation is a store defined by address. The DELFI data is used for getting the benchmark measure of space productivity (sales per square meter) and for defining large entrants. It contains yearly information on all stores in the Swedish market between 1993 and 2002. Information such as revenues, sales space, type, owner, chain as well as location is available for each store.[22] Like the FS-RAMS data, municipality characteristics are merged to each store. Appendix B presents variable definitions and details about the second data set. Note that the unit of observation differ between FS-RAMS and DELFI. A firm based on organization number in FS-RAMS consists of one or several stores based on addresses in DELFI. Hence, we observe physical entry and exit in DELFI which is not necessarily equivalent to changes in organization number observed in FS-RAMS. The main part of the paper is based on the FS-RAMS data upon which 'firm' to a high extent is used throughout the text.

■ **Market definition and large entrants.** We explore large entrants' influence on productivity moments in local geographic markets. This raises the issues how to define large entrants and local markets in Swedish food retailing. As mentioned above, the DELFI data contain information about physical entry and, in addition, each store is categorized with a type (12 different) depending on size, geographical location, product assortment etc. The natural starting point for characterizing large entrants is therefore based on the DELFI data. We define the five largest types as 'large' whereas the remaining types are labeled 'small'.[23] It is central to use entrants based on firms when analyzing productivity at the firm level because each firm consists of one or several establishments (stores) that are possibly located in different local markets. Therefore, we base the grouping of firms in the FS-RAMS

[21] The regional data are collected from from SCB.

[22] All owners (chains) report data each year during the collection.

[23] The five largest types are hypermarkets, supermarkets, department stores, supermarkets, grocery stores and other stores. The remaining (small) types are small supermarket, small grocery stores, convenience stores and mini markets. Gas-station stores and seasonal stores were excluded from the analysis due to insufficient information during time period.

data on the large stores' sales distribution in the DELFI data. Firms in FS-RAMS with sales between maximum and the 5th percentile of large stores' sales in the DELFI data are defined as large, otherwise small.

For each particular firm, the size of the local market will of course depend on its type i.e. large firms capture consumers from a wider geographical area if we compare to small firms. Analyzing the effects of large firms on productivity, the appropriate market definition should be closely connected to the appropriate geographical market for large types. Our theoretical model assumes that retail markets are isolated geographic units; firms in one market competitively interact only with other firms in the same local market. Food products fulfill basic needs and are therefore located close to consumers making it hard to define isolated local markets. Another central characteristic of retail food products is their relatively short durability resulting in frequent purchase patterns among consumers. We therefore believe that consumers travel a relatively short distance when buying food (except if prices are sufficiently low). Consequently, nearness to work and home are two central aspects for consumers when choosing firm and the travel distance likely increase with the size of the firm.[24] Defining local markets perfectly requires information about the exact distance between firms.[25] With lack of this information we are, however, forced to rely on aggregated measures. Using a relatively broad market definition such as counties (in total 21) would be unreasonable regarding consumer cubstitutability among stores and most likely capture an extensive share of submarkets. On the other hand, using a relatively narrow market definition such as postal areas (in total 1534) unlikely measure market size correct for large firms. We believe that the best choice of local market is at an intermediate level between these two extremes. We then have two choices, local labor markets (in total 88) or municipalities (in total 290). The former consider commuting patterns that are central for the absolutely largest types such as hypermarkets and department stores. The latter is an appropriate definition for types such as supermarkets and grocery stores and has the advantage of including the local government decisions over new entrants. While the number of large entrants are limited during the time period, we have to bunch several of the largest types together. However, the four largest types are used for robustness of the large entrants. The main part of the analysis uses local labor

[24]The importance of these factors is confirmed by discussions with representatives from ICA, COOP and Bergendahls.

[25]According to representatives from ICA, the local market for a specific store type is equal to a circle with the radius equal to half of the distance to the nearest competitor of the same type.

markets as market definition. In addition, we also shed light on productivity using municipalities as market definition.

The data provide us with demographic information of individual municipalities. Total retail food demand is a function of the market's population but varies across income levels. The data contains age distribution of the population as well as the income levels. Both measures are central in order to analyze local market demand.[26] Accessibility and convenience are two important factors when consumers choose a firm. We do not have information on whether a firm is located along a major commuting road or whether it is part of a mall. Location-specific costs of running a retail establishment mainly take form of property costs.[27]

■ **Descriptive Statistics.** Table 1 presents descriptive statistics for the two data sets. The decline in the total number of firms is around 16 percent during the period 1996-2002. Contrary, the total cost of labor increases around 14 percent whereas the number of employees only increases around 3 percent. The average firm size increases as much as 50 percent whereas total number of square meters available for consumers increase slightly over 1 percent from 1993 to 2002. Finally, total sales increase 7 and 11 percent in FS and DELFI, respectively.

Characteristics of local labor markets with and without large entrants are shown in Table 2. The number of markets with large entrants varies between 14 and 23 during the time period. As expected, the average population is higher in markets with large entrants. Local markets with large entrants are also characterized by higher average income. The lower part of the table shows the four firm concentration, respectively. Large entry markets have, on average, lower four firm concentration compared to non-entry markets. Moreover, mean concentration increases over time in all markets.

To get an indication of how the productivity distribution looks like in different local markets, Table 3 presents summary statistics for the two benchmark measures: labor productivity and space productivity. There are nontrivial differences in the labor productivity moments. The standard deviation across markets in median labor productivity is 40 percent whereas it is 44 percent for the 10th percentile. For the

[26] See for example Toivonen and Waterson (2005), Smith (2004), Pakes (2004) and Bresnahan and Reiss (1991).

[27] There are two possibilities, either the individual retailer/chain owns the building where the firm is located or she/he rents it. Data on commercial rents or assess values are unfortunately not available at the municipality level. The most narrow level when data is available is at the county level (21 different).

interquartile measure, the corresponding deviation is 28 percent.[28] Furthermore, the standard deviation in productivity dispersion across markets is 30 percent less than its mean. On the other hand, the standard deviation across markets in median space productivity is 16 percent whereas it is around twice as large for the 10th percentile. There is also variation in the amount of within-market productivity dispersion. The standard deviation of the interquartile space productivity is 5 times less than its mean 0.664.

To view the characteristics of the productivity distribution of the two benchmark measures (labor and space) we construct kernel probability density estimates of the distribution related to large entrants. Figure 1 shows the productivity distribution of incumbents in markets below and above the median number of large entrants, respectively. The left column shows that the distribution of different productivity measures in markets with above median number of large entrants is clearly to the right of the one below. Independent of which measure we use, productivity is higher for all parts of the distribution. That is, we find the productivity in labor and space considerably higher in local markets with more large entrants. Hence, we got a first indication that large entrants tend to influence the productivity moments in a positive direction. The right column in Figure 1 presents the distribution for small and large types. Labor productivity in above median markets have lower interquartile dispersion compared to below median markets whereas the opposite is found for space productivity. The distribution above median is distinctly to the right of the one below median for both small and large types. Hence, independent of type, firms located in local markets with more large entrants have generally higher labor and space productivity compared to firms located in markets with less entrants. Furthermore, small firms are more productive in labor compared to large firms. The reverse is, on the other hand, found for space productivity.

5 Firm Productivity

Our empirical goal is to estimate changes in the distribution of the productivity that are caused by large entrants accounting for geographical differentiation. Therefore, we need to estimate firm productivity.

■ **Firm behavior.** Our model of competition between retail firms is based on

[28] An interquartile range of 0.275 in log-level within a market implies that the 75th percentile productivity firm can sell 27.5 percent more output than the 25th - percentile firm.

Ericson and Pakes (1995)' dynamic oligopoly framework. A firm is described by its states consisting of productivity $\omega \in \Omega$ and capital stock $k \in \mathbb{R}_+$. The firm is able to change its state (productivity) over time through its choice of investment $i \geq 0$ and/or labor l. Incumbent firms maximize the expected discounted value of future net cash flows. First, firms compete in the product market and collect their payoffs. Second, in the beginning of each time period, incumbents decide whether to exit or continue to operate.[29] If the firm exit, the scrap value ϕ is received. If the firm continues, it decides optimal level of labor and investment. Labor is chosen based on current productivity and capital accumulates according to $k_{t+1} = (1-\delta)k_t + i_t$, where δ is the discount rate. Changes in labor and/or investment do not guarantee a more favorable state tomorrow, but ensure more favorable distributions over future states. Firms' transitions from one productivity state to another are subject to an idiosyncratic shock. There is a variability in the fortunes of firms even if they carry out identical strategies. We denote $P_{\omega'}$ to be the family of probability distributions for future productivity ω' - one for each possible current productivity ω, level of investment i, and number of large entrants e^L.

$$(1) \qquad P_{\omega'} \equiv \left\{ p(\cdot|\omega, i, e^L), \forall \quad \omega \in \Omega = [0, 1, \cdots, \overline{\omega}], i \in R^+, e^L \in N \right\}.$$

To reach a unique equilibrium, we assume that $P_{\omega'}$ is stochastically increasing- in the first-order stochastic dominance sense- in ω, i, and e^L. Hence, we extend the assumption that transition probabilities of productivity follows a first order Markov process with $P(d\omega|\omega)$ used the OP framework.

Given the conditions of the model, we can now specify the maximization problem of the firm. We denote $V(\omega, k)$ to be the expected net present value of all future cash flows. $V(\omega, k)$ is defined by the solution to the following Bellman equation with the discount factor $\beta < 1$:

$$(2) \qquad \begin{aligned} V(\omega_{jt}, k_{jt}) = \quad & max \Big\{ \phi, \sup_{l_{jt}, i_{jt}} [\pi(\omega_{jt}, k_{jt}, e^L_{jt-1}) - c_i(i_{jt}, k_{jt}) - c_l(l_{jt}) + \\ & \beta E[V(\omega_{jt+1}, k_{jt+1})|\omega_{jt}, e^L_{jt}, i_{jt}] \Big\} \end{aligned}$$

where $\pi(\omega, k)$ is the profit function, $c_i(i)$ is the cost of investment; i is the investment choice of the firm; $c_l(l)$ is the cost of labor.[30] The solution gives the optimal policy functions for investment $i_t = \tilde{i}_t(k_t, \omega_t)$, labor $l_t = \tilde{l}_t(k_t, \omega_t)$ and exit. The exit rule $\chi_{t+1} = \tilde{\chi}_t(\omega_t, k_t)$ depends on the threshold productivity $\underline{\omega}_t(k_t, e^L_{t-1}, z_{t-1})$.

■ **Production function.** We assume that firms sell a homogeneous product with

[29] In reality, the decision to exit or stay in the market is may be taken by the chain. However, the chain takes this decision based on the store's results.

[30] Incumbent firms know their scarp value, ϕ, prior to making its exit and investment decisions.

Cobb-Douglas technology and that the factors underlying profitability differences among stores are neutral efficiency differences.[31] The production function is specified as

$$(3) \qquad q_{jt} = \beta_0 + \beta_l l_{jt} + \beta_k k_{jt} + \omega_{jt} + \xi_{jt},$$

where q_{jt} is the quantity sold by store j at time t, l_{jt} its log of labor input, and k_{jt} is log of capital input. The unobserved ω_{jt} is productivity and ξ_{jt} is either measurement error (which can be serially correlated) or a shock to productivity which is not predictable during the period in which labor can be adjusted.

□ **Price and demand shocks.** To extend the model to fit the retail market characterized by differentiated products, we allow prices to vary across firms.[32] The intuition behind the need to correct for the potential bias of ignoring demand in the estimation is as follows. Sales are frequently used as a proxy for output when physical output is not observed.[33] When firms have some market power, the prices set by the individual firm influences it's productivity.[34] Then, there will be a high variance in the relative prices i.e. firm prices relative to the industry price index. If the firm cuts the price, more inputs are needed to satisfy the increasing demand. The negative correlation between input and prices leads to underestimation of the labor and capital parameters in the production function (Melitz (2000)).[35]

Consider firms facing a downward sloping demand function that depends on the price of a basket of representative products p_{jt}, the aggregate price of retail food p_{mt} and the aggregate quantity sold q_{mt}. The demand function is given by

$$(4) \qquad p_{jt} = p_{mt} + \frac{1}{\eta} q_{jt} - \frac{1}{\eta} q_{mt} - \frac{1}{\eta} u^d_{jt},$$

[31] The algorithm is easy to generalize to a general specification, for example translog with neutral efficiency across stores would do well.

[32] Prices are assumed constant across firms in (3).

[33] Foster, Hatiwannger and Syverson (2006) analyze the relation between physical output, revenue, and firm-level prices in the context of market selection. They find that productivity based upon physical quantities is negatively correlated with establishment-level prices while the productivity based upon revenues is positively correlated with establishment-level prices. Removing price and demand shocks from productivity is applied in new dynamic-oligopoly games where productivity is a key primitive (Collard-Wexler (2006)).

[34] Under perfect competition, productivity of the price taking firms will not be influenced by firm level prices.

[35] If the products are perfect substitutes, deflated sales are a perfect proxy for unobserved quality adjusted output.

where η is the elasticity of substitution between the differentiated products in the industry and u^d_{jt} is an idiosyncratic shock specific to store j.[36] Firms are assumed to operate in a market characterized by horizontal product differentiation, where η captures the substitution elasticity among different products - η is finite and $\eta < -1$. The demand system is quite restrictive and implies one single elasticity of substitution for all product baskets and hence there are no differences in cross price elasticities.[37]

Since the price of individual firms are unobserved we deflate the output with the price industry deflator. The deflated output is defined as $y_{it} = q_{it} - p_{mt}$. Controlling for price and demand shocks in the production function in (3) we have

$$(5) \qquad y_{jt} = \left(1 + \frac{1}{\eta}\right)[\beta_0 + \beta_l l_{jt} + \beta_k k_{jt}] + \left(-\frac{1}{\eta}\right)\beta_q q_{mt} + \left(1 + \frac{1}{\eta}\right)\omega_{jt} + \zeta_{jt},$$

where m is the market and $\zeta_{jt} = ((1+\eta)/\eta)\xi_{jt} - (1/\eta)u^d_{jt}$.

□ **Productivity distribution.** As large firms enter, incumbent firms can only expect potential productivity changes caused by the entrants. Our transition probability states assumption implies that the productivity of firm j in a local market is

$$(6) \qquad \omega_{jt} = \tilde{g}(\omega_{jt-1}, e^L_{mt-1}) + \upsilon_{jt},$$

where e^L_{mt} is the number of large entrants in a local market. The actual firm's productivity ω_{jt} in period t can be decomposed into expected productivity $\tilde{g}(\omega_{jt-1}, e^L_{mt-1})$ and a random shock υ_{jt}. Our key assumption is that the impact of large entrants in a local market on productivity affect only the conditional expectation that we model as an unknown function $\tilde{g}(\cdot)$. In contrast, the random shock υ_{jt} does not depend on the number of large entrants.[38] The timing assumptions are important in this context: When incumbent firms make their decisions in the beginning of period t, they measure the effect of large entrants on productivity in period t through $\tilde{g}(\omega_{jt-1}, e^L_{mt-1})$. The actual effect, however, also depends on the realization of the productivity innovation υ_{jt} that occurs after large firms enter. The conditional expectation function $\tilde{g}(\cdot)$ is unobserved from the point of view of the econometrician (but known to the store) and must be estimated non-parametrically.[39] The

[36] The prices and quantities are expressed in logarithm form.

[37] The elasticity of substitution can be allowed to differ across local markets in the estimations.

[38] The innovation υ_{jt} may be thought as the realizations of uncertainties that are naturally linked to productivity plus the uncertainties given by the effect of the large entrants.

[39] If we consider an increase in the number of large entrants that changes ω_{jt} to $\tilde{\omega}_{jt}$, then ($\tilde{\omega}_{jt}$ - ω_{jt}) approximates the effect of this change in productivity on output in percentage terms. The change in

productivity evolves according to the conditional transition probabilities and by substituting (6) into (5) we get

$$y_{jt} = \left(1+\frac{1}{\eta}\right)[\beta_0 + \beta_l l_{jt} + \beta_k k_{jt}] + \left(-\frac{1}{\eta}\right)\beta_q q_{mt} + g(\omega_{jt-1}, e^L_{mt-1}) + \varepsilon_{jt} + \zeta_{it}, \tag{7}$$

where $g(\cdot) = \left(1+\frac{1}{\eta}\right)\tilde{g}(\cdot)$ and $\varepsilon_{jt} = \left(1+\frac{1}{\eta}\right)\upsilon_{jt}$. The value of k_{jt} is determined by i_{jt-1} in period $t-1$ and e^L_{mt-1} is uncorrelated with ε_{jt} because of our timing assumptions. We now turn to the choice of labor.[40]

□ **Labor.** Labor l_{jt} is correlated with the random shock in productivity ε_{jt}. We can, however, observe the optimal labor in the previous period l_{jt-1} and back out previous productivity ω_{jt-1} using the inverse labor demand function. Hence, we calculate unobserved productivity ω_{jt-1} from the policy function of labor, a difference to OP that instead use the policy function of capital. The main advantage is that zero investments are included in the analysis, which is important due to that retail firms often invest one year followed by several years without investments. In year $t-1$, the firms choose current labor l_{jt-1} based on current productivity ω_{jt-1} which gives the demand for labor as

$$l_{jt-1} = \frac{1}{1-\beta_l}[\beta_0 + ln(\beta_l) + \beta_k k_{jt-1} + \omega_{jt-1} - (s_{jt-1} - p_{jt-1}) - ln(1+\frac{1}{\eta})],$$

where s_{jt-1} is the total wage paid by firm j. Solving for ω_{jt-1}, we find the inverse labor demand function.[41]

$$\omega_{jt-1} = \frac{\eta}{1+\eta}\left[\lambda_0 + [(1-\beta_l) - \frac{1}{\eta}\beta_q]l_{jt-1} - (1+\frac{1}{\eta})\beta_k k_{jt-1} + s_{jt-1} - p_{mt-1} + \frac{1}{\eta}q_{mt-1}\right], \tag{8}$$

where $\lambda_0 = -ln(\beta_l) - ln(1+1/\eta) - \beta_0(1+1/\eta)$ combines the constant terms $-\beta_0$, $-\beta_l$, and η.

□ **Selection.** Firms decisions to exit in period t depend directly on ω_{jt} and therefore, the decision will be correlated with ε_{jt}. To identify β_l and β_k, we use estimates of the survival probabilities.[42] Substituting the survival probabilities and the la-

ω_{jt} shifts the production function and hence measures the change in total factor productivity.

[40]The condition for identification is that the variables in the parametric part of the model are not perfectly predictable (in the least square sense) by the variables in the non-parametric part (Robinson (1988)). Hence, there cannot be a functional relationship between the variables in the parametric and non-parametric part (see Newey et al. (1999)). Including shifters for large entrants guarantee the identification. The shifter e^L_{jt} cannot be perfectly predicted from ω_{jt}.

[41]The inverse labor demand function can be determined from the cost function and marginal revenue, see Doraszelski and Jaumandreu (2006) for more details.

[42]See Appendix C for a detailed description.

bor demand functions into (7) yields the final production function that we want to estimate.

(9)

$$y_{jt} = \left(1+\frac{1}{\eta}\right)[\beta_0 + \beta_l l_{jt} + \beta_k k_{jt}] + \left(-\frac{1}{\eta}\right)\beta_q q_{mt}$$
$$g(\mathscr{P}_{t-1}, \lambda_0 + [(1-\beta_l) - \frac{1}{\eta}\beta_l] l_{jt-1} - (1+\frac{1}{\eta})\beta_k k_{jt-1} + s_{jt-1} - p_{mt-1} +$$
$$\frac{1}{\eta} q_{mt-1}, e^L_{mt-1}) + \varepsilon_{jt} + \zeta_{jt}.$$

■ **Estimation strategy.** The estimation of the production function consists of two parts. In step one, we use a probit model with a third order polynomial to estimate the survival probabilities. The predicted survival probabilities are then substituted into (9) that are estimated in the second step. We now turn to details about the estimation procedure of the latter step. The model (9) is semiparametric in the sense that it contains both finite and infinite dimensional unknown parameters. We estimate (9) using sieve minimum distance (SMD) procedure proposed in Newey and Powell (2003) and Ai and Chen (2003) for independent and identically distributed (i.i.d) data.[43] The goal is to obtain an estimable expression for the unknown parameters of interest $\boldsymbol{\beta}$ and g_{K_T} where K_T include all parameters in $g(\cdot)$. We approximate $g(\cdot)$ by a polynomial of order three. A third order polynomial series of labor, capital, large entrants and demand conditions are used as instruments. Using the specified GMM implementation, the parameter values $(\boldsymbol{\beta}, g_{K_T})$ are jointly estimated. Appendix D presents a detailed description of the estimation procedure.

■ **Results.** Table 4 presents summary statistics for the TFP market regression variables. Just like in the descriptives for the benchmark measures in Table 3There are nontrivial differences in the productivity moments. The standard deviation across markets in median productivity is 16 percent whereas it is twice as large for the 10th percentile. For the interquartile measure, the corresponding deviation is 17 percent. Furthermore, the standard deviation in productivity dispersion across markets is three times its mean. An interquartile range of 0.415 in log-level within a market implies that the 75th percentile productivity firm is roughly 42 percent more productive than the 25th - percentile firm. Small firms have higher dispersion in the lower productivity bound compared to large firms.

[43]Chen and Ludvigson (2007) show that the SMD procedure and its large sample properties can be extended to stationary ergotic time series data.

6 Local Market Productivity

6.1 Econometric Specification

Our goal is to asses the role of large entrants in determining the differences in productivity across firms and the evolution of the firm productivity over time. We test for the effect of large entrants on the productivity distribution, computing nine different measures of productivity moments at the local market level. We measure productivity dispersion using interquartile ranges of TFP among firms in each market-year.[44] The central tendency of the local productivity distribution is measured using median for TFP. We choose median to minimize measurement errors. The market's minimum productivity level is measured by the 10^{th} percentile TFP in the local labor market. This measure is equal to the minimum productivity level in some markets. However, the 10^{th} percentile measure avoids more questionable bottom-end productivity levels in large markets. In addition to the TFP, we also construct the productivity moments for the benchmark measures labor- and space productivity.

We use the following specification to test for the impact of large entrants on moments of local productivity and size distributions:

$$(10) \quad \theta_{mt} = \gamma_0 + \gamma_e e^L_{mt} + X_{c,mt}\gamma_o + \varepsilon_{mt}.$$

The dependent variable, one of the moment measures discussed above in market m year t, depends on the number of large entrants e^L_{mt}, a vector $X_{c,mt}$ of other influences on the moments, and a market-year specific error term. The local market controls in $X_{c,mt}$ include variables that affect the decision to enter in a local market with a large firm such as sunk cost, demand density, and average income. For the FS data we follow Sutton (1991) and define sunk costs as the market share of the median firm multiplied by the capital-output ratio for the local market. The corresponding measure for the DELFI data is based on sales space. Using (10) we want to test if more large entrants should result in both higher minimum and average productivity. Below we will present the results using labor markets as market definition. The analysis based on municipalities is shown in Appendix E. The local labor markets, offer a potential number of 616 observations (88 LMs x 7 years) for both TFP and labor productivity whereas 880 observations (88 LMs x 10 years) are present for space productivity.

■ **Aggregate Productivity Decomposition.** We present a formal productivity

[44] This measure of dispersion is used in order to minimize the influence of spurious outliers.

growth decomposition for the Swedish food retailing. Productivity in local markets can be expressed as a weighted average of firm's productivity ω_{imt} in market m, $\Omega_{mt} \equiv \sum_{i \in I_{mt}} s_{imt}\omega_{imt}$, where $s_{imt} = sales_{imt}/sales_{mt}$ for TFP and sales productivity and $s_{mt} = wages_{imt}/wages_{mt}$ for labor productivity. Retail food productivity can be expressed as a weighted average of the market's productivity Ω_{mt} , $\Omega_t \equiv \sum_{m \in M} s_{mt}\Omega_{mt}$, where $s_{mt} = sales_{mt}/sales_t$ for TFP and space productivity and $s_{mt} = wages_{mt}/wages_t$ for labor productivity. The change in retail productivity between year t and t' can be written

$$
\begin{aligned}
\Delta\Omega_{mt,t'} = \; & \textstyle\sum_{i \in C_{t,t'}} s_{im,t}\Delta\omega_{imt,t'} + \sum_{i \in C_{mt,t'}} (\omega_{imt} - \Omega_{mt})\Delta s_{imt,t'} \\
& + \textstyle\sum_{i \in C_{mt,t'}} \Delta\omega_{imt,t'}\Delta s_{imt,t'} - \sum_{i \in X_{mt,t'}} s_{imt,t'}(\omega_{imt} - \Omega_{mt}) \\
& + \textstyle\sum_{i \in E_{mt,t'}} s_{imt'}(\omega_{imt'} - \Omega_{mt})
\end{aligned} \tag{11}
$$

where Δ is the difference operator ($\Delta\Omega_{mt,t'} = \Omega_{mt'} - \Omega_{mt}$), $C_{mt,t'}$ is the set of firms that operated in t and $t^{'}$ (continuing firms). $E_{mt,t'}$ is the set that operated in $t^{'}$ but not in t (entering firms), and $X_{mt,t'}$ is the set that operated in t but not in $t^{'}$ (exiting firms).

6.2 Empirical Results

Table 5 presents our main regression results from the estimations of equation (10). For each productivity moment of TFP, we report the parameter estimates (coefficients and heteroscedastic standard errors) of large entrants, sunk cost, and demand density. The results support the predictions of our model. The productivity dispersion declines with the number of large entrants. The median and 10^{th} percentile productivity levels are all higher in markets with more large entrants. A new large entrant in a local market implies: a decrease in expected TFP dispersion by approximately 0.002 log points; [45] Due to the complexity of measuring productivity in retail markets we have emphasized the importance of using benchmark measures as complements to TFP. Table 6 presents robustness of our findings using the benchmark measures labor and sales productivity. The results also show that productivity dispersion declines and both median and lower bound productivity increase with the number of large entrants as large firms enter. The decrease in expected labor productivity dispersion is approximately 0.001 log points; and the decrease in expected

[45] Let θ be one of the productivity moments. Then the marginal effect of one additional entrant in the market can be measures as $\frac{\partial E[\theta|e^L]}{\partial e^L} \simeq \frac{E[\theta]}{N}$. The number N gives us information about the impact of large entrants on the conditional mean on entry of the productivity moments

space productivity dispersion is approximately 0.003 log points - but this is not significant at the 10% significance level. Hence, large entrants have a greater impact on the TFP dispersion compared to labor dispersion. This is consistent with the story that large entrants bring more advanced technologies and practices that help to increase productivity which are then adopted by others. A new large entrant in a local market corresponds to about a 0.3 percent increase in median TFP levels and a 0.1 percent increase in 10^{th} percentile TFP levels, respectively.

The decomposition consists of five terms and Table 7 presents the results for the difference between the base year $t = 1996$ and $t' = \{1997, \cdots, 2002\}$ for the FS-RAMS data and $t = 1996$ and $t' = \{1993, \cdots, 2002\}$ the for the DELFI data. The first term (column 2) is the increase in retail productivity in market m when the continuing firms increase their productivity at initial sales for TFP and space productivity, and at initial wages for labor productivity.[46] The second term (column 3) is the increase in productivity resulting when continuing firms with above -average productivity expand their share of sales (TFP and space productivity) and share of wages (labor productivity) relative to firms with below-average productivity. The third term (column 4) is the cross-firm term. The fourth (column 5) is the increase in productivity due to exits and entrants.[47] For TFP, reallocation due to net entry played a dominant role i.e. economic activity was reallocated from less towards more productive establishments. Increasing productivity of continuing firms at their initial sales (for space productivity) and at their initial wages (for labor productivity) was a major factor for retail productivity growth until 2000. After 2000, the increase in labor productivity was due to the continuing firms with above-average labor productivity that expanded their shares of wages relative to firms with below average labor productivity. The sign of the cross term reflects a negative covariance between labor productivity and wage changes.

■ **Robustness.** Table 8 in Appendix E shows municipality characteristics over time for markets with and without large entrants. The number of markets with large entrants varies between 3 and 20 during the time period.[48] As expected, the average population is higher in markets with large entrats. Although not reported in the table, the same conclusion holds for different age groups. There are, how-

[46] Column 2 shows the percentage industry productivity gain between t and t', that is $(\Delta\Omega/\Omega) \times 100$.

[47] Columns 2-5 shows the share of the percentage productivity gains due to terms $j = 1, 2, 3, 4, 5$ in equation (11), that is $(term_j/\Delta\Omega) \times 100$.

[48] Two entrants in a local market the same year are present for a few markets, otherwise one large entrant is the most common.

ever, differences in the distribution across age groups. The average share of people between 20 and 39 years is higher for entry markets whereas the shares of younger and older people are lower. Local markets with large entrants are also characterized by higher average income. The lower part of the table shows the four firm/store concentration, respectively. Large entry markets have, on average, 20-40 percent lower four store concentration compared to non-entry markets. Moreover, mean concentration increases over time in all markets.

To analyze productivity moments at the municipality level and how those are affected by large entrants, we split the municipalities in two groups - with and without entrants. The results are presented in Tables 9, 10, and 11 in Appendix E. Then, we compare the mean and the standard deviation for the following productivity moments: interquartile range, 10th percentile, 25th percentile, median and 75th percentile. For space productivity, the mean of the moments are all higher in markets with large entrants. In addition, the standard deviation is lower. For all parts of the productivity distribution, space productivity is improved on average whereas the standard deviation across markets declines. In other words, the markets become closer to each other regarding space productivity. For labor productivity and TFP, the results differ for the mean values in the lower part of the distribution. We observe a decrease in mean labor productivity and TFP in the 10th and the 25th percentile. That is, the less productive firms are punished by the large entrants whereas the more productive firms increase their productivity. Still, the average standard deviation across markets is lower if large entrants are present.

Following the specification for the local market analysis in Section 6.1, we analyze how the large entrants influence productivity moments using municipality as market definition. Using municipalities instead of local labor markets result in increasing heterogeneity among markets. Therefore, we use quantile regression in addition to GMM in order to test if large entrants have a similar effect on all parts of the productivity distribution. For space productivity, the results are consistent with the one presented in Section 6.2 i.e. the 10th percentile and median increase whereas dispersion decrease. For TFP, the median and the 75th percentile increase. On the other hand, the 10th and 25th percentile decrease. As a result of large entrants, the most productive firms become better off and the less productive firms become worse off. This gives an increase in dispersion. The results are in line with the descriptive statistics at the municipality level. Furthermore, they are consistent with Boone (2000) finding that inefficient firms are punished harder than efficient firms as competition increases. Although not significant, similar patterns as for TFP are shown for labor productivity. This indicates that capital and technology are important contributors to productivity improvements in the Swedish retail food market. For both TFP and the benchmark measures, less productive firms located in markets with high population density are worse off compared to if they where located in low dense markets. Contrary, firms with high productivity are better off if they are located in markets with high population density. In addition, dispersion increase in dense markets. Finally, increasing sunk costs also leads to higher dispersion.

7 Conclusions

The present study gives new insights into the entry regulation's impact on market competition and productivity in Swedish food retailing. The answer to the question how large entrants influence productivity is as follows; lower bound productivity and central tendency increase whereas within-market productivity dispersion decrease. Hence, we conclude that 'big-box' entrants are highly important for market competition. Our findings have several important implications. First, working as a potential entry barrier, the entry regulation in Sweden accounts for some of the persistent within-retail industry productivity dispersion. Second, other factors such as sunk cost and demand density also support the persistent productivity differences observed in local markets.

As a contribution to the ongoing debate regarding the entry regulation in Sweden, the results can serve as a basis for policy discussions. The policy of allowing new retail food firms compounds, except market competition, also a bunch of additional issues e.g. the traffic situation, environmental aspects and consumption patterns. These areas are interesting for future research. Although our study relates to the Swedish market, the conclusions are important in a broader context. More specific, they relate to other European countries with similar entry regulations in retailing. Still, firm-level studies based on each country are needed to receive deeper insights we therefore recommend attention to these issues in future research.

References

Ackerberg, D., Caves, K. and Fraser, G.: 2005, Structural identification of production functions. mimeo, UCLA.

Ackerberg, D. and Pakes, A.: 2005, Notes on relaxing the scalar unobservable assumption in olley an pakes. mimeo, Harvard University.

Aghion, P., Blundell, R., Griffith, R., Howitt, P. and Prantl, S.: 2006, The effect of entry on incumbent innovation and productivity, *mimeo* .

Ai, C. and Chen, X. .: 2003, Efficient estimation of models with conditional moment restrictions containing unknown functions, *Econometrica* **71**(6), 1795–1843.

Aquirregabiria and Vicentini: 2006, Dynamic spatial competition between multistore firms. mimeo, University of Toronto.

Asplund, A. and Friberg, R.: 2002, Food proces and market structure in sweden, *Scandinavian Journal of Economics* **104**(4), 547–567.

Asplund, M. and Nocke, V.: 2006, Firm turnover in imperfectly competitive markets, *Review of Economic Studies* **73**, 295–327.

Bartelsman, E. J. and Doms, M.: 2000, Understanding productivity: Lessons from longitudinal microdata, *Journal of Economic Literature* **38**(3), 569–594.

Beresteanu, A. and Ellickson, P. B.: 2006, The dynamics of retail oligopoly. mimeo, Duke University.

Berry, S.: 1992, Estimation of a model of entry in the airline industry, *Econometrica* **60**, 889–917.

Bertrand, M. and Kramarz, F.: 2002, Does entry regulation hinder job creation? evidence from the french retail industry, *Quarterly Journal of Economics* pp. 1369–1413.

Boone, J.: 2000, Competitive pressure: The effects on investments in product and process innovation, *RAND Journal of Economics* **31**, 549–569.

Boverket: 1999, Handeln i planeringen, *Technical report*, Boverket.

Boylaud, O. and Nicoletti, G.: 2001, Regulatory reform in retail distribution, *Technical report*, OECD.

Bresnahan, T. F. and Reiss, P. C.: 1987, Do entry conditions vary across markets?, *Brookings Papers on Economic Activity* pp. 883–871.

Bresnahan, T. F. and Reiss, P. C.: 1990, Entry in monopoly markets, *Review of Economic Studies* **57**, 531–553.

Bresnahan, T. F. and Reiss, P. C.: 1991, Entry and competition in concentrated markets, *Journal of Political Economy* **99**(5), 977–1009.

Caves, R.: 1998, Industrial organization and new findings on the turnover and mobility of firms, *Journal of Economic Literature* **36**(4), 1947–1982.

Chen, X. and Ludvigson, S.: 2007, Land of addicts? an empirical investigation of habit-based asset pricing models. mimeo, New York University.

Clark, R., D. S. D. P. and Waterson, M.: 2002, Buyer power and competition in european food retailing. Edward Elgar, Cheltenham.

Coggins, J. and Senauer, B.: 1999, Grocery retailing, *Technical report*, U.S. Industry in 2000: Studies in Competitive Performance.

Collard-Wexler, A.: 2006, Productivity dispersion and plant selection in ready-mix concrete industry. mimeo, New York University.

De Loecker, J.: 2006, Product differentiation, multi-product firms and structural estimation of productivity. mimeo, Stern School of Business, New York University.

Doraszelski, U. and Jaumandreu, J.: 2006, R&d and productivity: Estimating production functions when productivity is endogenous. mimeo, Harvard University.

Dunne, T., Klimek, S., Roberts, M. and Xu, Y.: 2005, Entry and exit in geographical markets, *mimeo* .

Ericson, R. and Pakes, A.: 1995, Markov-perfect industry dynamics: A framework for empirical work, *Review of Economic Studies* **62**, 53–83.

Foster, L., Haltiwanger, J. and Krizan, C. J.: 2006, Market selection, reallocation, and restructuring in the u.s. retail trade sector in the 1990s, *The Review of Economics and Statistics* **88**(4), 748758.

Foster, L., Hatiwannger, J. and Syverson, C.: 2006, Reallocation, firm turnover and efficiency: Selection on productivity or profitability? mimeo, University of Chicago.

Griffith, R. and Harmgart, H.: 2005, Supermarket entry and planning regulation, *mimeo* .

Haskel, J. and Khawaja, N.: 2003, Productivity in uk retailing: Evidence from micro data, *mimeo* .

Hoj, J., Kato, T. and Pilat, D.: 1995, Deregulation and privatisation in the service sector, *Technical report*, OECD.

Hopenhayn, H. A.: 1992, Entry, exit and firm dynamics in long run equilibrium, *Econometrica* **60**(5), 1127–1160.

Hulten, C. and Wykoff, F.: 1981, chapter The measurement of Economic Depreciation, in C. Hulten ed., Depreciation, Inflation, and Taxation of Income from Capital, Urban Institute Press, Washington D.C.

Jaumandreu, J.: 2006, Using price and demand information to identify production functions, *mimeo* .

Jia, P.: 2006, What happens chen wal-mart comes to town: An empirical analysis of the discount retailing industry. mimeo, M.I.T.

Jovanovic, B.: 1982, Selection and the evolution of industry, *Econometrica* **50**(5), 649–670.

Katayama, H., Lu, S. and Tybout, J.: 2003, Why plant-level productivity studies are often misleading, and an alternative approach to inference. NBER Working Paper.

Klette, T. and Griliches, Z.: 1996, The inconsistency of common scale estimators when output prices are unobserved and endogenous, *Journal of Applied Econometrics* **11**(4), 343–361.

Kylebäck, H.: 2004, *Varuhandeln I Sveringe Under 1900-Talet*, BAS.

Levinsohn, J. and Melitz, M.: 2002, Productivity in a differentiated products market equilibrium. mimeo, Harvard University.

Levinsohn, J. and Petrin, A.: 2003, Estimating production functions using inputs to control for unobservables, *The Review of Economic Studies* **70**(2), 317–341.

MacDonald, J.: 1994, Does import competition force efficient production?, *Review of Economics and Statistics* **76**, 721–27.

Maican, F.: 2006, Productivity dynamics, r&d, and competitive pressure. mimeo, Department of Economics, Göteborg University.

Mazzeo, M.: 2002, Product choice and oligopoly market structure, *RAND Journal of Economics* **33**, 221–242.

Melitz, M.: 2000, Estimating firm level productivity in differentiated product industries. mimeo, Harvard University.

Muendler, M.: 2005, Estimating production functions when productivity change is endogenous. mimeo, University of California, San Diego and CESifo.

Newey, W. K. and Powell, J.: 2003, Instrumental variables estimation of nonparametric models, *Econometrica* **71**(3), 1557–1569.

Newey, W., Powell, J. and Vella, F.: 1999, Nonparametrric estimation of triangular simultaneous equations models, *Econometrica* **67**(3), 565–603.

Nickell, S. J.: 1996, Competition and corporate performance, *Journal of Political Economy* **104**(4), 724–746.

Olley, S. and Pakes, A.: 1996, The dynamics of productivity in the telecommunications equipment industry, *Econometrica* **Vol. 64**(No. 6), 1263–1297.

Pakes, A.: 2004, Common sense and simplicity in industrial organization, *Review of Industrial Organization* **23**, 193–215.

Pavcnik, N.: 2002, Trade liberalization exit and productivity improvements: Evidence from chilean plants, *Review of Economic Studies* **69**, 245–276.

Pilat, D.: 1997, *OECD Working Paper* .

Pilat, D.: 2005, Assessing the productivity of the uk retail sector: Some further reflections, *The International Review of Retail, Distribution and Consumer Research* **15**(3), 291 296.

Reynolds, J., Howard, E., Dragun, D., Rosewell, B. and Ormerod, P.: 2005, Assessing the productivity of the uk retail sector, *The International Review of Retail, Distribution and Consumer Research* **15**, 237–280.

Robinson, P., M.: 1988, Root-n-consistent semiparametric regression, *Econometrica* **56**, 931–954.

Seim, K.: 2005, An empirical model of firm entry with endogenous product-type choices, *RAND Journal of Economics, forthcoming* .

Smith, H.: 2004, Supermarket choice and supermarket competition in market equilibrium, *Review of Economic Studies* .

Smith, H.: 2007, Store characteristics in retail oligopoly, *Forthcoming, RAND Journal of Economics* .

Sutton, J.: 1991, *Sunk Costs and Market Structure*, Cambridge, MIT Press.

Syverson, C.: 2004, Market structure and productivity: A concrete example, *Journal of Political Economy* **112**(2), 1181–1222.

The Swedish Competition Authority: 2001:4, Kan kommunerna pressa matpriserna? (can the municipalities put pressure on prices?), *Technical report*, Stockholm.

The Swedish Competition Authority: 2004:2, Konsumenterna, matpriserna och konkurrensen (consumers, retail food prices, and competition), *Technical Report 2*, Stockholm.

Toivonen, O. and Waterson, M.: 2005, Market structure and entry: where's the beef?, *RAND Journal of Economics* **36**(3), 680–699.

Table 1: Characteristics of The Data

A. Financial Statistics(FS) and Regional Labor Statistics(RAMS) Data							
Year	Stores	Large Stores	Large Entry	Sales	Value Added	Total Wages	Employment
1996	3,332	742	-	313,305	42,693	21,338	43,829
1997	3,280	798	44	321,425	46,015	22,610	44,148
1998	3,197	788	34	327,578	45,868	23,290	44,382
1999	3,120	761	36	333,377	46,690	23,653	43,753
2000	3,032	704	56	333,161	47,254	24,202	44,632
2001	2,860	731	51	320,964	45,763	23,336	43,202
2002	2,802	816	42	334,361	48,231	24,375	44,964
B. Delfi Marknadsparter AB (DELFI) Data							
						Mean Sales Space	Total Sales Space
1993	5,341	859	-	501,871	-	468	2,497,732
1994	5,101	874	25	494,263	-	486	2,479,190
1995	4,928	889	19	501,327	-	505	2,488,455
1996	4,664	905	21	504,588	-	538	2,510,028
1997	4,518	925	8	494,469	-	550	2,483,248
1998	4,351	926	9	507,646	-	587	2,552,794
1999	4,192	932	14	517,898	-	600	2,514,367
2000	3,989	943	22	537,778	-	649	2,587,952
2001	3,647	933	24	541,009	-	678	2,471,510
2002	3,575	922	4	555,678	-	706	2,525,084

NOTE: Firms have at least one employer. Sales, value-added, and wages are measured in thousand 1996 SEK. Firms in the FS data with sales between maximum and the 5^{th} percentile of large store sales in the DELFI data are defined as large, otherwise small. The number of large entrants differ, since DELFI data contain physical entry and FS data contain organizational entry.

Table 2: Local Market Characteristics

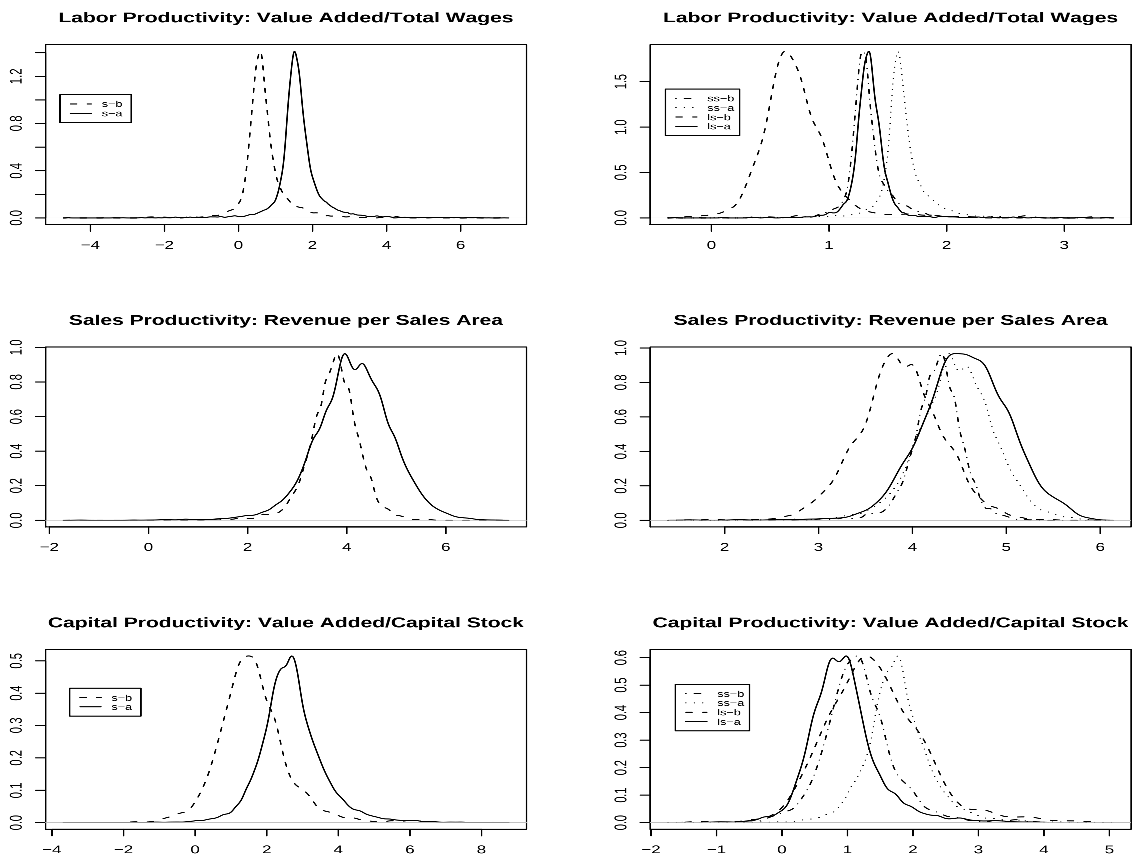
Year	1997	1998	1999	2000	2001	2002
A. Markets Without Large Entrants						
Number of Markets	66	72	74	66	65	66
Median Population	48,905	136,434	104,867	89,198	62,908	76,354
Mean per capita Income	143.8	150.8	157.1	162.6	169.6	175.8
Mean Firm Concentration (C_4)	0.611	0.553	0.588	0.601	0.601	0.669
B. Markets With Large Entrants						
Number of Markets	22	16	14	22	23	22
Median Population	880,360	950,851	954,916	898,430	905,806	912,326
Mean per capita Income	154.5	163.7	172.6	180.1	188.2	196.0
Mean Firm Concentration (C_4)	0.427	0.430	0.426	0.448	0.510	0.493

NOTE: Annual per capital income is in thousands of 1996 SEK.

Table 3: *Retail Benchmark Productivity and Demand: Size Moments*

A. Labor Productivity: Value Added/Wages, all firms					
				$75^{th} - 25^{th}$	$90^{th} - 10^{th}$
Variable	*Mean*	*Std. Dev.*	*Skewness*	*Percentile Range*	*Percentile Range*
Productivity Dispersion (Interquartile Range)	0.376	0.275	1.762	0.321	0.648
Median Productivity	0.640	0.401	-7.981	0.133	0.339
Output-Weighted Average Productivity	-	-	-	-	124.653
10^{th} Percentile Productivity	0.327	0.441	-4.915	0.285	0.600
Firm level Productivity	0.693	0.695	0.795	0.474	1.185
Number of Firms	40.009	110.589	6.800	29.000	89.400
B. Space Productivity: Sales/Square meter, all stores					
Productivity Dispersion (Interquartile Range)	0.664	0.170	0.092	0.210	0.407
Median Productivity	3.707	0.158	-0.166	0.185	0.390
Output-Weighted Average Productivity	-187.149	674.206	-6.293	137.648	301.349
10^{th} Percentile Productivity	2.966	0.267	-0.365	0.301	0.643
Store level Productivity	3.692	0.662	-0.808	0.748	1.574
Number of Stores	79.435	162.986	5.632	65.250	132.000
C. Demand Density					
Ln(Population)	10.708	1.267	0.586	1.736	3.737
Demand Density - Ln(pop/mi^2)	4.090	1.985	0.364	1.937	5.058

NOTE: This table summarizes firm-level labor productivity distribution moments across 616 market-year observations for labor productivity and 880 market-year observations for sales productivity.



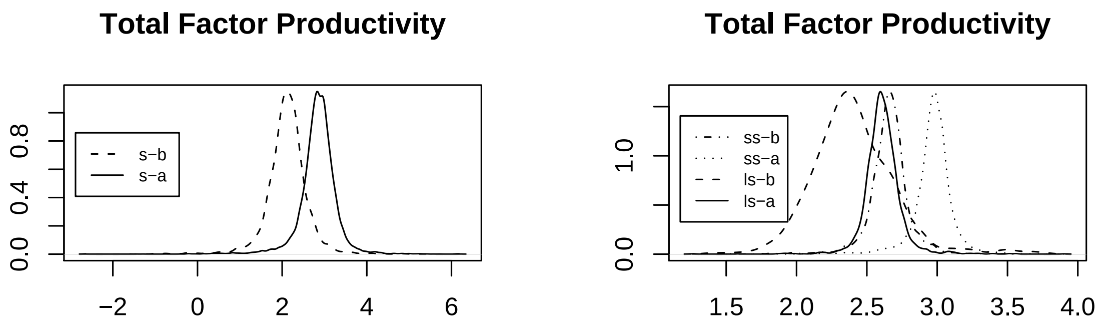
NOTE: The notations are as follows.*s-b*: Firms in Markets Below Median Large Entrants;*s-a*: Firms in Markets Above Median Large Entrants. *ss-b*: Small Firms in Markets Below Median Large Entrants. *ss-a*: Small Firms in Markets Above Median Large Entrants.*ls-b*: Large Firms in Markets Bellow Median Large Entrants.*ls-a*: Large Firms in Markets Above Median Large Entrants.

Figure 1: Benchmark Productivity Kernel Density Estimates, Firms in Markets Above and Below Median Number of Large Entrants

Table 4: *Total Factor Productivity(TFP): Size Moments*

Variable	*Mean*	*Std. Dev.*	*Skewness*	$75^{th} - 25^{th}$ *Percentile Range*	$90^{th} - 10^{th}$ *Percentile Range*
A. Productivity: TFP, all firms					
Productivity Dispersion (Interquartile Range)	0.415	0.173	0.462	0.203	0.427
Median Productivity	2.135	0.156	-0.292	0.165	0.342
Output-Weighted Average Productivity	-	-	-	98.522	239.128
10^{th} Percentile Productivity	1.685	0.307	-1.423	0.294	0.618
Firm level Productivity	2.116	0.566	-1.283	0.497	1.056
Number of Firms	35.319	76.217	5.621	31.500	58.600
B. Productivity: TFP, small firms					
Productivity Dispersion (Interquartile Range)	0.388	0.181	0.628	0.219	0.438
Median Productivity	2.070	0.172	0.631	0.172	0.363
Output-Weighted Average Productivity	-	-	-	57.642	132.597
10^{th} Percentile Productivity	1.620	0.350	-1.359	0.357	0.748
Firm level Productivity	2.021	0.585	-1.363	0.470	1.039
Number of Firms	26.563	54.966	5.665	23.000	46.000
C. Productivity: TFP, large firms					
Productivity Dispersion (Interquartile Range)	0.197	0.181	0.818	0.329	0.432
Median Productivity	2.408	0.178	0.527	0.193	0.413
Output-Weighted Average Productivity	-3.270	44.738	-6.627	3.752	7.381
10^{th} Percentile Productivity	2.242	0.256	-0.060	0.322	0.571
Firm level Productivity	2.400	0.386	0.544	0.371	0.764
Number of Firms	10.898	23.791	4.881	9.000	18.200

NOTE: This table summarizes firm-level productivity distribution moments across 616 market-year observations. TFP is estimated using method described in section 6.



NOTE: The notations are as follows.*s-b*: Firms in Markets Below Median Large Entrants;*s-a*: Firms in Markets Above Median Large Entrants. *ss-b*: Small Firms in Markets Below Median Large Entrants. *ss-a*: Small Firms in Markets Above Median Large Entrants.*ls-b*: Large Firms in Markets Bellow Median Large Entrants.*ls-a*: Large Firms in Markets Above Median Large Entrants.

Figure 2: TFP Kernel Density Estimates, Firms in Markets Above and Below Median Number of Large Entrants

Table 5: *Market Regression Results: TFP Moments*

	Interquartile Range	*Median*	10^{th} *Percentile*
Large Entry	-0.002	0.003	0.001
	(0.0008)	(0.0004)	(0.0005)
Sunk Cost	5.075	1.311	2.073
	(0.8042)	(0.1862)	(0.8495)
Pop. Density	0.001	-0.0003	-0.002
	(0.0001)	(0.0001)	(0.0004)

NOTE: Two stage GMM is used for estimation of market equation (10) specified in section 7. 616 market-year observations are used. Reported standard errors (in parentheses) are robust to heteroskedasticity. TFP is estimated using the method described in section 6.

Table 6: *Market Benchmark Regression Results: Labor and Space Productivity Moments*

A. Labor Productivity: Value Added/Wages			
	Interquartile Range	*Median*	10^{th} *Percentile*
Large Entry	-0.001	0.003	0.004
	(0.0005)	(0.0040)	(0.0020)
Sunk Cost	-0.610	0.034	0.546
	(0.6226)	(0.0117)	(0.7380)
Pop. Density	0.001	-0.001	-0.001
	(0.0002)	(0.0009)	(0.0003)
B. Space Productivity: Sales/Square meter			
Large Entry	-0.003	0.006	0.003
	(0.005)	(0.0003)	(0.0011)
Sunk Cost	174.637	0.084	404.829
	(148.275)	(0.0102)	(24.0416)
Pop. Density	0.002	0.001	0.0004
	(0.0001)	(0.0001)	(0.0001)

NOTE: Two stage GMM is used for estimation of market equation (10) specified in section 7. 616 market-year observations for labor productivity and 880 market-year observations for sales productivity are used. Reported standard errors (in parentheses) are robust to heteroskedasticity.

Table 7: *Decomposition of Retail Food Productivity Growth in Sweden*

A. Productivity Growth: Total Factor Productivity					
Growth Between 1996 and	*Industry Growth (1)*	*Within Stores (2)*	*Between Stores (3)*	*Cross Stores (4)*	*Net Entry (5)*
1997	5.41	53.47	-22.52	24.74	44.30
1998	5.21	-46.28	-15.62	37.90	124.00
1999	3.51	-123.20	-0.92	69.22	154.90
2000	1.69	-204.64	20.56	84.52	199.547
2001	0.70	-849.69	-7.85	342.81	614.73
2002	2.58	-157.61	-13.62	94.40	176.83
B. Productivity Growth: Value Added per Wages					
1997	3.53	683.99	422.48	-1024.06	17.58
1998	1.63	896.07	972.44	-1890.59	122.07
1999	3.02	388.55	559.68	-913.74	65.49
2000	2.01	1627.08	723.71	-2320.91	70.11
2001	3.05	56.75	393.24	-435.82	85.83
2002	1.89	363.91	623.17	-942.87	55.78
C. Productivity Growth: Revenue per Sales Area					
1993	-2.05	207.11	186.48	-316.94	23.34
1994	-1.19	216.17	230.81	-342.37	-4.61
1995	2.31	87.12	-53.71	81.83	-15.24
1997	0.40	-222.47	-223.09	627.43	-81.86
1998	1.14	-138.46	-127.45	350.57	15.35
1999	5.81	14.96	-28.67	105.23	8.48
2000	7.80	20.79	-26.64	88.12	17.72
2001	14.44	28.31	-16.17	56.72	31.13
2002	18.74	26.30	-12.77	51.21	35.25

NOTE: All figures are in percentages. The used weights are the following: sales shares for TFP and sales productivity; and wage shares for labor productivity.

Appendix A. The FS data We now describe the variables used SECOND data. Value added is total shipments, adjusted for changes in inventories, minus the cost of materials. Real value added is constructed by deflating value added by a five-digit industry output deflater. The deflectors are taken from Statistics Sweden. The labor variable is the total number of employees. The total wages come from RAMS. We deflated sales, wages, and investment by the consumer price index(CPI) from IMF-CDROM 2005. The capital measure is constructed using a perpetual inventory method, $k_{t+1}(1-\delta)k_t + i_t$. Since the capital data distinguish between buildings and equipment, all calculations of the capital stock are done separately for buildings and equipment. As suggested by Hulten and Wykoff (1981) buildings are depreciated at a rate of 0.361 and equipment at 0.1179.

In order to construct capital series using the perpetual inventory method, we need an initial capital stock. Some of the firms in FS since 1973. We set the initial capital stock to the first occurrence in FS. We define entry when the year of entry in FS is the same as the year of first data collection. FS contain all firms in different industries after 1996.

Appendix B. The DELFI data Each year, the owners (chains) report information regarding all firms they are operating. Each firm has an identification number linked to its address. Revenues are presented in 19 classes. There are 12 different store types defined based on size, geographical location, product assortment etc. hypermarket, department firm, supermarket, grocery firm, other firm, small supermarket, small grocery firm, convenience firm, gas-station firm, mini market and seasonal firm.

Appendix C, Selection. The firms decision to exit in period t depends directly on ω_{jt} and therefore, the decision will be correlated with ε_{jt}. To identify β_l and β_k, we use estimates of the survival probabilities. These probabilities are given by

(12)

$$\begin{aligned} Pr(\chi_t = 1 | \underline{\omega}_t(k_t, e^L_{mt-1}, z_{mt-1}), F_{t-1}) = \quad & Pr(\omega_t \geq \underline{\omega}_t(k_t, e^L_{mt-1}, z_{mt-1})| \\ & \underline{\omega}_t(k_t, e^L_{mt-1}, z_{mt-1}), \omega_{t-1}, e^L_{mt-1}) \\ = \quad & P_{t-1}(i_{t-1}, l_{t-1}, k_{t-1}, s_{t-1}, p_{mt-1}, q_{mt-1}, \\ & e^L_{mt-1}, z_{mt-1}) \\ \equiv \quad & \mathscr{P}_{t-1} \end{aligned}$$

where the second equality follows from (8). Controlling for selection, we can express $g(\cdot)$ as a function of threshold productivity $\underline{\omega}_t$ and the information set F_{t-1}. As a result, the threshold market productivity is written as a function of $\mathscr{P}_t$ and F_t.

Substituting equation (8) and (12) into (7) yields

$$\begin{aligned} y_{jt} = \; & \left(1+\tfrac{1}{\eta}\right)[\beta_0+\beta_l l_{jt}+\beta_k k_{jt}] + \left(-\tfrac{1}{\eta}\right)\beta_q q_{mt} \\ & g(\mathscr{P}_{t-1}, \lambda_0 + [(1-\beta_l) - \tfrac{1}{\eta}\beta_l]l_{jt-1} - (1+\tfrac{1}{\eta})\beta_k k_{jt-1} + s_{jt-1} - p_{mt-1} + \\ & \tfrac{1}{\eta}q_{mt-1}, e^L_{mt-1}) + \varepsilon_{jt} + \zeta_{jt}, \end{aligned}$$

Appendix D, Estimation strategy. We now turn to the estimation of equation (12) and (9). In step one, we use a probit model with a third order polynomial to estimate the survival probabilities in (12). The predicted survival probabilities are then substituted into (9) that are estimated in the second step. We now turn to details about the estimation procedure of the latter step. The model (9) is semiparametric in the sense that it contains both finite and infinite dimensional unknown parameters. We estimate (9) using sieve minimum distance (SMD) procedure proposed in Newey and Powell (2003) and Ai and Chen (2003) for independent and identically distributed (i.i.d) data.[49] The goal is to obtain an estimable expression for the unknown parameters of interest $\boldsymbol{\alpha} = (\boldsymbol{\beta}, g)^{'}$. We denote the true value of the parameters with a subscript "a": $\boldsymbol{\alpha}_a = (\boldsymbol{\beta}_a, g_a)^{'}$. The moment conditions can be written more compactly as

$$(13) \quad E[\rho_j(\boldsymbol{x}_t, \boldsymbol{\beta}_a, g_a)|\boldsymbol{F}^*_t] = 0 \quad j = 1, \cdots, N$$

where N is the total number of firms, $\boldsymbol{F}^*_t$ is the information set at time t, and $\rho_j(\cdot)$ is defined as

$$\begin{aligned} \rho_j(\boldsymbol{x}_t, \boldsymbol{\beta}_a, g_a) \equiv \epsilon_{jt} + \zeta_{jt} = \; & y_{jt} - \left(1+\tfrac{1}{\eta}\right)[\beta_0+\beta_l l_{jt}+\beta_k k_{jt}] - \left(-\tfrac{1}{\eta}\right)\beta_q q_{mt} \\ & -g(\omega_{jt-1}, e^L_{mt-1}) \end{aligned}$$

Let $\boldsymbol{F}_t$ be an observable subset of $\boldsymbol{F}^*_t$. Equation (13) then implies

$$(14) \quad E[\rho_j(\boldsymbol{x}_t, \boldsymbol{\beta}_a, g_a)|\boldsymbol{F}_t] = 0 \quad j = 1, \cdots, N$$

If the information set $\boldsymbol{F}_t$ is informative enough, such that $E[\rho_j(\boldsymbol{x}_t, \boldsymbol{\beta}, g)|\boldsymbol{F}_t] = 0$ for all j and for any $0 \leq \beta < 1$, then $(\boldsymbol{\beta}, g)^{'} = (\boldsymbol{\beta}_a, g_a)^{'}$. The true parameter values must satisfy the minimum distance relation

$$\boldsymbol{\alpha}_a = (\boldsymbol{\beta}_a, g_a)^{'} = arg \min_{\boldsymbol{\alpha}} E[m(\boldsymbol{F}_t, \boldsymbol{\alpha})^{'} m(\boldsymbol{F}_t, \boldsymbol{\alpha})],$$

where $m(\boldsymbol{F}_t, \boldsymbol{\alpha}) = E[\rho(\boldsymbol{x}_t, \boldsymbol{\alpha})|\boldsymbol{F}_t]$, $\rho(\boldsymbol{x}_t, \boldsymbol{\alpha}) = (\rho_1(\boldsymbol{x}_t, \boldsymbol{\alpha}), \cdots, \rho_N(\boldsymbol{x}_t, \boldsymbol{\alpha}))^{'}$ for any candidate values $\boldsymbol{\alpha} = (\boldsymbol{\beta}, g)^{'}$. The moment conditions are used to describe the SMD estimation of $\boldsymbol{\alpha}_a = (\boldsymbol{\beta}_a, g_a)^{'}$. The SMD procedure has three parts. First, we can

[49] Chen and Ludvigson (2007) show that the SMD procedure and its large sample properties can be extended to stationary ergotic time series data.

estimate the function $g(\cdot)$, that has an infinite dimension of unknown parameters, by a sequence of finite-dimensional unknown parameters (sieves) denoted g_{K_T}. The approximation error decreases as the dimension K_T increases with sample size N. Second, the unknown conditional mean $m(\boldsymbol{F}_t, \boldsymbol{\alpha}) = E[\rho(\boldsymbol{x}_t, \boldsymbol{\alpha})|\boldsymbol{F}_t]$ can be replaced with a consistent nonparametric estimator $\hat{m}(\boldsymbol{F}_t, \boldsymbol{\alpha})$ for any candidate parameter values $\boldsymbol{\alpha} = (\boldsymbol{\beta}, g)^{'}$. Third, the function g_{K_T} can be estimated jointly with the finite dimensional parameters $\boldsymbol{\beta}$ by minimizing a quadratic norm of estimated expectation functions:

$$(15) \quad \hat{\boldsymbol{\alpha}} = arg \min_{\boldsymbol{\beta}, g_{K_T}} \frac{1}{T} \sum_{t=1}^{T} \hat{m}(\boldsymbol{F}_t, \boldsymbol{\beta}, g_{K_T})^{'} \hat{m}(\boldsymbol{F}_t, \boldsymbol{\beta}, g_{K_T})$$

We approximate $g(\cdot)$ by a polynomial of order three and substitute it in (14) as if it was the true model. Since the errors $\rho_j(\cdot)$ are orthogonal to the regressors $\boldsymbol{F}_t$ we use third order power series of $\boldsymbol{F}_t$, denoted $\boldsymbol{P}$, as instruments. In our setting we choose the following instruments: $\boldsymbol{F}_t = (1, l_{t-1}, k_t, e^L_{mt-1}, z_{t-1})$. We estimate $m(\boldsymbol{F}, \boldsymbol{\alpha})$ as the predicted values from regressing the errors $\rho_j(\cdot)$ on the instruments. Using $\boldsymbol{P}$, we specify the weighting matrix as $\boldsymbol{W} = I_N \otimes (\boldsymbol{P}^{'} \boldsymbol{P})^{-1}$ and the estimation becomes a GMM case. The weighting matrix $\boldsymbol{W}$ gives greater weight to moments that are highly correlated with the instruments. Using the specified GMM implementation, the parameter values $(\boldsymbol{\beta}, g_{K_T})$ are jointly estimated.

Appendix E, Robustness tables

Table 8: Municipality Characteristics

Year	1996	1997	1998	1999	2000	2001	2002
A. Markets Without Large Entrants							
Number of Markets	269	281	280	276	271	269	287
Median Population	31,239	32,487	30,366	30,408	31,260	30,208	35,702
% 0-19 years	24.64	24.55	24.49	24.46	24.15	24.19	23.99
% 20-39 years	25.82	25.62	25.21	24.7	25.09	24.50	24.77
% 40-64 years	31.10	31.45	31.86	32.32	32.41	32.80	32.93
% over 65 years	18.44	18.37	18.44	18.52	18.34	18.51	18.31
Mean per capita Income	144.5	149.2	155.5	161.0	170.7	177.7	184.7
Mean Store Concentration (C_4)	0.542	0.543	0.555	0.573	0.567	0.607	0.593
Mean Firm Concentration (C_4)	0.668	0.474	0.538	0.769	0.522	0.641	0.654
B. Markets With Large Entrants							
Number of Markets	19	7	8	13	18	20	3
Median Population	57,971	115,418	187,302	188,478	88,408	91,233	474,921
% 0-19 years	24.31	23.44	23.16	22.68	23.65	22.95	22.46
% 20-39 years	28.10	29.66	30.16	30.90	27.37	29.16	32.20
% 40-64 years	30.65	30.17	30.36	30.31	31.81	31.41	30.24
% over 65 years	16.94	16.73	16.31	16.11	17.17	16.48	15.10
Mean per capita Income	146.4	151.1	157.9	178.1	172.1	182.8	193.9
Mean Store Concentration (C_4)	0.382	0.343	0.347	0.321	0.443	0.388	0.268
Mean Firm Concentration (C_4)	0.494	0.366	0.443	0.763	0.582	0.599	0.665

NOTE: Mean values are presented for the structure of the population. Annual per capital income is in thousands of 1996 SEK.

Table 9: *Space productivity in market with and without entrants: Size moments*

A. Space productivity: markets without large entrants					
				$75^{th} - 25^{th}$	$90^{th} - 10^{th}$
Variable	*Mean*	*Std. Dev.*	*Skewness*	*Percentile Range*	*Percentile Range*
Productivity Dispersion (Interquartile Range)	0.503	0.212	0.457	0.274	0.540
10^{th} Percentile Productivity	3.286	0.334	-0.990	0.365	0.788
25^{th} Percentile Productivity	3.523	0.254	-0.220	0.309	0.611
Median Productivity	3.784	0.216	0.220	0.273	0.520
75^{th} Percentile Productivity	4.025	0.220	0.282	0.297	0.558
Std. Dev.	0.457	0.172	1.706	0.187	0.384
Store level Productivity	3.804	0.520	-0.469	0.629	1.215
Log of Population Density	3.817	1.908	0.500	1.789	5.204
B. Space productivity: markets with large entrants					
Productivity Dispersion (Interquartile Range)	0.534	0.150	0.124	0.187	0.366
10^{th} Percentile Productivity	3.345	0.229	-0.367	0.268	0.513
25^{th} Percentile Productivity	3.602	0.181	0.262	0.287	0.456
Median Productivity	3.875	0.166	0.669	0.225	0.391
75^{th} Percentile Productivity	4.136	0.197	0.663	0.229	0.445
Std. Dev.	0.471	0.127	1.341	0.111	0.287
Store level Productivity	3.922	0.512	-0.405	0.614	1.216
Log of Population Density	5.228	1.934	-0.184	3.142	4.300

NOTE: This table summarizes store space productivity distribution moments across 880 market-year observations for space productivity.

Table 10: *Labor productivity in market with and without large entrants: Size moments*

A. Labor productivity: markets without large entrants					
				$75^{th}-25^{th}$	$90^{th}-10^{th}$
Variable	*Mean*	*Std. Dev.*	*Skewness*	*Percentile Range*	*Percentile Range*
Productivity Dispersion (Interquartile Range)	0.351	0.250	1.915	0.268	0.560
10^{th} Percentile Productivity	0.293	0.364	-2.344	0.268	0.627
25^{th} Percentile Productivity	0.464	0.232	-1.963	0.180	0.390
Median Productivity	0.622	0.205	0.378	0.175	0.371
75^{th} Percentile Productivity	0.815	0.280	1.188	0.276	0.577
Std. Dev.	0.455	0.344	1.541	0.376	0.778
Store level Productivity	0.673	0.617	0.877	0.403	0.986
B. Labor productivity: markets with large entrants					
Productivity Dispersion (Interquartile Range)	0.406	0.192	1.060	0.195	0.408
10^{th} Percentile Productivity	0.229	0.327	-1.994	0.254	0.553
25^{th} Percentile Productivity	0.462	0.162	-0.517	0.149	0.326
Median Productivity	0.645	0.145	1.351	0.147	0.330
75^{th} Percentile Productivity	0.867	0.213	1.421	0.225	0.447
Std. Dev.	0.597	0.314	1.135	0.400	0.726
Store level Productivity	0.682	0.699	0.274	0.452	1.136

NOTE: This table summarizes firm labor productivity distribution moments across 616 market-year observations for labor productivity.

Table 11: *TFP productivity in market with and without large entrants: Size moments*

A. TFP productivity: markets without large entrants					
				$75^{th} - 25^{th}$	$90^{th} - 10^{th}$
Variable	*Mean*	*Std. Dev.*	*Skewness*	*Percentile Range*	*Percentile Range*
Productivity Dispersion (Interquartile Range)	0.369	0.233	1.898	0.266	0.539
10^{th} Percentile Productivity	1.731	0.401	-1.839	0.359	0.784
25^{th} Percentile Productivity	1.937	0.267	-1.584	0.244	0.521
Median Productivity	2.129	0.210	-0.586	0.220	0.439
75^{th} Percentile Productivity	2.306	0.216	-0.475	0.238	0.474
Std. Dev.	0.414	0.273	1.779	0.263	0.592
Store level Productivity	2.110	0.529	-1.166	0.470	0.999
B. TFP productivity: markets with large entrants					
Productivity Dispersion (Interquartile Range)	0.461	0.167	0.603	0.201	0.386
10^{th} Percentile Productivity	1.637	0.383	-1.982	0.356	0.713
25^{th} Percentile Productivity	1.939	0.183	-0.576	0.227	0.411
Median Productivity	2.172	0.144	-0.295	0.177	0.362
75^{th} Percentile Productivity	2.400	0.168	0.340	0.178	0.370
Std. Dev.	0.539	0.261	1.550	0.276	0.527
Store level Productivity	2.118	0.625	-1.421	0.537	1.146

NOTE: This table summarizes firm labor productivity distribution moments across 616 market-year observations for labor productivity.