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 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; Sales 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') stores have gained market shares and the total number of stores 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 store 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 stores in the Swedish retail food market. First, we estimate 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. Finally, we discuss how the planning regulation influence productivity in local markets. 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 store is allowed to enter. To our knowledge, the present study is the first on analyzing how large entrants affect incumbents' productivity in Swedish food retailing.

In the first part of the paper, we estimate store 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 serially correlated productivity terms. Incumbent stores 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, stores respond to changes in the environment. Hence, we jointly

[1]See Ericson and Pakes (1995); Hopenhayn (1992) and Jovanovic (1982) for theoretical contributions. See Aghion, Blundell, Griffith, Howitt, and Prantl (2006), Caves (1998) and others for empirical contributions.

[2]See for example Nordic Competition Authorities (2005:1) for a description.

[3]Swedish Competition Authority (2001:4)

analyze large entrants impact on stores' 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 stores 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. Secondly, we recover productivity from the stores' optimal choice of labor following Doraszelski and Jaumandreu (2006) i.e. a further difference to OP is that labor has dynamic implications. Thirdly, the effect on productivity caused by large entrants are explicitly incorporated when estimating productivity. New stores enter because they have either high productivity or low entry costs. We emphasize the importance of large entry on productivity for three reasons. First, large entrants are the core of the structural development in Swedish food retailing over the last twenty years. The national chains have worked out clear store concepts among which large ('big-box') stores have grown most. Second, the planning regulation is to a higher extent linked to large stores than small once.[5] Third, the catchment area of consumers is huge for large stores in comparison to small stores so we anticipate large entrants to influence consumer welfare and productivity more than small entrants.[6]

Moreover, the retail food market is characterized by differentiated products so the assumption of perfect competition in OP is not reasonable. The estimated production function will capture price and demand shocks that we control for by introducing a demand system as in Klette and Griliches (1996).[7] Stores are assumed to

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

[5]The entry regulation forces owners to do formal applications to the municipality on each new entrant. New buildings are commonly used for large store entrants that are externally located. Large entrants are supposed to have an extensive impact on the local market structure and therefore needs detailed evaluations in the planning process.

[6]If a small store enter, a limited number of consumers are anticipated to purchase in the new store. On the other hand, if a large store enter we expect an extensive share of the local market population as potential consumers. In addition, large stores have for example greater opportunities to innovate in new technologies that could be applied by smaller stores types later.

[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 stores sell homogeneous products

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 stores' decision 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 store 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 store 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 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. Our focus on the distribution of productivity give a deep understanding how productivity changes as large stores enter. [10] We consider the endogeneity issues by using general method of moments throughout the estimations of the productivity distribution. Because of the complexity of measuring productivity in retail markets, we use detailed store data that provide a number of different productivity measures based on two unique data sources. In addition to TFP, we consider labor and capital productivity as well as sales productivity.

Our research yields several important findings. The empirical results show that TFP, labor productivity and sales productivity (revenues per square meter) increase in local markets where large stores enter. Improvements in productivity are found both for the median store and among the least efficient stores. In addition, pro-

which is unreasonable in the setting of retail food. De Loecker (2006) and Doraszelski and Jaumandreu (2006) use the same demand system.

[8]The endogenous productivity model justifies the retention of observations with non-positive investment in the retail sector (few stores invest in capital every year in the retail sector). Without incorporating demand and large entrants, the only unobserved store-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 decision to enter are made simultaneously due to the entry regulation that force the stores to propose a formal application to the municipality before they enter.

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

ductivity 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 relate literature whereas Section 3 gives an overview of the market. Section 4 describes the data and presents descriptive statistics. Section 5 presents the modeling approach followed by the estimation in Section 6. Implications of productivity are reported in Section 7 whereas 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 studies on entry in local markets and the growing literature on productivity distribution in local markets.

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 (Olley and Pakes (1996); Ackerberg and Pakes (2005); Levinsohn and Petrin (2003); Pavcnik (2002) and Ackerberg, Caves, and Fraser (2005)).

Recent extensions on the OP framework emphasize the importance to control for price and demand shocks when estimating productivity (Melitz (2000); Levinsohn and Melitz (2002); Katayama, Lu, and Tybout (2003); De Loecker (2006); Doraszelski and Jaumandreu (2006); Jaumandreu (2006)). Removing price and demand shocks from productivity is also applied in new dynamic-oligopoly games where productivity is a key primitive (Collard-Wexler (2006)). 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.[11] When firms sell differentiated products, i.e. have some market power as

[11]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

in food retailing, the prices set by the individual store influences it's productivity.[12] Then, there will be a high variance in the relative prices i.e. store prices relative to the industry price index. If the store 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)).[13] We build on the just mentioned literature and correct for the omitted price bias by introducing a demand system when estimating productivity.

Recently, the interest for retail markets in economic research has started to grow. Putting attention to innovation and productivity in a cross industry study, Aghion, Blundell, Griffith, Howitt, and Prantl (2006) state that entry is important for the incentives to innovate among incumbents. Foster, Haltiwanger, and Krizan (2006) use census data to show that aggregate productivity dynamics in U.S. retailing are mainly determined by reshuffling of resources from less to more productive establishments. Entry and exit of stores are found to be more important contributors to productivity growth than the expansion of incumbents. This stand in contrast to the manufacturing sector where incumbents often are found to be major contributors to productivity growth (Pilat (2005)). Haskel and Khawaja (2003) find that entry and exit of retail stores in U.K. contributes to a lesser fraction of productivity growth compared to U.S.. A number of reports end up with the same conclusion comparing UK with other countries, see Reynolds, Howard, Dragun, Rosewell, and Ormerod (2005) for a summary.[14]

In the present study, we discuss productivity and its link to large entrants and regulation. Lack of data on formal applications force us to evaluate the effects indirect. There are a couple of attempts of analyzing the planning regulation in retail markets directly. A number of studies shed light on the link between regulation and firm performance doing cross-country comparisons (Pilat (2005), Boylaud and

quantities is negatively correlated with the establishment-level prices while the productivity based upon revenues is positively correlated with the establishment-level prices.

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

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

[14]The importance of competition for productivity has also been considered in recent applications of the OP framework (Muendler (2005) and Maican (2006)). 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 MacDonald (1994); and Nickell (1996).

Nicoletti (2001), Hoj, Kato, and Pilat (1995)). Although the results point towards welfare gains of a more liberalized planning process, more firm level studies are needed (Pilat (2005)). Using U.K. firm data, Griffith and Harmgart (2005) empirically analyze the Supermarket industry and finds that the entry regulation influence market outcome. Furthermore, retail markets in France are found to have higher concentration and lower labor growth as a consequence of the regulation (Bertrand and Kramarz (2002)).

Until now we have considered studies at the industry level. Retail markets are located close to consumers and competition is taking place in local markets. Hence, we need to consider local geographical markets throughout the analysis. The present paper is therefore related to a field of empirical IO studies on local markets. A series of papers use static models to analyze entry and market structure in well defined local markets (Bresnahan and Reiss (1987); Bresnahan and Reiss (1990) and Bresnahan and Reiss (1991)).[15] Jia (2006) assesses the impact of large chain stores on the profitability and entry/exit decisions of small discount retailers. The results show that entrants by large discount chains such as Wal-Mart and K-Mart increase exit among small discount stores in local markets.[16] The explicit incorporation of large entrants and its effect on incumbents are a common link to the present paper.[17] To our knowledge, we are the first to apply the OP framework on local retail markets. Until now, we are aware of three studies that develop fully dynamic models for local competition. First, Aquirregabiria and Vicentini (2006) that apply a multiple dynamic model to estimate multi store competition including spatial and dynamic considerations in local markets. Second, Dunne, Klimek, Roberts, and Xu (2005) that focus on market size and competition in the dentist and chiropractor markets. Finally, 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. The advantage of fully dynamic models is the ability to asses various policy changes.

The second part of the present study relates to a growing literature on distri-

[15]See Berry (1992); Mazzeo (2002); Seim (2005) and Toivonen and Waterson (2005) for extensions.

[16]The chain effect is identified from the stores' geographic clustering patterns. However, using a static model she is unable to incorporate both a competition effect and a chain effect.

[17]Smith (2007) analyzes consumer and producer benefits (welfare effects) for changes in store characteristics such as size, location, brand and additional stores. In some sense, he can evaluate the welfare effects caused by large entrants.

bution of firm productivity in local markets. Syverson (2004) uses a static model and argues that demand explains an extensive part of the persistent productivity dispersion in the concrete industry. Analyzing the distribution of firm turnover in a dynamic setting, Asplund and Nocke (2006) also emphasize the importance of entry and exit for the persistent differences within industries. Finally, Collard-Wexler (2006) explains the persistent productivity differences in the ready-mix concrete industry by arguing that extensive sunk costs and high volatility in productivity counteract exit by the inefficient firms.

3 Overview of the Swedish Retail Food Market

■ **The retail food market.** The strategy for retail food stores 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 are certainly important. Generally, successful operation of retail food stores 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 stores started to develop already in the beginning of the 1900s century. In the middle of the 1960s, technical development such as fridge and freezer, together with the expansion of 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, stores have increased (Kylebäck (2004)). 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 stores collaborating in purchasing and advertising. The centralized decision making has anyhow been put forward over the years. Axfood is also a mix of different stores, 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 store concepts. Opposite to ICA and Axfood, COOP consists of centralized cooperatives where decision are made at the cooperative level (national or local).[18] Both Axfood and COOP has 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

[18] There exist national cooperatives as well as local cooperatives.

parts capturing around 4 percent of the market. Finally, stores owned by various independent owners, (labeled Others), incorporates a market share around 8 percent. Contemporary to the gain in market shares among large stores, we observe a decline in the total number of stores, more centralized chains and well-defined store concepts. Investments in 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 supply chain management and self-scanning by consumers.

■ **Entry regulation.** On July 1st, 1987, a new regulation was imposed in Sweden, the Plan- and Building Act (PBA)[19] for a detailed description. 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 thorough the right to appeal the decisions taken by the local governments at the municipality level. Many European countries have similar land-use planning regulations i.e. power at the local authority level (Nordic Competition Authorities (2005:1)). 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 (Swedish Competition Authority (2001:4), Swedish Competition Authority (2004:2)). An investigation by 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 with a higher market share of large- and discount stores were found to have lower price levels. Noteworthy is also a study by Asplund and Friberg (2002) finding that large stores offer low prices in the Swedish market. How large entrants influence market competition and productivity growth has, anyhow, not been analyzed in detail. Pilat (2005) claims that, *if* entry and exit of stores drive productivity growth, entry regulations are of severe importance. Planning regulation may affect productivity by preventing entry. For example, it might end up with retail stores operating below minimum efficient scale resulting in low productivity lev-

[19] See The Swedish Competition Authority, 2001:4.

els. Furthermore, a decrease in competition can slow down the use and adoption of information and communication technologies (ICT). Coggins and Senauer (1999) emphasize that large stores increase the competitive pressure on incumbents making innovation, e.g. cost reductions and efficiency improvements, necessary for survival. Therefore, a more restrictive entry policy may hit innovations and consequently the productivity of the whole industry. [20]

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. [21]

4 Data and the Market Definition

■ **Data.** We use two main data sets in the empirical analysis. The first source of data is a census of Swedish retail food stores 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. The information, available at the individual store level, covers the time period 1996 to 2002. The FS-RAMS database is used to estimate the firm productivity. In this data one firm is defined based on organization number. Therefore, one firm in FS-RAMS may contain one or more stores. Appendix A gives more information about the FS data. The second data source consists of yearly information on all retail food stores operating in the Swedish market between 1993 and 2002. The data is collected by Delfi Marknadsparter AB (DELFI) and contain each stores' revenues, sales space, store type, owner, chain as well as location in the municipality - and local labor market, respectively. [22] We also add regional charac-

[20] One might argue that chains adopt similar strategies as their competitors and buy already established stores. As a result, more efficient stores 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 stores in external positions making the regulation highly important. Of course, we cannot fully rule out this opportunity.

[21] One can argue that it would be intuitive to analyze 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 (Swedish Competition Authority (2001:4).

[22] Each owner (chain) reports data each year during the collection.

teristics from SCB to each store. By merging on the municipality level, we connect regional information such as population, total area, average income and political preferences to the individual stores. Appendix B presents variable definitions and details about the second data set. Detailed store data allow us to comprise yearly information regarding all individual stores in the market, putting a strength to our analysis compared to studies on the industry level. In addition, in DELFI data we observe physical entry. We define the large entrants in the FS-RAMS data based on the information from DELFI.

A store's productivity is a major determinant whether it changes type or exits.[23] Retailers' definition of output includes the *service* element that vary from very large to very small depending on their focuses. Output in the retail sector depends on the quality of services provided by the labor as well as on adoption of systems that electronically link cash registers to scanners and credit card processing machines. The FS-RAMS data confirms productivity variations in both labor and capital. If the value of the store's output is higher than the cost of inputs, output can be explained by other factors such as chain effect and productivity.

Due to the complexity of defining input and output in retailing it is important to use several productivity measures throughout the analysis. The two data sources give opportunities to bring a number of different aspects of productivity relevant for the retail food market; total factor productivity (TFP), labor productivity, capital productivity and sales productivity (sales per square meter). The latter will be defined from the DELFI-data whereas the others will come out of the FS data. Using store level productivity we are able to study if large stores are more productive than small stores.

■ **Market definition and large entrants.** The empirical test of the model explores large entrants' influence on productivity moments in independent geographic markets. This raises the issues how to define large entrants and local markets within Swedish food retailing. In the DELFI data, each store is categorized with a type (12 different) depending on size, geographical location, product assortment etc. We

[23]Productivity of one store depend on its type(format) because the type(format) is related to the business model. For example discount format means more than just to sell low price goods. It relies on minimizing complexity e.g. cost and services, and maximizing stock turn. Other business models relies on the diving sales in more expensive locations and stores. However, if the cost of labor is high, then gross margins are likely to be high and productivity low. From the retailer's point of view it is important to know whether selling more products at the lower prices induce more efficiency than selling fewer products at higher prices.

argue that these multiple requirements are a reliable source for defining large and small stores. Hence, we first use the DELFI data and define the five largest types as 'large' whereas the remaining types are labeled 'small'.[24] Second, we base the grouping of stores in the FS data on the large stores' sales distribution in the DELFI data. Stores in the FS data with sales between maximum and the 10th percentile of large store sales in the DELFI data are defined as large, otherwise small.

For each particular store, the size of the market will of course depend on its type i.e. large stores capture consumers from a wider geographical area if we compare to small stores. A central characteristic of retail food products is their relatively short durability making consumers purchase them on a rather frequent basis. Hence, we believe that consumers travel a relatively short distance when buying food (except if prices are sufficiently low). Hence, store location is certainly important. Consequently, nearness to work and home are two central aspects for consumers when choosing store.[25] We use the Statistics Sweden's Local Labor Market definition(LM) as our market definition. LMs are collections of municipalities centered to 'metropolitan areas'. Worker commuting patterns are the main feature considering the definition. The selection criteria ensure that municipalities in a given LM are economically intertwined. This classification process groups of 290 Swedish municipalities into 88 markets that are mutually exclusive and exhaustive of the land mass of the Sweden.[26] The LM-based market definition is a compromise between contradictory requirements. Our theoretical model assumes that retail markets are isolated geographic units; stores in one market competitively interact only with other stores in the same local market. If we use municipality as a market, we are unlikely to measure market size correctly for large stores. Analyzing the effects of large stores on productivity, the appropriate market definition should be closely connected to the appropriate geographical market for large types. LMs are large enough to min-

[24]The five largest types are hypermarkets, supermarkets, department stores, supermarkets, grocery stores and other stores. The remaining (small) types are small supermarket, small grocery store, convenience store, gas-station store, mini markets and seasonal stores. See Appendix B for detailed definitions of the store types.

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

[26]LMs are defined in two steps; First, a municipality is denoted independent if 'out commuting' from the municipality is less than 20 percent and the 'in commuting' to the municipality is less than 7,5 percent. Second, all municipalities that don't fulfill the above requirements are connected to the municipality to which most citizens are traveling. See Statistics Sweden for more detailed information about the LM creation, www.scb.se.

imize cross-market shopping. However, we do not want to make markets so large that there is very little competitive interaction between the included stores by using for example counties (in total 12). Stores placed in too large markets may not all respond to the same market forces (external or actions of industry competitors). We believe that LMs are a suitable compromise to resolve the tension between isolating markets yet ensuring that the retailers within them are interconnected.[27]

The data provide us with demographic information of individual municipalities and LMs. Due to our market definition, characteristics of the latter are used as a proxy for demand. Total retail food demand is a function of the market's population but varies across income levels. Due to the difficulties in providing the data, demographic characteristics other than population and per capita income are, unfortunately, excluded from the analysis. Accessibility and convenience are two important factors when consumers choose a store. We do not have information on whether a store 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.[28]

■ **Descriptive Statistics.** Table 1 presents descriptive statistics for the two data sets. The decline in the total number of stores 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 increase around 3 percent. The average store size increase 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.

To get an indication of how the productivity distribution looks like in different local markets Table 2 presents summary statistics for the two benchmark measures: labor productivity and sales 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 interquartile measure, the corresponding deviation is 28 percent.[29] Furthermore,

[27]For robustness we also use municipality as a market definition. The results are available from the authors.

[28]There are two possibilities, either the individual retailer/chain owns the building where the store 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 (18 different).

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

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 sales 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 sales productivity is 5 times less than its mean 0.664.

To view the characteristics of the productivity distribution of the different benchmark measures (labor, capital and sales) we construct kernel probability density estimates of the distribution related to large entrants. Figure 1 shows the productivity distribution 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, firm/store productivity is higher for all parts of the distribution. That is, we find the productivity in labor, capital as well as sales 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. There are two common trends for labor and capital productivity in above median markets: First, interquartile dispersion seems to be lower compared to below median markets. Second, small firms are more productive than large. 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/stores located in local markets with more large entrants have generally higher sales productivity compared to stores located in markets with less entrants. In contrast to the other productivity measures, sales productivity is higher for large types compared to small.

Figure 2 shows productivity in labor, capital and sales together with the consumer price index. Interestingly, labor and capital productivity go in the opposite direction of each other. Sales are expectedly closely connected to market prices.

5 The modeling approach

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 the productivity.

■ **The model.** Our model of competition between retail stores is based on Ericson and Pakes (1995) dynamic oligopoly framework. For each period of time, we observe a set of incumbent stores currently active in local markets.[30] In the setting of retailing, large entrants and product differentiation are central features anticipated to have an impact on store behavior. We assume that entrants are exogenous. The assumption restricts our model from true dynamics where entry is endogenous as in Beresteanu and Ellickson (2006) and Aguirregabiria, Mira, and Roman (2007). However, our entry assumption allow us only to focus on the impact of entrants on incumbents i.e. not to put forward what determines entry.

A store is described by its states consisting of productivity $\omega \in \Omega$ and capital stock $k \in \mathbb{R}_+$. The store is able to change its state (productivity) over time through its choice of investment $i \geq 0$ or/and labor l. Incumbent stores maximize the expected discounted value of future net cash flows. First, stores 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.[31] If the store exit, the scrap value ϕ is received. If the store 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.[32] Stores' transitions from one productivity state to another are subject to an idiosyncratic shock. There is a variability in the fortunes of stores 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, that cause correlation between the outcomes of different stores in the same market.[33]

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

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 an exogenous first-order Markov process with $P(d\omega|\omega)$ used the OP framework.

[30]According to our definition we observe 88 distinct geographical markets (LMs).

[31]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.

[32]A change in type is considered an investment because it may help the store to increase its productivity.

[33]Profits of the stores in the same market are correlated.

Given the conditions of the model mentioned above, we can now specify the maximization problem of the store. 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 $\beta < 1$:

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

where $\pi(\omega, k)$ is the profit function, $c_i(i)$ is the cost of investment; i is the investment choice of the store; $c_l(l)$ is the cost of labor. [34] If the store's current productivity indicates that continuing in operation is not worthwhile, the store closes down. If the store decides to continue then it chooses an optimal policy for investment and labor. We define the indicator function χ_t to be equal to zero if the store exits. The exit rule, the investment and labor policy equations are written as

$$\chi_{t+1} = \tilde{\chi}_t(\omega_t, k_t) = \begin{cases} 1 & \text{(continue) if} \quad \omega_t \geq \underline{\omega}_t(k_t, e^L_{t-1}, z_{t-1}) \\ 0 & \text{(exit) otherwise,} \end{cases} \tag{3}$$

$$i_t = \tilde{i}_t(k_t, \omega_t) \tag{4}$$

and

$$l_t = \tilde{l}_t(k_t, \omega_t) \tag{5}$$

The function $\underline{\omega}_t(\cdot)$ denotes the threshold productivity. For each capital stock k_t, demand condition z_{mt-1}, number of large entrants e^L_{mt-1}, and store specific location there exists an exit threshold productivity. If the value of productivity is below the threshold the store exits, otherwise it stays in operation. Furthermore, both functional forms $\underline{\omega}_t(\cdot)$ and $i_t(\cdot)$ are determined "as a part of the Markov Nash equilibrium, and will depend on all the parameters determining the equilibrium."(Olley and Pakes (1996)). These functions depend on the market structure and the prices when these decisions are made. In the empirical section, we filter out price and demand shocks from productivity - getting reliable estimates of productivity in an environment of imperfect competition. [35]

6 Estimation

■ **Production function.** We assume that stores sell a homogeneous product with Cobb-Douglas technology and that the factors underlying profitability differences

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

[35] In the OP framework all these factors are allowed to change over time, but they are assumed constant across stores in a given time period.

among stores are neutral efficiency differences.[36] The production function is specified as

$$q_{jt} = \beta_0 + \beta_l l_{jt} + \beta_k k_{jt} + \omega_{jt} + \xi_{jt}, \tag{6}$$

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. Productivity may be highly correlated over time and perhaps also across stores. The ω_{jt} is a state variable in the store's decision problem and it is a determinant of liquidation, labor, and investment decisions.

□ **Price and demand shocks.** To extend the model to fit the retail market where stores sell differentiated products, we allow prices to vary across stores.[37] When stores have some market power the inverse input demand functions depend on output demand. Consider stores 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

$$p_{jt} = p_{mt} + \frac{1}{\eta} q_{jt} - \frac{1}{\eta} q_{mt} - \frac{1}{\eta} u^d_{jt}, \tag{7}$$

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.[38] Stores 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.[39]

Since the price of individual stores 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 (6) we have

$$y_{jt} = \left(1 + \frac{1}{\eta}\right) [\beta_0 + \beta_l l_{jt} + \beta_k k_{jt}] + \left(-\frac{1}{\eta}\right) \beta_q q_{mt} + \left(1 + \frac{1}{\eta}\right) \omega_{jt} + \zeta_{jt}, \tag{8}$$

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

[37] Prices are assumed constant across stores in (6).

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

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

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

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

$$(9) \qquad \omega_{jt} = \tilde{g}(\omega_{jt-1}, e^L_{mt-1}) + \upsilon_{jt},$$

where e^L_{mt} is the number of large entrants in a local market. The actual store'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.[40] The timing assumptions are important in this context: When incumbent stores 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 stores 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.[41] The productivity evolves according to a conditional transition probabilities and by substituting (9) into (8) we get

$$(10) \qquad \begin{aligned} y_{jt} = \; & \left(1+\tfrac{1}{\eta}\right)[\beta_0 + \beta_l l_{jt} + \beta_k k_{jt}] + \left(-\tfrac{1}{\eta}\right)\beta_q q_{mt} \\ & + g(\omega_{jt-1}, e^L_{mt-1}) + \varepsilon_{jt} + \zeta_{it}. \end{aligned}$$

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.[42]

[40] 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.

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

[42] 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, Powell, and Vella (1999)). Including shifters for large entrants guarantee the identification. The shifter e^L_{jt} cannot be perfectly predicted from ω_{jt}.

□ **Labor.** In the beginning of year t the store observes current productivity ω_{jt} and chooses labor l_{jt} based on this i.e. 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. In retailing, stores often invest only one year followed by several years without investments. Backing out productivity from the policy function of labor allow us to incorporate zero investments into the analysis. In year $t-1$, the stores 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 store j. Solving for ω_{jt-1}, we find the inverse labor demand function[43]

$$(11) \quad \begin{aligned} \omega_{jt-1} = \quad & \tfrac{\eta}{1+\eta}\Big[\lambda_0 + [(1-\beta_l) - \tfrac{1}{\eta}\beta_q]l_{jt-1} - (1+\tfrac{1}{\eta})\beta_k k_{jt-1} + \\ & s_{jt-1} - p_{mt-1} + \tfrac{1}{\eta}q_{mt-1},\Big] \end{aligned}$$

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.** The stores 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.[44] Substituting the survival probabilities and the labor demand functions into (10) yields the final production function that we want to estimate.

$$(12) \quad \begin{aligned} y_{jt} = \quad & \left(1+\tfrac{1}{\eta}\right)[\beta_0 + \beta_l l_{jt} + \beta_k k_{jt}] + \left(-\tfrac{1}{\eta}\right)\beta_q q_{mt} \\ & g(\mathscr{P}_{t-1}, \lambda_0 + [(1-\beta_l) - \tfrac{1}{\eta}\beta_l]l_{jt-1} - (1+\tfrac{1}{\eta})\beta_k k_{jt-1} + s_{jt-1} - p_{mt-1} + \\ & \tfrac{1}{\eta}q_{mt-1}, e^L_{mt-1}) + \varepsilon_{jt} + \zeta_{jt}, \end{aligned}$$

■ **Estimation strategy.** We now turn to the estimation of the survival probabilities and (12). 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 (12) that are estimated in the second step. We now turn to details

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

[44]See Appendix C for a detailed description.

about the estimation procedure of the latter step. The model (12) is semiparametric in the sense that it contains both finite and infinite dimensional unknown parameters. We estimate (12) 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.[45] The goal is to obtain an estimable expression for the unknown parameters of interest $\boldsymbol{\beta}$ and $g(\cdot)$. 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.

□ **Size moments of estimated TFP.** Table 3 presents summary statistics for the TFP market regression variables. There 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.

7 Econometric Specification of Local Market Productivity

■ **Econometric Specification.** Our goal is to asses the role of large entrants in determining the differences in productivity across stores and the evolution of the store 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 interquartiles ranges of TFP, labor productivity, and sales productivity among stores in each LM-year market.[46] The central tendency of the local productivity distribution is measured using median for TFP, labor productivity, and sales productivity. We choose me-

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

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

dian to minimize measurement errors. The market's minimum productivity level is measured by the 10^{th} percentile TFP, labor productivity, and sales productivity 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.

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

$$(13) \quad \theta_{mt} = \gamma_0 + \gamma_e e^L_{mt} + X_{c,mt}\gamma_o + \varepsilon_{mt}.$$

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 LM -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 store 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 store multiplied by the capital-output ratio for the local market. The corresponding measure for the DELFI data is based on sales space. Using (13) we want to test if more large entrants should result in both higher minimum and average productivity. Our market definition, local labor market, offers 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 sales productivity.

■ **Aggregate Productivity Decomposition.** We present a formal productivity growth decomposition for the Swedish food retailing. Productivity in local markets can be expressed as a weighted average of store'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 sales productivity and $s_{mt} = wages_{mt}/wages_t$ for labor productivity. The change in retail productivity between year t and t' can be written

$$(14) \quad \begin{aligned} \Delta\Omega_{mt,t'} = \; & \textstyle\sum_{i \in C_{t,t'}} s_{im,t}\Delta\omega_{imt,t'} + \sum_{i \in C_{mt,t'}} (\omega_{imt} - \Omega_{mt})\Delta s_{imt,t'} \\ & + \textstyle\sum_{i \in C_{mt,t'}} \Delta\omega_{imt,t'}\Delta s_{imt,t'} - \sum_{i \in X_{mt,t'}} s_{imt,t'}(\omega_{imt} - \Omega_{mt}) \\ & + \textstyle\sum_{i \in E_{mt,t'}} s_{imt'}(\omega_{imt'} - \Omega_{mt}) \end{aligned}$$

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

8 Empirical Results

Table 4 presents our main regression results from the estimations of equation (13). For each dependent variable, 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; a decrease in expected labor productivity dispersion by approximately 0.001 log points; and a decrease in expected sales productivity dispersion by approximately 0.003 log points - but this is not significant at the 10% significance level. [47] 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.

Due to the complexity of measuring productivity in retail markets we have emphasized the importance of using benchmark measures as complements to TFP. Table 5 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.

The decomposition consists of five terms and Table 6 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 stores increase their productivity at initial sales for TFP and sales pro-

[47] 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

ductivity, and at initial wages for labor productivity.[48] The second term (column 3) is the increase in productivity resulting when continuing stores with above -average productivity expand their share of sales (TFP and sales productivity) and share of wages (labor productivity) relative to stores with below-average productivity. The third term (column 4) is the cross-store term. The fourth (column 5) is the increase in productivity due to exits and entrants.[49] 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 stores at their initial sales (for sales 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 stores with above-average labor productivity that expanded their shares of wages relative to stores with below average labor productivity. The sign of the cross term reflects a negative covariance between labor productivity and wage changes.

9 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 stores 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,

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

[49] Columns 2-5 shows the share of the percentage productivity gains due to terms $j = 1, 2, 3, 4, 5$ in equation (14), that is $(term_j/\Delta\Omega) \times 100$.

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.

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Table 1: Characteristics of The Data

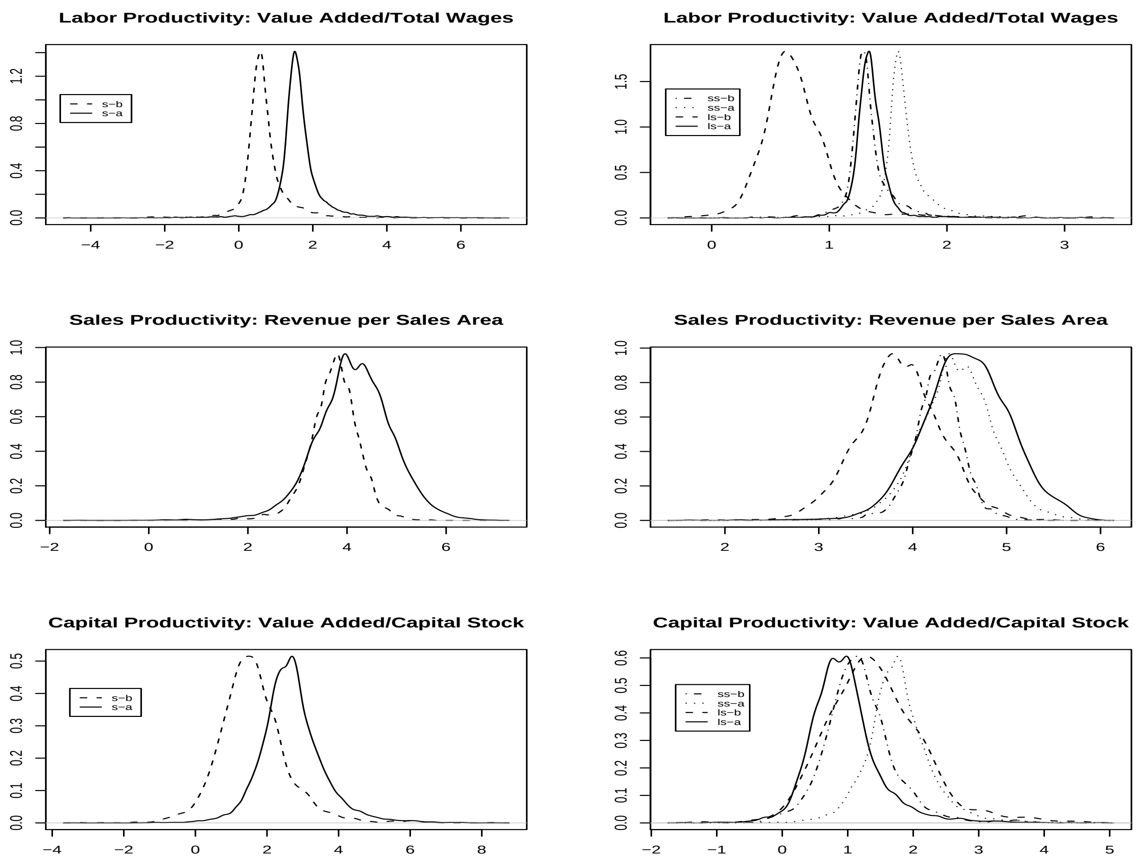
A. Financial Statistics(FS) and Regional Labor Statistics(RAMS) Data							
Year	Stores	Large Stores	Large Entry	Sales	Value Added	Total Wages	Employment
1996	3,332	742	-	313,305	42,693	21,338	43,829
1997	3,280	798	44	321,425	46,015	22,610	44,148
1998	3,197	788	34	327,578	45,868	23,290	44,382
1999	3,120	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: *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
Store level Productivity	0.693	0.695	0.795	0.474	1.185
Number of Stores	40.009	110.589	6.800	29.000	89.400
B. Sales Productivity: Revenue per Square area, 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

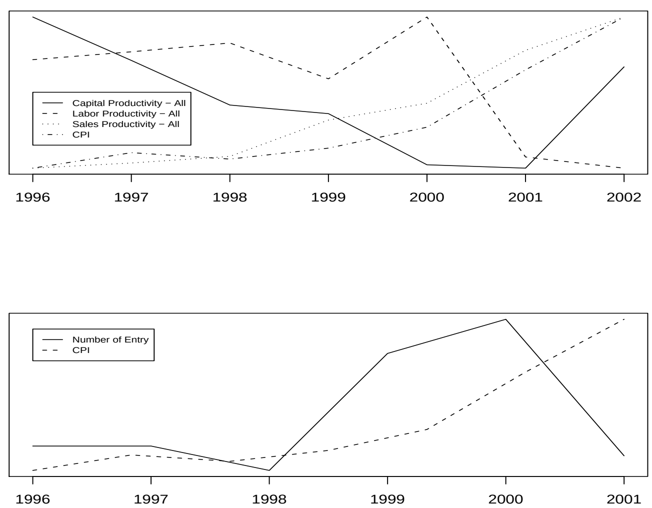
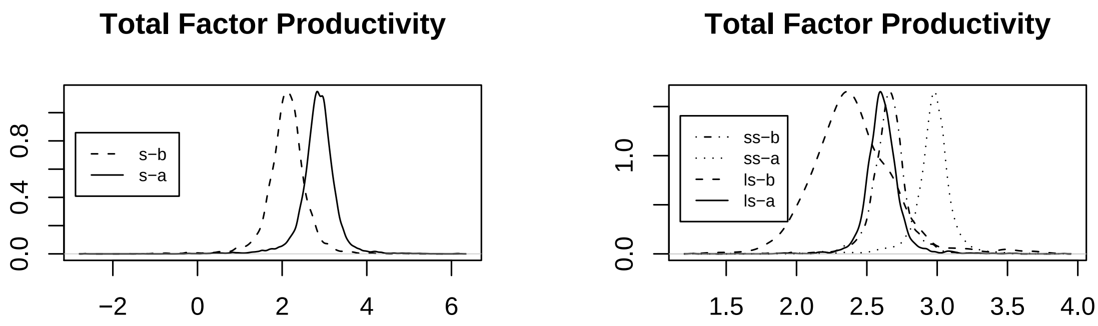


Figure 2: Labor Productivity, Capital Productivity, Sales Productivity, Number of Entry, and CPI

Table 3: *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
Store level Productivity	2.116	0.566	-1.283	0.497	1.056
Number of Stores	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
Store level Productivity	2.021	0.585	-1.363	0.470	1.039
Number of Stores	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
Store level Productivity	2.400	0.386	0.544	0.371	0.764
Number of Stores	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 3: TFP Kernel Density Estimates, Firms in Markets Above and Below Median Number of Large Entrants

Table 4: *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 (13) 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 5: *Market Benchmark Regression Results: Labor and Sales 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. Sales Productivity: Revenue per Sales Area			
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 (13) 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 6: *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 employers. 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 stores they are operating. Each store 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 store, supermarket, grocery store, other store, small supermarket, small grocery store, convenience store, gas-station store, mini market and seasonal store.

Appendix C, Selection. The stores 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

(15)

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

where the second equality follows from (11). 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 (11) and (15) into (10) yields

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

Appendix D, Estimation strategy. We now turn to the estimation of equation (15) and (12). In step one, we use a probit model with a third order polynomial to estimate the survival probabilities in (15). The predicted survival probabilities are then substituted into (12) that are estimated in the second step. We now turn to details about the estimation procedure of the latter step. The model (12) is semi-parametric in the sense that it contains both finite and infinite dimensional unknown parameters. We estimate (12) 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.[50] 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

$$(16) \quad E[\rho_j(\boldsymbol{x}_t, \boldsymbol{\beta}_a, g_a)|\boldsymbol{F}^*_t] = 0 \quad j = 1, \cdots, N$$

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

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

Let $\boldsymbol{F}_t$ be an observable subset of $\boldsymbol{F}^*_t$. Equation (16) then implies

$$(17) \quad E[\rho_j(\boldsymbol{x}_t, \boldsymbol{\beta}_a, g_a)|\boldsymbol{F}_t] = 0 \quad j = 1, \cdots, N$$

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

[50] 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:

$$(18) \quad \hat{\boldsymbol{\alpha}} = arg \min_{\boldsymbol{\beta}, g_{K_T}} \frac{1}{T} \sum_{t=1}^{T} \hat{m}(\boldsymbol{F}_t, \boldsymbol{\beta}, g_{K_T})^{'} \hat{m}(\boldsymbol{F}_t, \boldsymbol{\beta}, g_{K_T})$$

We approximate $g(\cdot)$ by a polynomial of order three and substitute it in (17) 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.