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Bad Neighbours?

Local Price Competition in the Norwegian Grocery Retail Market

DAMIAN SANCHEZ OLSEN AND MARTIN SANCHEZ OLSEN

SUPERVISORS: FRODE STEEN AND MORTEN SÆTHRE

FOOD

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Damian Sanchez Olsen† Martín Sanchez Olsen‡

Frode Steen and Morten Sæthre

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*Norwegian School of Economics, Department of Economics, Helleveien 30, NO-5045 Bergen. This thesis was written as a part of the Master of Science in Economics and Business Administration at the Norwegian School of Economics. Please note that neither the institution nor the examiners are responsible, through the approval of this thesis, for the theories and methods used, or results and conclusions drawn in this work.

†E-mail: damian.olsen@student.nhh.no.

‡E-mail: martin.olsen@student.nhh.no.

Abstract

The aim of this paper has been to examine the local competition between grocery retail stores in the Norwegian grocery retail market. Our attention has been on explaining the effect of market structure on prices. For this purpose we assemble an original dataset consisting of a selection of grocery retail stores in the city of Oslo, Norway. We construct several market structure variables based on different structural measures and employ a random-effects estimator to determine the relationship between market structure and prices, controlling for cost and demand factors as well as store characteristics.

First, our findings suggest that the variation in prices is directly related to the chain-concept affiliation of each store. Nonetheless, under the assumption that market structure is exogenous in our model, we estimate that (1) the distance to the nearest rival does not affect a store's pricing behaviour, (2) the number of rival stores has a negative effect on a store's price level, and (3) prices increase when there is at least one rival format in the local market. However, if the assumption of exogenous market structure does not hold, which there is reason to believe, then our estimated relationship between price and market structure only expresses the correlation between the two.

Keywords local price competition, the norwegian grocery retail industry, spatial competition, structure-price relationship, industrial economics

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Apart from this, the paper has benefited from unhealthy sleep habits, caffeine substances, and the involuntary family ties of the authors.

> Here is a prayer for you. Got a pencil? ... 'Protect me from knowing what I don't need to know. Protect me from even knowing that there are things to know that I don't know. Protect me from knowing that I decided not to know about the things I decided not to know about. Amen.' ... There's another prayer that goes with it. 'Lord, lord, lord. Protect me from the consequences of the above prayer.'
>
> — Douglas Adams, *Mostly Harmless* (2009)

to our loved ones,
should we meet again
post thesis

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1 Introduction

The Norwegian grocery retail market has over the last decade been primarily characterized by chain formation and centralization, with three groupings controlling nearly all of the market. This was further emphasized by ICA's withdrawal from the market in 2015, which saw the dominant players further strengthen their position. However, following major structural changes, the market has stabilized in 2016. This has led to an increased growth in the grocery retail market, which is closer to the level that the market experienced half a decade ago.

In the paper, we examine the local competition between grocery retail stores in the Norwegian grocery retail market—focusing attention on evaluating the impact of market structure on grocery retail prices. We assemble an original data set with price information from 49 stores located within the city of Oslo for the period week 11, 2016, to week 9, 2017, and observe a sample of discount, convenience and supermarket stores operating in fifteen distinct local markets. More precisely, our primary objective is to study if differences in grocery retail prices across stores and local markets can be attributed solely to chain-concept affiliation after controlling for factors that may affect the cost and demand conditions for the store, as well as for alternative measures of market structure. Under the hypothesis that each store is directly managed by the chain-concept they belong to, we would expect structural measures to have no impact on prices. Moving forward, we will also provide a detailed discussion on the endogeneity of market structure in our approach, as a store's price decision, as argued by Gullstrand and Jörgensen (2012), is affected by the local market, and the local market structure may not be disengaged from the pricing behavior of the stores in the particular market.

In the special case of competition being effective, grocery retail prices would be determined solely on the basis of marginal costs and demand controls, and there would not exist a systematic structure-price relationship (Lamm, 1981, p. 69). However, models of oligopolistic behavior generally agree that the competition increases with, inter alia, the number of stores in a local market, as argued by Asplund and Friberg (2002), and that the equilibrium prices should fall as competition increases. As demonstrated in Dobson and Waterson (2005, 2008), pricing according to local conditions should in fact be the profit-maximizing strategy in local markets. Chains may, nonetheless, find it profitable to set a uniform price when subject to different intensities of competition across various markets. In sum, exactly how equilibrium prices are related to market structure hinges crucially on the nature of the short-run interaction, and the potential for implicit collusion as national pricing can only be sustained with a credible, visible commitment to uniform pricing (Asplund and Friberg, 2002; Dobson and Waterson, 2008).

Our empirical strategy builds upon previous empirical research methods and insights from modern market theorists. However, where most of the previous empirical studies of market structure have focused on the analysis of cross-sectional data, we employ a random effects estimator to our panel data structure. That being said, to our knowledge, no papers on structure-price relationships have previously examined the Norwegian grocery retail market. The paper also extensively combines market structure measures employed in previous empirical research as we examine a vast amount of structural measures with the purpose of relating price variation to market structure. In addition, where the majority of the previous studies on price competition in grocery retailing have examined only the effect of market structure on supermarket prices, we also incorporate discount retailers and convenience stores in our sample.[1]

Our results seem to support the findings in Asensio (2014) in the sense that most of the variation in prices is directly related to the chain-concept each store belong to. Roughly 93 percent of the variations in prices can solely be attributed to the chain-concept affiliation of the store. However, unlike in Asensio (2014), we observe nonetheless a behavior of market structure measures and local socioeconomic attributes affecting prices. When assuming that market structure is exogenous in our model, our main findings is that (1) the distance to the nearest rival does not affect a store's pricing behaviour, (2) the number of rival stores have a negative effect on a store's price level, and (3) prices increase when there is at least one rival format in the local market. However, the causal interpretation of the estimated effects are only valid if the assumption of exogeneity holds. If this is not the case, which there is reason to believe, then the estimated relationships can only be interpreted as correlations.

The organization of the paper is as follows. In Section 2 we present an overview of the Norwegian grocery retail market. Section 3 includes a review of previous research on competition in local retail markets, whereas Section 4 introduces the concept

[1] Cleeren et al. (2010) use an empirical entry model to study the degree of intra- and interformat competition between discounters and supermarkets in Germany, while Zhu et al. (2009) examine competition between the three major firms in the retail discount industry.

of customized and uniform pricing of retail chains to provide a justification for the decision of grocery retail chains to fix their prices nationally as opposed to following a policy of local pricing. In Section 5 we present the data that we use in our empirical analysis, explain how the local markets and market basket of goods are defined, and present the variables we employ in our analysis. Section 6 specifies the model of price competition and reports the empirical results. Finally, the paper summarizes major conclusions and discusses the corresponding limitations of our selected approach.

2 The Norwegian Grocery Retail Market

Over the last decade the development in the Norwegian grocery retail market has been characterized by chain formation and centralization, the development of private labels, and increased vertical cooperation (NILF, 2013). In the most recent years ICA's withdrawal from the Norwegian market has been the key driver of change, with most of ICA's stores being acquired by Coop and the rest being mostly divided between NorgesGruppen and Bunnpris (Solem, 2017). However, following these major structural changes, the market has stabilized in 2016. This has led to an increased growth in the grocery retail market, which is closer to the level that the market experienced half a decade ago.

Moreover, the growth comes despite the fact that both food boxes and online delivery have a wider range of users now than one year ago (Nielsen, 2017). In addition, grocery stores are experiencing increased competition from other market channels such as restaurants and kiosks (NorgesGruppen ASA, 2017). Therefore, defining the relevant grocery retail market is far from unambiguous. Because even though the grocery retail market is dominated by grocery retail groupings such as NorgesGruppen and Coop, groceries are also sold through other stores and channels which are not uniquely identified within the grocery retail market. For the purpose of our thesis, we narrow down the grocery retail market to include only the market players that have their main emphasis on groceries sold through physical stores, thus excluding online delivery, kiosks, and gas stations as well as restaurants and fast-food chains.

2.1 Market Structure

Market Shares and Sales The primary characteristic of the Norwegian grocery retail market is its high market concentration of retailers, with three groupings controlling 96.1 percent of the market as of 2016 (Nielsen, 2017). When including the fourth largest grouping, Bunnpris[2], the total market share rises to over 99.9 percent (Nielsen, 2017). The high market concentration is further emphasized by the dominant position of the largest grouping, NorgesGruppen, whose revenues constitute about 40 percent of the total grocery retail market (Nielsen, 2017).

The market shares in the period from 2014 to 2016 are presented in Figure I. We see that the three largest groupings – NorgesGruppen, Coop, and Rema 1000 – have increased their market shares over the period. Coop has experienced the largest increase in market share, with an increase of over 30 percent. Coop's success may partly be explained by its acquisition of ICA Norway in mid-2015. This may have increased Coop's competitiveness through greater economies of scale and scope as well as increased purchasing power.

Further, in Table I we present selected descriptive statistics for the Norwegian grocery retail market for the period 2011-2016. The table includes the total revenues for the market, as well as the market shares by concept and by format. We see from Table I that the total revenues in the grocery retail market has seen an increase of over 50 percent during the last decade, totalling almost 170 billion NOK ex VAT as of 2016 (Nielsen, 2017). This implies a revenue growth that is almost one percentage point higher than the growth in the combined retail market, which grows approximately three percent yearly (Statistics Norway, 2017).

Moreover, in Table II we present the number of stores in the Norwegian grocery retail market by grouping and by geographical area. We observe that the total number of stores have declined over the period, which implies that the average revenue per store has increased substantially. According to (NILF, 2013), this revenue growth can mainly be attributed to the efficiency improvements and restructuring measures that have been carried out by the major players in the market.

[2]Bunnpris is an independent chain but has had a procurement and distribution cooperation with REMA 1000 since 2012, where Rema 1000 has been responsible for the procurement negotiations and contracts as well as the deliveries (NILF, 2013). However, as of 2017, NorgesGruppen have overtaken these tasks on behalf of Bunnpris (Norwegian Competition Authority, 2016).

TABLE I—DESCRIPTIVE STATISTICS FOR THE NORWEGIAN GROCERY RETAIL MARKET

	2011	2012	2013	2014	2015	2016
Revenues, in MNOK	143,717	148,119	153,506	160,145	164,310	169,413
			MARKET SHARES BY CHAIN (in Percent)			
Rema 1000	21.3	22.2	23.1	23.7	24.2	24.4
Kiwi	15.2	16.0	16.9	17.7	18.9	19.9
Coop Extra	1.8	2.3	3.2	6.1	7.9	11.5
Meny	9.0	9.7	10.3	10.2	10.7	10.9
Spar/Eurospar	6.8	6.8	6.8	6.7	6.9	7.0
Coop Obs	5.5	5.6	5.5	5.4	5.5	5.4
Coop Prix	6.6	6.6	6.1	4.4	4.2	5.3
Coop Mega	5.7	5.2	4.5	3.7	3.7	4.3
Bunnpris	3.8	3.7	3.6	3.4	3.9	3.9
Joker	3.3	3.4	3.4	3.5	3.6	3.7
			MARKET SHARES BY FORMAT (in Percent)			
Discount	54.9	57.4	59.7	61.8	63.4	65.1
Supermarket	25.6	25.4	25.0	23.7	23.0	22.2
Convenience	10.3	9.2	8.5	8.3	7.8	7.3
Hypermarket	9.3	8.1	6.7	6.1	5.8	5.4

TABLE I. Notes to Table I. The table includes the following descriptive statistics for the Norwegian grocery retail market for the period 2011-2016: total revenues in million NOK, the market shares by concept in percent, and the market shares by format in percent. The convenience format does not include sales from kiosks and gas stations. There are missing observations for Coop with regards to number of stores in 2011 and 2012. (Nielsen, 2015, 2016a, 2017; NorgesGruppen ASA, 2017; Coop Norge SA, 2016; Reitangruppen AS, 2016)

Stores The development in the Norwegian grocery retail market has over the last decade been characterized by fewer but larger stores and longer opening hours (NILF, 2013). Over the last years, however, the three largest groupings have all increased their number of stores, in direct contrast to the market in general. This increase in number of stores can most likely be attributed to ICA's withdrawal from the Norwegian market, with most of ICA's stores being acquired by Coop, NorgesGruppen, and Rema 1000[3] (Solem, 2017).

Furthermore, when we decompose the reduction in the total number of stores by geographical area, we observe that the decline in number of stores has not been uniformly distributed across areas. According to Gullstrand and Jörgensen (2012), this pattern may be explained by distribution costs and scale economies, which enable only the largest chains to be successful in remote areas with low population density; another possible explanation could be changes in population patterns across areas. Either way, Oslo is the only area that has seen an increase in the number of stores during the period, whereas the number of stores in Northern Norway has seen a decline of almost ten percent.

Figure I—Market Shares in the Norwegian Grocery Retail Market, 2014-2016

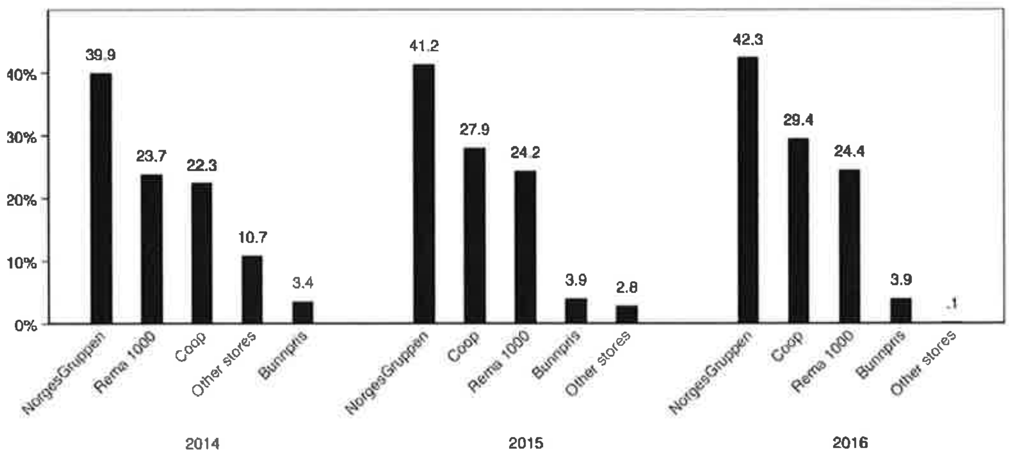

Figure I. Market shares in the Norwegian grocery retail market in the period 2014-2016, in percentages. Market shares are based on Nielsen Norway's Grocery Register and include all co-operative and private grocery stores in Norway, excluding Svalbard. Grocery sales from gas stations and kiosks as well as food boxes and online groceries, are not included in the figure. The market shares of ICA Norway are included under 'Other stores' in 2014 and 2015, following ICA's withdrawal from the Norwegian market during 2015. (Nielsen, 2015, 2016a, 2017)

[3]Rema 1000 acquired several leasing contracts from ICA (Solem, 2017).

Table II—Number of Stores in the Norwegian Grocery Retail Market, By Grouping and Geographical Area

	2012	2013	2014	2015	2016	%Δ
In Total	3,917	3,899	3,899	3,806	3,814	-2.6
By Grouping						
– NorgesGruppen	1,681	1,714	1,768	1,806	1,850	10.0
– Coop	—	793	804	1,259[a]	1,250	57.6
– Rema 1000	505	528	541	565	594	17.6
By Geographical Area						
– Western Norway	843	841	839	825	831	-1.4
– West-Eastern Norway	721	723	720	698	698	-3.2
– Oslo	365	376	369	371	377	3.3
– East-Eastern Norway	806	799	808	785	792	-1.7
– Central Norway	636	632	634	625	622	-2.2
– Northern Norway	546	528	529	502	494	-9.5

Table II. Notes to Table II. The table includes the number of stores in the Norwegian grocery retail market for the period 2012-2016 by geographical area, as well as the percentage change over the period. No information on the number of Coop stores in 2012 was found. [a] For 2015, the ICA stores are included under Coop, since Coop's acquisition of ICA Norway went through in mid-2015. (Nielsen, 2015, 2016a, 2017; NorgesGruppen ASA, 2017; Coop Norge SA, 2016; Reitangruppen AS, 2016)

The geographical differences in number of stores also extend to the chain level. NorgesGruppen is particularly present in Eastern and Western Norway, but has a relatively low number of stores in Norther Norway (NOU 2011:4, 2011b). Coop, on the other hand, is well represented in Northern Norway, as well as in Central Norway, whereas Rema 1000 is more or less equally represented across all areas (NOU 2011:4, 2011b).

Concepts and Formats There are ten main grocery retail concepts in the Norwegian grocery retail market, which we present in Table I. The three largest concepts in terms of market share are Rema 1000, Kiwi, and Extra, constituting over half of the market's revenues (Nielsen, 2017). These three concepts all operate within the discount format of the market, and together with Coop Prix and Bunnpris they make up almost two thirds of the grocery retail market, which is almost an increase of

20 percent for the discount format in the last five years. Although the discount format has seen a steep increase in the recent years, this format no longer only consists of retail concepts with limited product ranges and low prices; there is a clear trend that retail concepts within the discount format have increased their product ranges, focusing also on fresh produce, inter alia (Virke, 2015).

The second largest grocery retail format is the supermarket, constituting almost a quarter of the market. The supermarket format offers a wider range of products than the discount format and competes for customers not only through pricing but more importantly through its assortment (Virke, 2015). Meny has long held a leading position within the supermarket format, which also includes Spar/Eurospar and Coop Mega. However, the supermarket format has seen a steady decline in the recent years, losing market shares to the discount format.

The third largest grocery retail format is convenience. The convenience format consists of Joker and Coop Marked as well as some independent retailers. This format offers the smallest range of products of all formats in the market; stores belonging to this format are usually located in the districts and often provide the only option for purchasing groceries and adjoining services to residents in the area (Virke, 2015).

The last grocery retail format is the hypermarket. The hypermarket format offers the widest range of products of all the formats, with a variety of non-food products and fresh produce encouraging one-stop shopping behavior in consumers (Virke, 2015). Nonetheless, this format has seen the steepest decline in market share of all the formats, leaving only one retail concept, Coop OBS!, as of 2016. Hence, the trend in the Norwegian grocery retail market seems to adduce that the formats that do not clearly emphasize low prices are losing traction.

2.2 Major Players

2.2.1 NorgesGruppen ASA

NorgesGruppen is the market leader in the Norwegian grocery retail market, with 1,850 grocery stores distributed throughout Norway, of which 812 are wholly owned (NorgesGruppen ASA, 2017). Besides its grocery retail activities, NorgesGruppen also has operations within wholesale, real estate, and convenience and is one of Norways's largest purchasing organizations, with large purchases annually for grocery, service and large-scale households (NorgesGruppen ASA, 2017).

Within the grocery retail market, NorgesGruppen operates with five main concepts: Joker, Spar/Eurospar, Meny, Kiwi, and Nærbutikken. Kiwi operates within the discount format and is the largest of NorgesGruppen's concepts with a market share of about 20 percent as of 2016, constituting almost half of NorgesGruppen's revenues from its grocery retail activities (Nielsen, 2017). NorgesGruppen's second largest concept is Meny, constituting over a fourth of NorgesGruppen's grocery retail revenues (Nielsen, 2017). Unlike Kiwi, Meny operates within the supermarket format, as do Spar/Eurospar. Joker and Nærbutikken are smaller concepts, operating within the convenience format.

Furthermore, NorgesGruppen has an extensive range of private labels. First Price is the chain's range of low-cost goods, which are available in all the chain's stores, whereas Jacobs Utvalgte is the chain's premium label (NILF, 2013). In addition, NorgesGruppen has other private labels within foods, ingredients and food storage products (NILF, 2013).

2.2.2 Coop Norge SA

Coop is the second largest grouping in the Norwegian grocery retail market, with 1,250 stores as of 2016. Over the last few years Coop has strengthened its position through the acquisition of ICA Norway in 2015. Unlike the other groupings, Coop is owned by the consumers through regional cooperatives (NILF, 2013). Although Coop has no ownership in the stores, it owns the rights to the concepts and is responsible for procurement, supply chain, marketing, and chain management (NILF, 2013).

Coop is also the only grouping in the market that has concepts within all formats, with Coop Obs being the only concept within the hypermarket format as of 2016. Coop Obs mainly focuses on grocery goods, but also offers products within most branches of specialist retailing (NILF, 2013). Within the discount format Coop operates with two concepts, Prix and Extra. Coop Extra is Coop's largest concept as of 2016, experiencing a steep increase in market share over the last years. Coop Mega operates within the supermarket format, whereas Coop Market operates within the convenience format and is the smallest of the concepts in the Coop grouping.

Furthermore, Coop has several private labels in their product range. X-tra is Coop's range of low-cost goods, which covers an extensive range of different product categories (Norwegian Consumer Council, 2015). Smak-forskjellen is Coop's premium label, differentiating the goods along quality and origin parameters (Norwegian Consumer Council, 2015). In addition, Coop Änglamark consists of organic and environmentally friendly goods, whereas Coop Kaffe is one of Norway's largest coffee producers (NILF, 2013).

2.2.3 Reitangruppen AS

Reitangruppen AS is the only grouping in the Norwegian grocery retail market that operates with a single concept, Rema 1000. Moreover, as opposed to NorgesGruppen and Coop, all Rema 1000 stores are operated as franchises, where each store is operated independently under conditions set by the chain management (Norwegian Consumer Council, 2015). As of 2016, Reitangruppen is the third largest grouping in the market, with 594 stores and a market share of over 24 percent. In addition to grocery retailing, Reitangruppen also operates kiosks and gas stations as well as having a separate distribution subsidiary (NILF, 2013).

Furthermore, Rema 1000 operates within the discount format and focuses on districts with high population density, which has contributed to Rema's growth in the recent years (NILF, 2013). In addtion, Rema's product range within private label has also contributed to the chain's growth, with products within both food and non-food categories. Within the food category Rema 1000 has labels such as Nordfjord, Solvinge and Godehav, covering meat, chicken and fish products.

In the recent weeks, Rema 1000 has been the subject of criticism after a series of long-term and exclusive agreements were signed in the beginning of 2017 (Valvik and Lynum, 2017). The exclusive agreements not only reduced the number of brands in Rema's product range, but also forced several of Rema's former suppliers to undertake extensive restructuring and downsizing measures (Valvik and Lynum, 2017).

2.3 Competition Parameters

Price, product range, and location are the three most important factors when consumers in the Norwegian grocery retail market decide between stores (NorgesGruppen ASA, 2016). Other competition parameters include, inter alia, opening hours, service levels, and quality of goods, as well as brand image (NOU 2011:4, 2011a).

Price Price is perhaps the most important competition parameter in the Norwegian grocery retail market. The increased attention given to prices by consumers and the frequent price comparisons in the media, have among others things contributed to increased awareness to prices and margins in the industry (NOU 2011:4, 2011a). This is, inter alia, illustrated in NorgesGruppen's annual report, where it is stated that NorgesGruppen stores should always be competitive on price (NorgesGruppen ASA, 2017). The focus on price in the market is perhaps further emphasized by the considerable growth experienced by the discount format in the recent years, although increases in product range may also have played a part in this growth. Furthermore, the price focus in the grocery retail market has also led to the emergence of loyalty programs[4], which attempt to attract and retain customers by offering personalized discounts, inter alia. Moreover, the price competition has not only increased the use of personalized discounts, it has also sparked the development of private labels[5] in the market (Virke, 2015). Part of the development in private label is driven by the increase in the discount format, and therefore it has become increasingly important for chains to have products in their range that can drive the price competition (NOU 2011:4, 2011a). It has proven more advantageous to the chains to sell cheaper private labels than to reduce the price and margins of other brands, although results suggest that the introduction of private labels in Sweden has contributed to lower prices on national brands as well (NOU 2011:4, 2011a; Asplund and Friberg, 2002).

Product Range & Location In addition to prices, both product range and location are important competition parameters in the grocery retail market. Using product range as a competition parameter has primarily been reserved to the supermarket and hypermarket formats. However, the increase in the number of private labels in the market has contributed to product range becoming an increasingly important competitive factor between different grocery chains as well as within product categories, through the means of product exclusivity (NILF, 2013).

[4]As of 2016, 66 percent of all costumers in the grocery retail market participate in a loyalty program (Nielsen, 2016b). However, since then Rema 1000's has introduced a new loyalty program, Æ, which led to Kiwi, Coop, and Meny releasing their own loyalty programs soon after. We therefore expect that the participation in loyalty programs is even higher as of 2017.

[5]Private labels include products that are sold exclusively within the grocery chain under a brand name that the chain owns and controls (Virke, 2015).

According to NILF (2013), private labels help build and strengthen customer loyalty to the chain as opposed to brands that are not exclusive to the chain.

Furthermore, according to NOU 2011:4 (2011a), consumer choices suggest that the relevant grocery markets are local and that consumers often decide between stores based on location. In addition, the Norwegian Consumer Council (2015) argues that consumers are often reluctant to change between stores if the stores are far apart, even when there is money to be saved by doing so.

In summary, although the parameters we have discussed all influence the competition between firms in the Norwegian grocery retail market, the focus of this paper is on price as the competition parameter.

3 Previous Research

There has been a growing empirical literature dealing with the relationship between prices and competition in the grocery retail market, where the literature is most developed in the case of horizontal competition (Connor, 1999; Asensio, 2014). The study on retail food prices and competition focuses largely on whether increased competition in a geographical defined area, measured by concentration, market structure or new entries, has any disciplinary effect on prices or not (Gullstrand and Jörgensen, 2012).

Data for the studies on the retail food prices and competition is usually obtained by sampling from different geographical markets on municipality or metropolitan level, usually defined as regions or urban areas, from which market structure, prices and variables driving demand and costs are observed (Asensio, 2014, p. 4). In short, as Asensio (2014) highlights most authors have found that higher concentration is associated with higher prices. Nevertheless, most of the variation in prices is explained by factors specific to the store, such as chain affiliation or store size, implying that the magnitude of local competition is relatively small.

Pricing practices in the grocery retail market have long been of interest both from a positive and prescriptive standpoint (Connor, 1999, p. 121). Positive studies, which almost exclusively are concerned with pricing under different degrees of competition, have primarily been within the scope of industrial-organization (IO) economics. The studies vary considerably in price indexes, time period, concentration indexes, control variables, sample size, and level of aggregation (Yu and Connor, 2002). According to Connor (1999), there are several noteworthy cross-sectional empirical studies of grocery retail price indexes in the IO tradition. Marion et al. (1979) uses extensive price-check data for grocery retailers operating in 36 cities, and find, by the means of a market-basket price index of 94 branded food items, that markets shares and concentration are positively related to the market-basket price index. The results in Marion et al. (1979) were verified by Cotterill (1986) using a cross section of subpoenaed price data of a product basket from 35 supermarkets in eighteen mostly small, isolated Vermont towns and cities, finding that prices are higher in markets where supermarket concentration is high. In addition, Lamm (1981) also finds, for eighteen major Standard Metropolitan Statistical Areas, that concentration is positively related to food prices, drawing on the price of a homogeneous market basket of food for a family of four published by the Bureau of Labor Statistics.

On the other hand, with emphasis on the geographic variations in prices among proximate rivals firms, Fik (1988) examined spatial competition in the retail food market in the metropolitan area of Tucson in the U.S. Fik (1988) models the price competition as price-reaction functions and by using individual store prices together with the distance to the nearest competitor, the study finds that there is statistical evidence that the intensity of price reaction is a decreasing function of the distance between rival chains. The study conducted by Zhu et al. (2009) on the competition among Wal-Mart, Kmart and Target in the U.S. food market stresses in addition the importance of store characteristics for understanding the spatial competition. They suggest that the competitive pressure from a store is prominent on other stores located within a few kilometres. Moreover, the paper finds that the impact rapidly declines with additional distance, with the Wal-Mart supercenters being the only ones competing beyond 15 kilometres.

One of the few studies that fails to find a positive relationship between local market concentration and grocery prices is one authored by Newmark (1990). However, Yu and Connor (2002) examines the sensitivity of Newmark's analysis to a number of methodological and measurement factors. Yu and Connor substitutes, inter alia, the absolute purchase cost employed by Newmark for a true index of food prices. The initial retesting was highly successful in the sense that the correction of the flaws led to a strongly positive and highly significant concentration estimate. On the other hand, according to Asplund and Friberg (2002), the lack of sufficient geographical variation in the data, which is necessary to trace the relatively small effect of the price-concentration relationship, is the main explanation for the absence of statistically significant results in Newmark (1990). Nevertheless, the retesting by Yu and Connor (2002) shows the importance of careful statistical craftsmanship and good data, especially for the independent variables (Connor, 1999).

However, fewer structure-price studies have been performed outside the U.S. According to Connor (1999), a probable reason is, inter alia, that reliable food-price surveys are not available or do not cover enough cities for cross-sectional statistical testing. For the Swedish grocery retail market, Gullstrand and Jörgensen (2012) examine the competitive situation by using a detailed dataset covering all Swedish food retailers. The results are unambiguous and suggest that price competition is substantial but that the effect wears off quickly, implicating that a variation in competition may be an important explanation for price variations within Sweden. More precise, Gullstrand and Jörgensen find that the price competition is substantial among neighbouring stores within a kilometre, with no significant effect between stores separated by a distance of more than one kilometre. Consequently, they conclude that the competition among Swedish food stores is indeed local, and that the area of a municipality should be considered as many small local markets for food retailing. Their definition of local competition is hence more narrowly defined than in most previous studies, supporting the notion found in studies of Swedish consumer behavior stating that the consumers' main food store is close in terms of distance. The results also support the notion that the size of a store substantially lowers prices, and that prices are positively associated with population and wealth.

Asensio (2014), on the other hand, conducts an empirical structure-price analysis of supermarkets located in the city of Barcelona, Spain. He estimates the extent to which variation in supermarket prices depend on neighbourhood and store characteristics, the degree of local competition, as well as chain policies The degree of local competition is measured by different market structure variables. However, only the prices corresponding to the second quarter of 2011 for stores with a selling area above 400 square metres are used in the study. Asensio finds that the supermarkets do not respond to local competitive conditions, and that the only variable that seems to have an impact on prices beyond the chain affiliation of the supermarket is the size of the store, in the sense that economies of scale leads to lower prices. As Asensio acknowledges, the results contradict the conclusion reached by Asplund and Friberg (2002) on the competition between Swedish grocery retail stores, which is found not to depend on chain affiliation at the local market level. However, to depict whether each store is operated independently, Asplund and Friberg (2002) uses HHI on store, chain and region level as structural measures. Asensio (2014), on the other hand, includes instead the number of supermarkets located at a given distance from the store whose prices are observed, to measure the degree of competition.

In Chile, Lira et al. (2012) investigates empirically the relationship between market structure and consumer prices in the supermarket industry. They use a panel of monthly data from 16 cities and find a positive relationship between local competition and prices as well as evidence of lower prices in the presence of major national chain in the cities, underscoring the importance of formats. Cleeren et al. (2010) further emphasizes the importance of formats as the results suggests that intra-format competition is significantly stronger than inter-format competition among supermarkets.

A more relevant problem with the empirical structure-price literature is however, according to Asensio (2014), that it often does not take into account the potential endogeneity of market structure, as 'observed market structures are not randomly assigned (e.g. levels of concentration result from strategic decisions by firms when deciding whether to enter or exit a given market)' (p. . Not correcting for the endogeneity of the variables used to measure intensity of local competition may bias the results Singh and Zhu (2008). As reported by Cotterill (2006), the majority of previous literature estimating price-competition relationships in supermarkets, does not seem to have addressed the potential endogeneity bias. Two exceptions are the previously mentioned studies by Gullstrand and Jörgensen (2012) and Asensio (2014) on the grocery retail market in Sweden and Barcelona, respectively. To instrument different structural measures, Asensio (2014) argues that 'the obvious [instruments] are the socioeconomic attributes of the neighbourhoods that have been shown not to be related to prices, but which would influence the presence of a supermarket' (p. 11). More precisely, he uses population density, income and land values as instruments. Gullstrand and Jörgensen (2012), on the other hand, uses the economic structure in the broad neighbourhood of each store as instruments (i.e. regional dummies, HHI (based on sales) within 50 kilometres, and the store size of the nearest competitor based on the Euclidean distance). In Section 6.1.1, we supply a discussion on the endogeneity of market structure.

4 Customized and Uniform Pricing

In the following section we will introduce the concept of customized and uniform pricing of retail chains to provide the rationale behind the decision of grocery retail chains to fix their prices nationally as opposed to following a policy of local pricing.

As justified and illustrated by Dobson and Waterson (2005, 2008), retail chains essentially either set a chain- or country-wide price, or they customize prices to the store level according to local demand and competitive conditions.[6] By committing not to customize prices at the store level and instead adopt uniform pricing across all stores in the chain, raising overall profits thereby, the retail chains could under certain circumstances have a strategic incentive to soften competition in competitive markets. If the chains do not modify their pricing policy according to local circumstances, we would not observe any relationship between market structure measures at the local level, and prices. The reasoning, as mentioned in Asensio (2014), is that although pricing according to local conditions should be the profit-maximizing strategy in local markets, chains may find it profitable to set a uniform price when subject to different intensities of competition across various markets. Hence, if we do not find any significant impact of market structure on prices, we may have reason to believe the chains set a uniform price across all local markets.

Dobson and Waterson (2005, 2008) argue that different retail locations have, inter alia, different degrees of competition. Hence, we might expect prices to be customized across locations built on the notion that firms are better off practicing third degree price discrimination between locations of differing competitive intensity. However, under these circumstances firms may nevertheless practice uniform pricing rather than varying prices across locations. As highlighted by Særvoll and Tjøm (2013, p. 13), the Norwegian grocery retail chains operate both on a national and local level, where e.g. Kiwi follows a national pricing policy, while Rema 1000 sets prices according to local conditions. Drawing heavily on Dobson and Waterson (2005, 2008), we will in the continuation provide insight into the nature and extent of the circumstances where a uniform pricing strategy offers the stores operated by a multi-market retail chain greater profit than a local pricing strategy.

[6] Keep however in mind that in our case any given chain could have several different concepts who seemingly act independent of one another. Thus, chains could in this case be viewed as chain-concepts.

Analytical Framework The analytical framework considers a chain-store (C) which serves all local markets in a country. The country is made up of N (≥ 2) distinct and economically separate local retail markets. The framework assumes the existence of two type of markets, respectively large, competitive markets and smaller, uncompetitive markets. In each of the larger, competitive markets the chain-store faces competition from an independent local store (I), such that the competitive markets make up a local duopoly. There exists D ($\geq N$) local duopolies where competition is characterized by Bertrand-Nash conduct. In the smaller markets, labelled M ($= N - D$), the chain-store enjoys a monopoly position. We denote each of the M monopoly markets by $k = 1 + D, ..., N$, and each of the D duopoly markets by $h = 1, ..., D$. The bifurcation of the local markets picks up the fact that local markets differ in respect to consumer demand, the number of players operating, and the intensity of competition.

Further, we assume that consumer demand is identical within, but not between, each market type. The stores have complete information about the market. Moreover, to ease the exposition further, Dobson and Waterson (2005, 2008) assume that within each market type, consumer demand and operating costs are identical. In addition, there is no consumer demand or cost connection between the markets, such that profits are separable across markets. We also assume that the operating costs are identical for the chain-store and the independent store, and that the stores operate under a constant marginal and unit cost of zero.

Customized Pricing With a local pricing strategy (L), the chain-stores' monopoly price will be dependent on the consumer demand in the monopoly markets (α). In the duopoly markets the price will depend on the intensity of competition (γ). The local pricing equilibrium price in monopoly markets is given by

$$p^m \equiv p^L_{Ck} = \frac{\alpha}{2} \qquad \alpha \in (0, 1)$$

while the corresponding price in duopoly markets is provided by

$$p^d \equiv p^L_{Ch} = p^L_{Ih} = \frac{1 - \gamma}{2 - \gamma} \qquad \gamma \in (0, 1)$$

When the consumer demand functions are identical across all markets, i.e. $\alpha = 1$, and the competing stores' products are viewed as being demand independent, i.e. $\gamma = 0$, then the chain-store will be indifferent between using local pricing and uniform pricing, and the price in the monopoly and duopoly markets will be equal to 1/2. Otherwise (i.e. $\alpha \neq 1$) the chain-store will strictly prefer to use local pricing.

The combined profits of the chain-store across all markets under local pricing (L) are

$$\Pi_C^L = \sum_{h=1}^{D} \pi_{Ch}^L + \sum_{k=D+1}^{N} \pi_{Ck}^L = \frac{D(1-\gamma)}{(1+\gamma)+(2-\gamma)^2} + \frac{M\alpha^2}{4}.$$

Uniform Pricing With a uniform pricing strategy (U), on the other hand, the chain-store sets a single price across all markets to maximise its combined profits. The equilibrium prices when the chain-store adopts uniform pricing is given by

$$p_C^U = \frac{(1-\gamma)[D(2+\gamma)+2\alpha M(1+\gamma)]}{D(4-\gamma^2)+4M(1-\gamma^2)},$$

which depends, as we observe, on the intensity of competition (γ), consumer demand in the monopoly markets (α), as well as the number of monopoly (M) and duopoly (D) markets.

The combined profits of the chain-store for the monopoly and duopoly markets under uniform pricing are thus

$$\Pi_C^U = \sum_{h=1}^{D} \pi_{Ch}^U + \sum_{k=1}^{N} \pi_{Ck}^U = \frac{(1-\gamma)(D+M(1-\gamma^2))[(2+\gamma)D+2\alpha M(1+\gamma)]^2}{(1-\gamma)[D(4-\gamma^2)+4M(1-\gamma^2)]^2}.$$

Profit Comparison To facilitate the comparison of the profits for the chain-store under local pricing and uniform pricing, it is convenient to substitute D and M with the parameter $\mu = M/N$ (where $\mu \in (0.1)$) which specifies the proportion of the markets that are monopoly markets for the chain-store. Equivalently, $1-\mu$ is the proportion of duopoly markets. Therein we can add that as long as the monopoly price is lower than the the duopoly price, then the chain-store, irrespective of the value of μ, prefers local pricing.

In other words, if $\Pi_C^L - \Pi_C^U > 0$ then a local pricing strategy will be the most profitable for the chain-store. Respectively, uniform pricing across all markets will be the most profitable if $\Pi_C^L - \Pi_C^U < 0$. Naturally, the chain-store is indifferent between local pricing and uniform pricing when $\Pi_C^L - \Pi_C^U = 0$. However, the default behavior of the chain-store is always to use local pricing, but the scope of uniform pricing increases substantially if the chain-stores (tacit) coordinate their pricing policy choices. Dobson and Waterson (2005) argue that only with a visible, credible commitment to uniform pricing across all markets, a uniform pricing can be sustained in equilibrium.

Dobson and Waterson (2005, 2008) also show that their theory of customized and uniform pricing strategies apply to other market structure forms. We therefore have reason to believe their results may help explain the rationale behind pricing strategies in the Norwegian grocery retail market. In the continuation we will draw on their basic idea when, inter alia, examining different market structure variables' effect on prices and thus assess if the grocery retail stores in Oslo seem to be directly managed by the chain-concept they belong to.

5 The Data

We assemble an original dataset that includes weekly price data for 49 stores within the city of Oslo for the period week 11, 2016, to week 9, 2017. The dataset consists of 99 unique goods within nine grocery categories, totalling 2,303 store-level observations across stores and weeks.[7] The data has been made available to us by NorgesGruppen ASA.

The structure of the dataset is focused around the local markets we identify in Section 5.1, for which we collect an extensive set of measures to reflect market-specific demand and cost conditions. On the local market level we have available demographic and socioeconomic information, whereas on the store-level the dataset includes information about chain affiliation, store concept and format, store size, and the geographical coordinates of the stores, as well as store revenues for 2015 for roughly half of the stores in the dataset.. The dataset includes price data for three different chains, seven different concepts, and three different formats.[8] On the article-level the

[7]In Section 5.3.1 we elaborate on the process of constructing store-week level observations.

[8]The chains that are included in the dataset are Chain A, Chain B, and Chain C, while concepts include Concept D, Concept E, Concept F, Concept G, Concept H, Concept I, and Concept J. With respect to formats, the dataset includes discounters, supermarkets, and convenience stores (see Table V).

dataset includes information about price, campaigns and categorization.

The final dataset is constructed by merging and trimming various datasets that include price data for the NorgesGruppen stores, price data for the price-comparison stores, and information about store and market characteristics. First, we begin by defining the relevant local markets (see Section 5.1). Then we proceed to construct the market structure variables in Section 5.3.2 using the store characteristics we have available. Third, since the frequency of the price data for the NorgesGruppen stores and the price-comparison stores differs, we aggregate the price data for the price-comparison stores on a weekly level[9] to match the price data frequency for the NorgesGruppen stores. Furthermore, since we do not have price data available for all stores, we retain only the stores that we have price data available for. This reduces the dataset from 1,968,989 observations to 810,150 observations.

Furthermore, information about grocery category is only available for the NorgesGruppen stores, and therefore we need to connect article IDs with category across all price-comparison stores. However, not all article IDs from the price-comparison stores were represented in the NorgesGruppen stores, resulting in a manual pairing process for these observations.[10] Furthermore, due to the low store representation and few price data observations we remove all observations for the six first weeks in the sample, namely week 5 through week 10 in 2016, as well as for the last two weeks, namely week 10 and 11 in 2017. This reduces the dataset to with 737,065 observations. The reason that the sample in the first few weeks is inconsistent is that the data-gathering from the price-comparison stores was initiated in early 2016 and evidently it took some weeks before the data-gathering scheme came into full effect. Next we remove observations with unreasonably low or high prices, as these observations can most likely be attributed to data-collection errors.

Further, we proceed to construct the market basket of goods and the store level price index based on a number of criteria (see Section 5.2 and 5.3). During the process of constructing a market basket and a price index, we first remove goods which are not reported in all stores across the sample period, which reduces our dataset with 537,250 observations to 196,815. However, note that the selected goods are not necessarily

[9] Price data for the price-comparison stores is included on a semi-weekly basis; however, the number of price data observations for the price-comparison stores depends on the frequency of price gathering.

[10] As with all manual processes, there is a risk that the process is inconsistent. However, we believe that we have been sufficiently meticulous to avoid such problems in the process.

represented in every store, every week.[11] By constructing the store level price index (on the basis of the market basket of goods) to include only one price observation for each store in each week, we reduce our sample to 2,303 store-week observations.

5.1 Defining the Local Market

Preferably we would want to avoid explicitly defining local markets since this exercise may result in local markets that do not coincide with the area of competition for the stores. However, while previous research generally has used municipalities (e.g., Gullstrand and Jörgensen, 2012), municipal districts (e.g., Asensio, 2014), cities (e.g., Lira et al., 2012), Metropolitan Statistical Areas[12] (e.g., Lamm, 1981) or Labor Market Areas[13] (e.g., Cohen and Mazzeo, 2007) to define market boundaries, we need to explicitly define local market areas, such as in e.g. Cotterill (1986), as we only have demographics and socioeconomic attributes available on the local market level. This will allow us to control for demographic and socioeconomic differences across markets in Section 6.

When defining the local markets to represent meaningful economic distinctions, overlapping local markets should not exist within the defined geographic markets, and consumers should not typically purchase groceries from stores outside of their local market, as argued by Cohen and Mazzeo (2007, p. 66). To define the local markets we employ NorgesGruppen's geolocation tool, which is a database of all grocery stores in the Norwegian grocery retail market and their location. The geolocation tool makes available demographic information on the local market-level based on the market parameters we define, as well as store characteristics and the geographical coordinates of each store.

Since the groupings in the Norwegian grocery market have not made public their pricing regions, we begin by defining our local markets around price-comparison stores[14]. Firstly, we use the price-comparison stores as a starting point because in

[11] We discuss this potential problem in Section 5.2

[12] A geographical region with a relatively high population density at its core and close economics ties throughout the area, defined by the Office of Management and Budget in the U.S.

[13] Provided and defined by the Bureau of Labor Statistics to represent integrated economic areas in the U.S.

[14] In this paper, price-comparison stores are defined as stores which NorgeGruppen collects price information from within the limitations of the common industry standard. The common industry standard is developed by the grocery chains in cooperation with the industry organization, Virke, and allows the grocery chains to collect price data from competitors for up to 20 hours per week (NorgesGruppen ASA, 2016).

addition to price data on NorgesGruppen stores the price-comparison stores are the market competitors that we have price information available for. Secondly, there is reason to believe that NorgesGruppen's choice of price-comparison stores has been motivated by the competition faced by these stores in particular, thus implying that the price-comparison stores are relevant competitors within their respective local markets. However, pricing data for the price-comparison stores is only available for certain areas within the city of Oslo. Therefore, our analysis is restricted to using local markets around the areas of Sagene and Lambertseter, which are located in the urban and suburban areas of Oslo, respectively.

Furthermore, the geolocation tool does not allow for market definitions other than those based on drive time. Nevertheless, both Norwegian Competition Authority (2015) and the UK Competition Commission, according to Dobson and Waterson (2008), employ drive time in determining the store choices consumers face at the local level, using different drive times depending on area characteristics. The relevant price-comparison stores are used as starting points for the drive time computation.

Since the areas of interest in our analysis differ in population density and settlement patterns, we decide on using a drive time of 2 minutes and 5 minutes for the urban and suburban area, respectively. The geolocation tool assumes that one minute of drive time equals a distance of roughly 750 meters. The difference in the choice of market definitions between the areas is motivated by the assumption that consumers are more likely to walk to grocery stores in urban areas, whereas they are more likely to drive in suburban areas, resulting in larger local markets. However, the drive time in the geolocation tool does not account for any traffic congestion patterns, resulting in local market definitions that we believe are too broad given our expectations to the actual drive time in the areas. Moreover, Cotterill (1986) argues that defining local markets that are too broad substantially reduces the ability of our models to explain pricing behavior. Hence, to take into account real drive time and the market definition concerns of Cotterill (1986), we discuss several different refinements to our local market definitions.

For the urban area we decide on narrowing down the area such that the maximum Euclidean distance between stores in the market is no more than 500 meters, which translates into an area of approximately 0.8 square kilometres. For the suburban area we decide to include stores within a maximum Euclidean distance of 1,500 meters,

FIGURE II—LOCAL MARKET BOUNDARIES

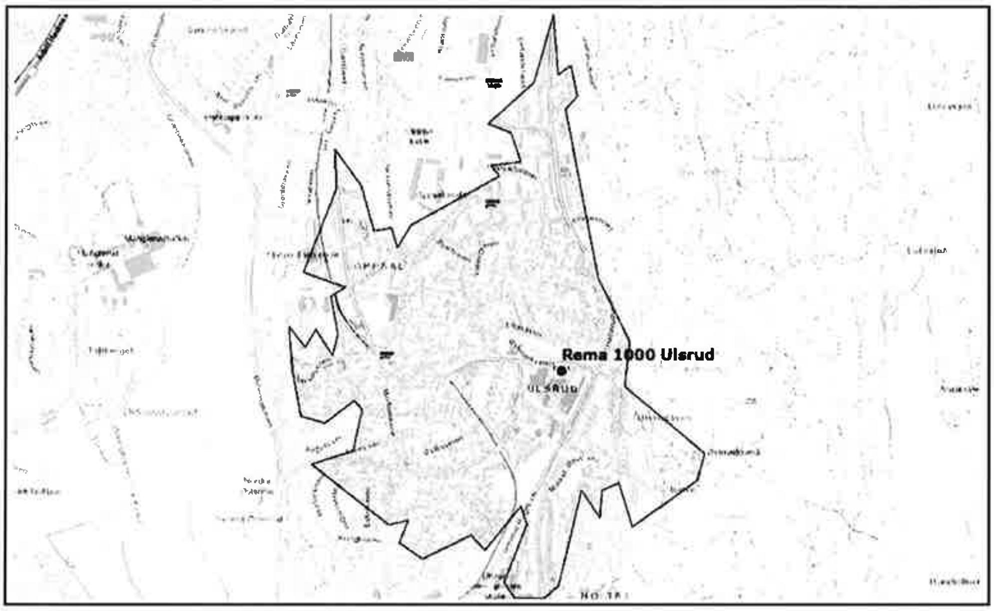

FIGURE II. Physical location of stores within the local market boundaries; here represented with Ulsrud in the suburban area of Oslo. (NorgesGruppen ASA, 2017)

which translates into an area of approximately 7 square kilometres. Using the 2-to-5 minute rule, the 500-to-1,500 meter refinement, and the natural boundaries of the typography of the respective areas, we identify 15 local markets. Table III reports selected statistics for the 15 local markets, including number of stores, demographics, and the number of observations for each local market. The local markets range in size from Ryen with 11 grocery stores and 11,781 residents, to Vossegata, with 3 grocery stores and 2,649 residents.

5.2 PRODUCT CATEGORIES AND MARKET BASKET OF GOODS

As we will discuss further in detail in Section 5.3, Cotterill (1986) argues that even when grocery retail stores provide the same good, each store's real and perceived service levels vary, which is termed enterprise differentiation by retailing economists.[15] Since the heterogeneity occurs at the store level, we can use the aggregate price level of a store for a market basket of goods rather than using the individual prices of goods.

In order to identify a comparable, homogeneous market basket of goods across all

[15] A grocery retail store is differentiated by the product-service-price mix it offers (Cotterill, 1986).

TABLE III—SELECTED MARKET DATA FOR 15 LOCAL GROCERY MARKETS IN OSLO

						Article Level	Store Level
Local Market	No. of Stores	Population	Population Density	Avg. Distance to Nearest Store	Income Index	No. of Obs. in Basket of Goods	No. of Obs. in Basket of Goods
				Urban Area			
Birkelunden	9	4,355	5,545	249.16	90.96	21,603	251
Sofieneberg	8	4,391	5,591	285.74	89.12	16,350	193
Darres Gate	7	1,245	1,585	359.27	95.11	7,989	102
Theresesgate	6	3,805	4,845	177.17	11,356	14,234	142
Ila	5	4,257	5,420	478.05	99.33	8,523	95
Sagene	4	1,479	1,883	171.17	100.35	8,152	97
Vossegata	3	2,649	3,373	435.28	94.69	5,594	77
Torshov	3	3,935	5,010	433.93	97.62	13,070	152
Total	45	26,116	—	—	—	92,637	1,109
Average	6	3,265	4,156	328.97	96.81	—	—
				Suburban Area			
Ryen	11	11,781	1,667	832.02	102.86	13,850	153
Prinsdal	10	3,606	510	496.49	102.60	14,015	170
Lambertseter	9	6,243	883	322.19	114.49	35,915	404
Ulsrud	8	5,310	751	1,272.78	105.25	5,718	69
Hellerud	7	8,238	1,165	690.71	95.80	12,677	146
Bryn	6	12,527	1,772	1,281.12	100.25	13,689	153
Ryensvingen	6	12,837	1,816	241.77	103.11	8,314	99
Total	57	60,542	—	—	—	104,178	1,194
Average	8	8,649	1,223	630.41	103.48	—	—
Total	102*	86,658	—	—	—	196,815	2,303
Average	7	5,777	2,787	530.18	100.00	—	—

Table III. Notes to Table III. Population density is measured as the ratio of population to square kilometre. The average income index defines the local market's average income relative to the average over all local markets. Since the dataset only has information about the number of people within categories of income, we assume a uniform distribution of income within the categories. *The number of stores sums to more than 51 because the local markets also include the stores which we do not have available price data for.

stores, we define a market basket comprised of 99 unique goods with price information from every store in approximately every week.[16] Of the 99 goods included in our market basket, 71 are food items.[17] Considering the ambition of having goods that are homogeneous across stores, we only include goods of national brands, i.e. private labels are excluded from the market basket. The goods are sampled from nine different product categories, of which one is non-food. The product categories are reported in Table IX (see Appendix A). The choice of product categories is motivated by the ambition of having categories with different characteristics.

Within the product categories we have variations with respect to storability, from extremely durable goods such as dry dinner dishes and candy, to cream and yogurt, which are less durable. Moreover, the product categories also vary from 'necessary' goods, such as margarine and laundry, to 'luxury' goods, such as chocolate bars and candy. The largest product category is by far yogurt with 29 unique goods, constituting almost a third of the entire market basket. We also note that the non-food category, laundry, is represented with 18 unique goods.

However, as we previously mentioned, we do not have price data for every store in every week. More precisely, we lack price data for a total of 195 store-week observations across twelve different stores in the sample.[18] Hence, there may exist a sample selection bias which could influence statistical significance and/or produce distorted results.[19] The fundamental issue to consider is why some stores have missing store-week observations and whether the (unobserved) factors determining selection are correlated with the residual e_{st} in Equation 1.[20]

An important aspect in this case, however, is that all of the missing store-week observations in the sample are from the price-comparison stores (i.e. Concept E and Concept F). Concept E and Concept F lack price observations for seven and five different stores, respectively. For Concept E, the store with the highest frequency of missing observations lacks price data for 33 weeks, while corresponding numbers for Concept F is 34 weeks. However, both the median Concept E and Concept F

[16] Initially we had information on a total of 1,790 unique goods across the 49 stores in our sample.

[17] In comparison, Gullstrand and Jörgensen (2012) use a market basket of goods consisting of 60 items, of which 55 are food items. Cotterill (1986) and Marion et al. (1979) base their price indices upon 121 and 94 representative products, respectively. Asplund and Friberg (2002), on the other hand, use two different market baskets with respectively 30 and 157 items.

[18] As a reminder, the sample contains 2,303 weekly price observations for 49 stores across 51 weeks.

[19] Sample selection bias can be viewed as a special case of endogeneity bias, arising when the selection process generates endogeneity in the selected sub-sample (Verbeek and Nijman, 1992).

[20] See Section 5.3 for a presentation of the equation formula.

store has missing observations for 11 weeks. The stores which lack observations are approximately evenly distributed both across the two chain-concepts (i.e. Concept E and Concept F), and across the areas in the sample (i.e. urban and suburban area).

Moreover, of the 195 missing observations, 48 observations coincides with the five weeks in July and August when the general staff vacation is held (i.e. from the second week of July, week 27, to the first week in August, week 31).[21] Additional 34 store-week observations are missing in weeks which in 2016 coincided with the Norwegian Constitution Day and the Christian holiday of Pentecost (week 20), Easter (week 12), winter break (week 8), and Christmas (week 52). In other words, most of the missing price observations for the price-comparison stores could thus be due to public holidays. It could hence be reasonable to assume that the unobserved process of collecting price data from the price-comparison stores (which is present in the residual of the price equation) and the prices themselves are uncorrelated, as well as uncorrelated with market structure.

To more formally check for the presence of selectivity bias (i.e. nonrandom/endogenous sample selection) in the random effects estimator (or, in fact, for consistency of the random effects estimator), we employ two simple tests proposed by Verbeek and Nijman (1992) for random effects models. To denote whether price observations are available for a given store in a given week, we first construct a dummy r_{st} which equals 1 if prices are observed and zero otherwise. The problem of sample selection bias arises from the fact that when estimating the parameters of interest (in our case, price and market structure), the conditioning upon the outcome of the selection process (i.e. upon $r_{st} = 1$) when estimating the model using the available observations may affect the unobserved determinants of price (Verbeek and Nijman, 1992, p. 682). To test the absence of non-random selection (i.e. if r_{st} is independent of u_s and e_{st}), the first approach, termed the variable addition test, is to include $T_s = \sum_{t=1}^{T} r_{st}$ in the specification of Equation (1). The second approach is to include $r_{s,t-1}$ in equation (1), which indicates whether store s is observed in the previous week or not.[22] In the two approaches, the variables of interest, T_s and $r_{s,t-1}$, should not enter the equation significantly under the hypothesis of no selectivity bias. In both cases, the null hypothesis is not rejected (p>.05), which is evidence that the

[21] If we expand the time period of the general staff vacation to also include week 26 and 32, the amount of missing observations increases to 58.

[22] According to Verbeek and Nijman (1992), the variable addition test seems to perform quite reasonable in practice, while the one based on $r_{s,t-1}$ has only very limited power.

sample selection is exogenous. Hence, we should expect consistent estimates from our random effects estimator in regards to sample selection bias.

5.3 The Variables

5.3.1 Price Level Index

The main variable of interest and the dependent variable in our empirical analysis is the price level of a store. As Cotterill (1986) argues, a measure of a store's aggregate price level rather than individual good prices is an appropriate price variable since the heterogeneity regarding, inter alia, perceived good quality and service levels variations occurs at the store level. However, where Gullstrand and Jörgensen (2012), Pinkse et al. (2002), Asensio (2014), and Cotterill (1984, 1986) among others use a cross section of stores, we follow the exposition in Asplund and Friberg (2002) to construct a weekly store level price index for each good in our panel. By constructing a price index we produce a price measure free of unit sizes such as kilos or litres (Cotterill, 1984, p. 6).

To obtain a weekly price level index for each store, we will calculate the average of the weekly store level price index over all goods in our defined market basket.[23] Due to the lack of detailed information on the consumption weights of goods included in our data set, we use unweighted averages when constructing the store level price index.[24]

Formally, the store level price index of good i in week t is defined as the nominal price of good i at store s in week t divided by the average nominal price for the good in week t. The store level price index of store s is then defined as the average price index of all goods $i \in (0, I)$. As a preliminary step, we construct a store level price index for each good i in store s in week t:

[23]To illustrate, we examine a case where store A and store B provide two goods in a given week. The price of the two goods are 12 and 20 in store A, and 15 and 23 in store B. The weekly store level index for each good (normalizing to a mean of 100) is then given by the price of the good divided by the average price of the good across the two stores in the given week (i.e. 88 and 93 in store A, and 111 and 107 in store B). The weekly store level price index of store A and store B is then the mean of the two goods the stores provide in the given week (i.e. 91 for store A, and 109 for store B).

[24]Gullstrand and Jörgensen (2012) also use unweighted averages when constructing the store level price index as consumption shares are not included in their dataset. Lira et al. (2012), on the other hand, are provided with the weighting for each good in their market basket in the budget of a representative consumer. Hence, they use weighted averages when constructing the store level price index.

$$PI_{ist} = \frac{p_{ist}}{\frac{1}{n_{St}} \sum_{st} p_{ist}}, \tag{1}$$

where p_{ist} is the price of good i in store s in week t, and n_{St} is the number of stores S in each week t. The index is normalized to have a mean of 100. Further, drawing on the specification in Gullstrand and Jörgensen (2012), we aggregate the price index of the goods into a weekly store level price index for store s in week t as follows:

$$PI_{st} = \frac{1}{n_{It}} \sum_{it} PI_{ist}, \tag{2}$$

where PI_{ist} is the price index of good i in store s in week t, and n_{It} is the number of goods I in each week t. We denote the natural logarithm of the store level price index *PRICE_STORE*.

5.3.2 Market Structure and Competition Intensity Variables

Drawing on the line of argument in Asplund and Friberg (2002), the level of prices should depend on the market structure of stores in the local market under the hypothesis that the pricing strategy of each store is determined independently. In order to test this hypothesis we construct various market structure variables that serve as measures of the intensity of competition in the local markets. We construct the market structure variables based on four different measures: concentration, closeness, number of rivals, and rival price level.

The Herfindahl–Hirschman Index (HHI) is a measure of market concentration and is based on the relative market shares of the stores. Preferably we would like to have information about revenues for all stores to derive the market shares in the local markets. However, since we lack information about store revenues for roughly half of the stores in our dataset, we base our approach on the exposition in Asensio (2014) and approximate the market concentration using relative store sizes. Unlike Asensio (2014), however, we extend our approach to take into account differences in the average revenue per square meter floor space between formats:

$$HHI_m = \sum_{s=1}^{n_m} s_i^2, \tag{3}$$

where HHI_m is the Herfindahl–Hirschman Index in local market m, and n_m is the number of stores in each local market m. s_i is the market share of store i, derived from

$$\frac{z_{ik} \times r_k}{Z_m} \times 100, \tag{4}$$

where z_{ik} is the store size of store i within format k measured in thousand square meters, r_k is the average revenue in NOK per thousand square meter within format k, and Z_m is the sum of the store size weighted revenues in each market. The intuition for the *HHI* measure is that the higher the value, the higher the concentration in the market; and the higher the concentration, the lower the competitive pressure between stores. Based on this, we expect there to be positive relationship between a store's price level and *HHI*, implying that markets with low concentration have lower prices. However, the extent to which our HHI variable indeed measures the market concentration depends on whether $z_{ik} \times r_k$ serves as a good proxy for the actual store revenues. This again depends on (1) if the calculated average revenues per square meter serve as a good proxy for the average revenues per square meter in our period[25], and (2) if the average revenues per square meter for each format is representative for the stores within that format. Although it is not obvious that these assumptions hold, and one can argue that they do not, we nevertheless include our HHI measure as the best approximation of concentration given our data limitations.

Furthermore, we also construct various market structure measures based on the number of rivals in a local market. Firstly, we construct a measure of the number of rival stores, *NUMCOMP*, based on the rationale that intensity of competition increases with the number of rival stores in the market. We therefore expect to find that a store's price level is affected negatively by the number rival stores in the market, although we expect this effect to be diminishing for higher number of rival stores. We also construct a measure of the number of rival chains, *NUMCHAIN*[26]. The intuition for including this measure is that there is reason to assume that stores that belong to the same chain are not in fact rivals, although some of the chains claim that their

[25] The obvious pitfall here is that substantial changes in store size between the periods may invalidate the estimates for average revenue per square meter.

[26] *NUMCHAIN* does not include independent stores; however, it is not entirely clear what constitutes an independent store, as NorgesGruppen has affiliated stores that they do not own but instead share an associated connection with. For the purposes of our analysis we consider these stores as independent.

stores compete freely.

Furthermore, we construct two measures for the number of formats in the market, *NUMSAMEFORM* and *NUMFORM*. The two measures differ in that the former depicts the number of stores with the same format as store i, whereas the latter measures the number of 'rival' formats that are different from store i's. The rationale for these measures is that (i) competition between stores within the same format may be stronger compared to stores within different formats, and (ii) there may also exist asymmetries in the competitive pressure between stores within different formats. Our expectation to *NUMSAMEFORM* draws on the argument in Connor and Peterson (1992), stating that the most intense price competition that a given grocery store experiences comes from stores that offer the same array of goods within the same local market. Hence, we expect to find that as the number of stores within the same format increases, the price declines. For *NUMFORM*, on the other hand, we expect to find that the competitive pressure is lower when stores in the local market belong to different formats.

With regards to closeness as a measure of the intensity of competition, we construct three measures of distance to nearest neighbour to try and capture the dynamics of competition between neighbouring stores. Drawing on Pinkse et al. (2002), the nearest neighbour measures are represented as $n \times n$ matrices with typical element i, j, where the elements are equal to one if store j is the nearest neighbour to store i and zero otherwise; that is, the nearest neighbour is the store j that is the shortest Euclidean distance[27] from store i, provided that the relevant restriction is met. This definition of nearest neighbour allows asymmetric relations, such that store i needs not be the nearest neighbour to store j.

D_NEARESTCOMP depicts the Euclidean distance between store i and the nearest rival store. We include this measure to examine if the distance to the nearest rival store affects a store's price level. The rationale is that neighbouring stores compete more intensely with each other than with other stores in the market. We therefore expect to find that price levels decline for lower distances to nearest rival store. Furthermore, *D_NEARESTCHAIN* depicts the Euclidean distance between store i and the nearest rival chain. We include this measure to examine if a store's

[27] According to NOU 2011:4 (2011a), the relative transport costs are in general the most important factor in determining the geographic extent of the markets. However, since our local markets are indeed narrow, the differences in transportation cost between stores are negligible, and thus we do not account for transportation cost in our nearest store matrix.

price level is more strongly affected by the closeness to another chain. We expect to find a positive relationship between a store's price level and the distance to the nearest rival chain, such that the closer the nearest chain is, the lower the price level. Finally, *D_NEARESTFORM* depicts the Euclidean distance between store i and the nearest store j within the same format. We include this measure to examine if a store's price level is affected by the distance to the nearest store within the same format. We expect to find that a store's price level is a negative function of the distance to the nearest same-format store. All distance variables are measured in thousand meters.

Based on the nearest rival store matrix we also construct two dummy variables, *NEAREST_SAMEFORM* and *NEAREST_SAMECHAIN*, that equal one if the nearest store to store i is within the same format or chain as store i, respectively. We construct these measures in order to test if the intensity of competition in the local market is affected in particular by neighbouring stores sharing (i) the same format or (ii) the same chain affiliation, regardless of the distance to the nearest store. We expect to find that the intensity of competition increases if neighbouring stores are within the same format, hence lower prices, whereas we expect to find a decline in competition if neighboring stores are within the same chain, hence higher prices.

Finally, we construct rival store-level price index variables[28], which implies that each row in the spatial weight matrix is interacted with the price level of the nearest neighbour that meets the relevant requirement. *PRICE_NEARESTCOMP* depicts the price level of the nearest store j to store i, whereas *PRICE_NEARESTFORM* depicts the price level of the nearest store within the same format as store i. We construct the rival price index to examine how the pricing of the nearest neighbour affects a store's price level.

5.3.3 Other Factors

Drawing on Asplund and Friberg (2002), variation in prices will also depend on cost and demand factors as well as store characteristics. Since this paper wants to address if price differences can be attributed to differences in market structure in excess of market- and store-specific factors, we include a number of demographic and socioeconomic factors in our models, such as average income and population density,

[28]Since these measures are obviously endogenous in a structure-price equation, their use in our models depends on finding valid instruments for them.

and store-specific factors such as store concept and store size.

Demographic and Socioeconomic Factors In terms of the demographic and socioeconomic factors, the local market is the smallest area for which we have data available. As discussed in Section 5.1, these data limitations prohibit us from controlling for store-specific variation in demographic and socioeconomic factors; however, although there will be differences across stores in the same local market, we believe that these differences, if any, are small over the period of interest. urthermore, in addition to differences in market structure, consumer income levels also differ between local markets, suggesting the presence of variation in local consumer demand. To control for these differences in demand per capita, wages, and willingness to pay across local markets, we use average per capita income as a proxy, since higher income levels may result in higher demand and hence higher prices. In addition, Cotterill (1986) argues that markets with high per capita income will tend to have more inelastic demand curves for groceries as groceries represents a smaller portion of the expenditures of high income households.

We also include population density as a proxy for the cost structure across local markets, since a high population density may result in higher costs through e.g. higher real estate prices. Hence, we will *a priori* expect to see higher prices in markets with high income and high population density.

Furthermore, in our dataset the information about income is given as the number of people within income categories.[29] In order to construct a measure of the average income in each local market, we assume that the average income within each category is equal across the local markets. Although there can be differences between local markets with respect to the within-category distribution of income, we believe that such differences will be negligible in our sample. Lastly, since we have refined the market definition for which the demographic and socioeconomic data is gathered, as discussed in Section 5.1, we adjust the income and population measures using the formula for the area of a circle as an approximation of the size and shape of the local markets.[30]

[29]That is, the number of people in the local market that have an income between 100' and 150' NOK, between 150' NOK and 200' NOK, and so on.

[30]We use the maximum distance between the price-comparison stores and any store i in the local market as the radius in the formula πr^2.

Store-Specific Factors Since the different chains and their concepts use different pricing strategies and offer different product ranges, we expect the concept of each store to be the main explanatory factor of price differences between stores, as previously discussed in Section 5.4. In addition, we use another store-specific factor, store size, as a proxy for the cost structure of each store, drawing on the discussion in Ellickson (2006) on the importance of economies of scale and scope on prices in retailing. With regards to the store size, intuitively we would expect to see a modest negative relationship between store size and a store's price level. On the other hand, Cotterill (1986) argue that large supermarkets differentiate themselves from smaller stores through providing additional services and departments to the extent that they can raise prices, suggesting that a quadratic relationship may exist between price levels and store size. However, we lack sufficiently variation in store size in our sample to expect a quadratic relationship between store size and price level in our model.

5.4 Preliminary Data Analysis

The dataset includes price data for 49 stores, of which respectively 23 and 26 stores are located in the urban and suburban area of Oslo. Of these 49 stores, Concept D is the most represented with 18 stores, followed by Concept G and Concept E with 9 and 7 stores, respectively (see Table V). For each of the stores we have, inter alia, information on store characteristics, such as concept and format, store size, and location.

In Table IV we report descriptive statistics for selected variables employed in our analysis. As we observe, prices are 49 percent higher in the most expensive store compared to the cheapest one and differ, on average, by nearly 8 percent, as reflected by the standard deviation. Gullstrand and Jörgensen (2012), and Asplund and Friberg (2002) find corresponding price differences for the Swedish grocery retail market of roughly 50 and 93 percent, respectively.[31] Furthermore, in the 90th percentile prices are almost 13 percent higher than the average, whereas in the 10th percentile prices are roughly 7 percent lower than the average (not shown). Altogether, there is clearly considerable variations in prices across stores for our market basket of goods.

Moreover, we observe that the average Oslo grocery retail store contains 730

[31] Among Vermont supermarkets, Cotterill (1986) finds an 11.82 percent range in prices, whereas Asensio (2014) finds that the most expensive store is 20 percent more expensive than the cheapest store. Both price ranges are considerably smaller compared to the price differences in our data set.

square metres of store space; sells groceries to households whose per capita income is NOK 294,300; and is situated in a local market with a population and population density per square kilometre of 5,920 and 2,800, respectively. We also see that in total our dataset includes seven different concepts and three different formats, where the median number of rival stores, rival chains (excluding independent stores) and rival formats in the local market is seven, two and two, respectively. Regarding the spatial environment of the stores in Oslo, the distance to the nearest store is rather short. Based on the Euclidean distance, we find that the average Oslo grocery retail store is located 460.40 metres from the nearest store in the local market, although it differs, inter alia, between urban and suburban markets.[32]

As Asensio (2014) also argues when analyzing prices of supermarkets located in the city of Barcelona, the chain-concept affiliation of each store is in our case as well expected to be the main explanation of price differences between stores. He argues

TABLE IV—DESCRIPTIVE STATISTICS FOR THE PRICE, MARKET STRUCTURE, AND FIRM STRUCTURE VARIABLES

VARIABLE	Mean	Median	Standard Deviation	Minimum	Maximum
STORE LEVEL PRICE INDEX	100.00	95.54	7.76	83.37	124.61
STORE SIZE	0.73	0.57	0.56	0.25	3.00
POPULATION	5.92	4.39	3.35	1.25	12.84
POPULATION DENSITY	2.80	1.77	1.97	0.51	5.59
PER CAPITA INCOME	29.43	29.20	2.30	25.96	33.34
HERFINDAHL-HIRSCHMAN INDEX (HHI)	3.87	3.33	1.68	1.69	7.40
NO. OF RIVAL STORES	6.35	7.00	2.28	2.00	10.00
NO. OF RIVAL CHAINS[A]	2.15	2.00	0.51	1.00	3.00
NO. OF RIVAL FORMATS	1.56	2.00	0.54	0.00	2.00
PRICE LEVEL OF NEAREST STORE	99.12	95.24	7.44	83.37	124.61
PRICE LEVEL OF NEAREST STORE INTRA-FORMAT	97.12	94.91	4.66	83.74	108.95
PRICE LEVEL OF NEAREST STORE RIVAL CHAIN	103.31	103.25	8.02	83.95	124.27
DISTANCE TO NEAREST STORE	0.472	0.401	0.365	0.05	1.46

TABLE IV. Notes to Table IV. HHI is measured in thousands; distance to nearest store is measured in thousand metres; store size is measured in thousand square metres; population is measured in thousands; population density is measured in thousands per square kilometre; and average per capita income is measured in ten thousand NOK. [a]Number of rival chains does not include independent stores.

[32]In comparison, Gullstrand and Jörgensen (2012) find for the Swedish grocery retail market that the median distance to the nearest store is around 500 metres.

TABLE V—INTRA-CONCEPT STORE LEVEL PRICE INDEX DIFFERENCES FOR THE MARKET BASKET OF GOODS

CONCEPT	Format	No. of Stores	Mean	Std. Dev.	Min	Max	Δ (%)
CONCEPT D	Discount	18	93.94	1.31	87.42	96.68	10.59
CONCEPT E	Discount	7	94.54	1.85	83.37	102.46	22.90
CONCEPT F	Discount	5	95.55	1.52	85.43	99.26	16.19
CONCEPT G	Convenience	9	113.02	2.71	104.33	124.61	19.44
CONCEPT H	Supermarket	4	103.58	1.61	99.11	108.67	9.64
CONCEPT I	Supermarket	4	105.74	4.31	99.36	119.75	20.52
CONCEPT J	Supermarket	2	104.66	1.76	100.70	108.95	8.20
TOTAL		49	100.00	7.76	83.37	124.61	49.47

further that the main justification for the expectation is that 'different chain-concepts apply different pricing strategies, and offer different ranges of products, qualities, and selling attributes' (p. 5). In Table V we therefore investigate the intra-concept differences in prices for the market basket of goods. As we observe, the cost to consumers of a grocery market basket of ninety-nine goods varies considerably across markets and stores within the same chain-concept. Concept D, Concept H and Concept J are the chain-concepts with the lowest percentage differences in prices between the most expensive and cheapest store with a difference of 10.59, 9.64 and 8.20 percent, respectively, whereas the corresponding price differences for Concept E and Concept I are 22.90 and 20.52 percent, respectively. The within-concept store level price index differences displayed in Table V seem to indicate that some concepts follow a national pricing strategy, whereas others set prices according to local conditions.

We also find clear price differences between formats, as well as price variations among stores within the same format. We note that the mean prices of discount stores are roughly 4-6 percent lower than the average and approximately 3-6 percent higher than the average in the supermarket stores. The convenience stores are on average the most expensive stores with 13 percent higher prices than the average. In Table IX (Appendix A), we also note that there is differences in nominal prices across the urban and suburban area. For eight out of nine product categories in our market basket of goods, goods sold in the urban area has, on average, a lower nominal price than the goods sold in stores located in the suburban area. Only chocolate bars are, on average, more expensive in the urban area.

TABLE VI—RELATION BETWEEN NUMBER OF CHAINS IN LOCAL MARKET AND THE STORE LEVEL PRICE INDEX BY FORMAT

		DISCOUNT			CONVENIENCE			SUPERMARKET		
NO. OF CHAINS	Total	Mean	Std. Dev.	Min Max	Mean	Std. Dev.	Min Max	Mean	Std. Dev.	Min Max
TWO	98.41	94.12	1.64	83.95 98.69	113.34	2.95	104.65 124.27	—	—	—
THREE	100.21	94.25	1.51	83.74 102.46	113.06	2.61	105.11 123.84	104.95	3.39	99.11 119.75
FOUR	100.30	94.14	1.53	83.37 99.30	112.99	2.70	105.29 123.57	103.05	1.40	99.85 107.41
FIVE	99.47	94.40	1.57	86.53 99.13	112.58	2.83	104.33 124.61	103.88	1.73	99.99 108.67

TABLE VI. Notes to Table VI. The table presents the relation between the number of chains present in the local market and the average store level price index.

To provide an initial view of the structure-price relationship, Table VI reports the relation between prices and the number of chains in a local market as an illustration. As we note, there seems to be a negative relation for the convenience and supermarket stores. However, the relation between prices and the number of chains is more ambiguous for the discount stores. Mean prices in local markets with four and five chains present are for the convenience stores on average 0.30 and 0.67 percent lower than prices in local markets where there is only one chain present. For the supermarket stores, mean prices in local markets with five chains present are on average 1.81 percent lower than prices in local markets with simply three chains present. However, as reflected by overall relatively large standard deviations and wide differences between minimum and maximum price, there are non-negligible price variations both interformat and intraformat for local markets with any given number of chains.

[33]The justification for using a reduced form in favor of a structural form is the number of possible relationships between prices and market structures, which depends on the strategic variable used by firms (price versus quantity) as well as the possibility of collusion (Gullstrand and Jörgensen, 2012, p. 6).

6 Empirical Results

6.1 Model Specification

To analyze the variation of prices in the city of Oslo, we specify reduced-form regressions with the store level price index as the explained variable.[33] The purpose is to explain the effects of market structure on prices when controlling for factors that may affect the cost and demand conditions for the store.

We use a random effects estimator[34], such as in Asplund and Friberg (2002), considering there is little or no variation in the explanatory variables over time. To test the hypothesized relationship between prices and market structure variables, including several control variables, we use generalized least squares (GLS) to estimate

$$ln(PI_{st}) = \alpha + \delta M_{st} + \beta \mathbf{W}_s + u_s + \lambda_t + e_{st}, \qquad (1)$$

where subscript s denotes the store ($s = 1, 2, 3, ..., 49$), and subscript t represents the week ($t = 1, 2, 3, ..., 51$). $ln(PI_{st})$ is the natural logarithm of the store level price index, *PRICE_STORE*. M_{st} is the market structure variable in focus[35], and $\mathbf{W}_s$ is the matrix of time-invariant exogenous firm and local market specific variables which may affect the store's demand and cost conditions. Furthermore, u_s is a disturbance term specific to the individual store which measures the difference between the average price at store s and the average price of all stores, λ_t is a vector of temporal dummies to capture the influence of aggregate trends and control for unobserved factors which change uniformly over time across all stores, whereas e_{st} is an IID$(0, \sigma^2)$ distributed error term. α is the intercept for the store level price index; β and δ are the parameters to be estimated.

A natural logarithmic transformation is performed on the additional price level

[34] Formally, for all the performed regressions we conducted first an F-test on the relevant fixed effects models and found that the the null hypothesis was rejected, favoring the fixed effects estimator over the pooled OLS model. We also conducted a Breusch-Pagan Lagrange multiplier (LM) test to examine if any random effects existed, finding that the null hypothesis was rejected, i.e. the random effects estimator was preferred over the pooled OLS model (see Section 6.2). Last, we carried out a Hausman specification test to compare the fixed effect models with its random counterpart. When the GLS random effects estimators are diagnosed as inconsistent, the fixed effects estimator should be the adopted estimation model. The null hypothesis was, however, not rejected, hence the random effects estimator was diagnosed as being consistent (i.e. p>.10) and favored over the fixed effects model. However, where the pooled OLS estimator is favored over the random effects estimator, we explicitly state this in the regression output.

[35] Note that not all the market structure variables employed in the analysis are time-variant.

variables prior to estimation in order to estimate the elasticities (e.g. *PRICE_NEARESTSTORE*). Furthermore, following the exposition in Cameron and Miller (2015), we use cluster-robust standard errors to account for cross-sectional heteroskedasticity and within-panel serial correlation in our models.

6.1.1 Exogeneity of Market Structure

There are two main reason why the market structure variables may not be exogenous in our structure-price model: First, price level may feed back into market structure through performance, causing a simultaneity bias. As argued in Evans et al. (1993), relatively profitable markets are exposed to entry, whereas relatively unprofitable markets are exposed to exit; thus, over time, market structure affects prices, but prices also affect market structure. Second, market structure may not be randomly assigned, which is a requirement for any standard regression model to yield consistent estimates in a structure-price model (Singh and Zhu, 2008). This constitutes a problem in our model if the observed market structure is the result of firms evaluating demand and cost characteristics as well as the competitive pressure in the market, and consequently basing their entry decision on this (Singh and Zhu, 2008).

An approach to dealing with the first problem of simultaneity in structure-price models was proposed by Evans et al. (1993) and involves using instrumental variables. However, the use of this approach is dependent on having valid instruments available for our market structure variables; unfortunately, we have no valid instruments available in our dataset, either because the potential instruments are believed to affect price directly or because they are endogenous themselves. As mentioned in Section 3, Asensio (2014), on the other hand, uses a number of demographic and socioeconomic factors as instruments for market structure. However, we find that this approach is not valid in our model, as there is reason to suspect that pricing decisions are not independent of local demographic and socioeconomic factors in our markets.

Furthermore, as an argument for potentially treating the market structure variables as exogenous over our period, except for rival price level, we refer to the findings of the Norwegian Competition Authority (2015) that suggest that in the Norwegian grocery retail market it takes on average two to three years from a grocery chain begins to plan the establishment of a store until the store is opened. Although there are differences across both regions and formats, the findings of the Norwegian Competition Authority

(2015) suggest that market structure responses to changes in market conditions take on average more than a year. However, treating market structure as exogenous in our analysis relies on the assumption that expectations about market conditions are uncorrelated with unobserved factors determining demand and costs. This assumption is violated if we believe that firms have decent information about market expectations. Thus, treating the effect of market structure on prices exogenously relies therefore on, inter alia, a strong assumptions about the relationship between the market expectations of the firms and the market structure.

Of particular concern is the potential problem of non-random assignment of market structure in our model. An approach to handling this potential problem is to estimate a fixed-effects model on the local market level, as suggested by Evans et al. (1993). The rationale is that although particular markets may indeed be more attractive than others, which affects pricing and entry behavior, this is fixed over time. However, because we do not have any variations in market structure in our sample, except for the rival price level, we are not able to follow the approach proposed by Evans et al. (1993).

Based on the above discussion, there are indications in both directions as to the exogeneity of market structure in our model, although in favor of market structure being endogenous. Although the findings of the Norwegian Competition Authority (2015) may be used to argue that a simultaneity bias is not present in our model, this approach does not account for the bias that may arise if the market structure is not randomly assigned in our model. There is therefore reason to believe that our market structure measures are endogenous in the structure-price model.

6.2 Store Price Level: Market Basket of Goods

Before estimating the model in Equation 1, we present in Table VII the first set of specifications, and ultimately our baseline specification of the store level price model. Other multivariate versions than the ones displayed were undeserving of further attention, in the sense that the additional variables included were either not significant, or only contributed to a marginal increase (at best) in the amount of explained variation in prices. In Equation I through III, the explained variable is the natural logarithm of the store level price index, *PRICE_STORE*, as defined in Section 5.3.1. To keep the table succinct, the parameter estimates on the temporal year-week dummies are not presented.

Equation I include only terms that identify the concept affiliation of each store. The specification is estimated using the random effects methodology, and all the estimated parameters are significantly different from zero on the .01 level. The concept affiliation terms are included in favor of chain affiliation as we aim to separately identify the different pricing policies of, inter alia, Concept H and Concept I, which are different concepts within the same chain. We note that roughly 93 percent of the variation in store level prices can be explained solely by the concept that each store belong to. Furthermore, we observe that Concept G is by far the most expensive concept with prices on average roughly 17 percent higher, *ceteris paribus*, than the base level concept, Concept D, which is in accordance with the preliminary results reported in Table V.

Equation II is an OLS estimation where we pool all observations across stores, assuming constant intercept and slopes for our sample of 49 stores and 51 weeks. Equation III, on the other hand, is estimated using a random effects model. Although the pooled OLS model has similar parameter estimates to the random effects model in Equation II, the Breusch-Pagan Lagrange multiplier (LM) test strongly favors the random effects specification. Hence, further we will focus on Equation III.

Building on the specification in Equation I, we introduce store size, average per capita income, and population density in the specification. The model explains roughly 93 percent of the variation in price, and has a Wald-ratio which is significant on .01 level. We note that the negative sign on the parameter estimates of store size, which is the only store attribute available in the dataset, is as expected *a priori* and could reveal the existence of economies of scale in the grocery retail market in Oslo. As has been shown in previous research, e.g. Asensio (2014) and Cotterill (1986) among others, economies of scale will result in lower prices for larger stores.

However, the parameter estimate of store size is not significant, which could be due to the small variation across the 49 stores in our sample. Recalling on the discussion of the descriptive statistics in Table IV, the median Oslo grocery retail store contains 570 square metres of selling space, ranging from 250 to roughly 3,000 square metres from the smallest to the largest store in the dataset. However, the distribution of store sizes in Oslo is heavily left skewed—in the 25th percentile, the selling space is 250 square metres, whereas in the 95th percentile, selling space is no larger than 1,374 square

TABLE VII—PARAMETER ESTIMATES OF THE BASELINE SPECIFICATIONS OF THE PRICE LEVEL OF GROCERY RETAILING STORES IN OSLO

	RANDOM EFFECTS	POOLED OLS	RANDOM EFFECTS
	I.	II.	III.
CONCEPT G	.1709***	.1652***	.1654***
	(.0016)	(.0046)	(.0049)
CONCEPT D	-.0151***	-.0184***	-.0183***
	(.0011)	(.0030)	(.0034)
CONCEPT H	.0828***	.0856***	.0850***
	(.0022)	(.0050)	(.0050)
CONCEPT I	.1030***	.1128***	.1115***
	(.0187)	(.0207)	(.0203)
CONCEPT E	-.0104***	-.0075*	-.0077*
	(.0016)	(.0044)	(.0043)
CONCEPT J	.0923***	.0845***	.0845***
	(.0009)	(.0051)	(.0057)
STORE SIZE (thousands)		-.0091	-.0083
		(.0070)	(.0069)
PER CAPITA INCOME (ten thous.)		.0025*	.0024*
		(.0014)	(.0014)
POPULATION DENSITY (thousands)		.0015	.0012
		(.0010)	(.0009)
INTERCEPT	4.5484***	4.4903***	4.4827***
	(.0112)	(.0407)	(.0384)
YEAR-WEEK DUMMIES	Yes	No	Yes
ADJ. R^2	.9314	.9338	.9361
F-RATIO	[a]	1854***	[a]
LM-RATIO	5274***		3484***
GLS $\sigma(e)$	.0171		.0171
GLS $\sigma(u)$	.0134		.0121
NO. OF OBS.	2,303	2,303	2,303

Robust standard errors clustered around stores presented within parentheses.
***, ** and * denote significance at the .01, .05 and .10 levels, respectively.
[a] As we are estimating at least as many estimators as we have clusters (i.e. 49), the model is not of sufficient rank to perform the model test.

metres (not shown). Only one store in the sample has a selling space of 3,000 square metres. In comparison, the average selling space of Vermont supermarkets included in Cotterill (1986) is approximately 3,650 square metres, ranging from 1,480 to nearly 7,300 square metres, where findings suggest that supermarket prices in Vermont are quadratically related to store size.

As we discussed in Section 5.3, per capita income is, inter alia, included as a proxy for wages—and if the price elasticity of demand is not uniform across the local markets, the households' willingness to pay (i.e. price elasticity of demand). Prices would also be higher in high income markets if such households demand costly extra services, as argued by Cotterill (1986). In Equation III, the parameter estimate on average per capita income is positive as hypothesized and significant at the 0.10 level. If the average per capita income in a local market increases with a hundred thousand NOK, the price increases by approximately 2.4 percent, *ceteris paribus*. Regarding the parameter estimate of population density, which is included as a proxy for the cost structure across local markets (e.g. cost of floor space), we find that population density in this specification has negligible effects on price, and is not statistically significant.

Structure-Price Equations To test the hypothesis that the pricing strategy of each store is independently determined, we regress various market structure measures on price level in order to capture the intensity of competition that a store is facing in the local market. In Table VIII we report the estimated parameters for different structural measures on the store level price index, *PRICE_STORE*, to examine to the relationship between the market structure measures and prices. All the reported equations use the random effects methodology outlined in Section 6.1. For each equation we also include the variables from Table VII, which, inter alia, includes store size, average income, and population density, as well as other control variables. Moreover, other multivariate versions than the ones reported in Table VIII were undeserving of further attention (see Table X in Appendix).

First of all, based on the discussion in Section 6.1.1 there is reason to suspect that our market structure measures are endogenous in our structure-price model. However, since the potential presence of endogeneity in our model builds on assumptions about (for us) unobserved characteristics that we cannot test empirically given our data, we proceed 'as if' the assumption of exogeneity holds when interpreting the estimates in the following paragraphs.

TABLE VIII—ESTIMATION EQUATIONS EXPLAINING THE PRICE LEVEL OF GROCERY RETAILING STORES IN OSLO WITH ALTERNATIVE STRUCTURAL MEASURES

	Method	Structural Measure Variable	EXPLANATORY VARIABLES: Structural Measure	Quadratic Term	Store Size (thousands)	Per Capita Income (ten thous.)	Population Density (thousands)	Intercept	Additional Variables[b]	Overall R^2 No. of Obs.	GLS [c] σ(e)	GLS [c] σ(u)
I.	GLS	*D_NEARESTCOMP*	-.0065		-.0080	.0021*	.0007	4.4945***	Yes	.9368	.0171	.0120
			(.00951)		(.0060)	(.0012)	(.0008)	(.0325)		2,303		
II.	GLS	*D_NEARESTCHAIN*	-.0189*		-.0114**	.0019**	.0008	4.6855***	Yes	.9442	.0159	.0115
			(.0107)		(.0056)	(.0010)	(.0010)	(.0268)		1,662		
III.	GLS	*D_NEARESTFORM*	.0007		.0025	.0030	.0023	4.4243***	Yes	.8797	.0143	.0148
			(.0033)		(.0043)	(.0021)	(.0019)	(.0623)		1,494		
IV.	GLS	*NUMCOMP*	-.0055*	[a] .0006**	-.0072	.0025*	.0018*	4.4848***	Yes	.9371	.0170	.0119
			(.0030)	(.0003)	(.0062)	(.0013)	(.0010)	(.0344)		2,303		
V.	GLS	*NUMCHAIN*	-.0162	[a] .0045	-.0097	.0032**	-.0000	4.4731***	Yes	.9349	.0170	.0123
			(.0138)	(.0027)	(.0061)	(.0015)	(.0008)	(.0403)		2,303		
VI.	GLS	*NUMFORM*			-.0075	.0023	.0009	4.4783***	Yes	.9354	.0170	.0116
					(.0076)	(.0014)	(.0010)	(.0393)		2,303		
		1.*NUMFORM*	.0103***									
			(.0045)									
		2.*NUMFORM*	.0071									
			(.0078)									
VII.	GLS	*NEAREST_SAMEFORM*	0.0001	.0027	.0029	.0022*	4.4252***	Yes	.8802	.0143	.0147	
			(.0001)	(.0041)	(.0019)	(.0017)	(.0584)		1,494			

Robust standard errors clustered around stores are presented within parentheses.

***, ** and * denote significance at the .01, .05 and .10 levels, respectively.

[a] Wald test for joint significance rejects the null hypothesis that the estimated parameters on the structural measure and its quadratic term are jointly equal to zero. *NUMCOMP* significant at the .10 level. *NUMCHAIN* not statistically significant from zero.

[b] Additional variables included are dummies for each store, concept affiliation dummies, a dummy indicating if the store is located in the urban area, and temporal dummies on year-week level.

[c] Generalized least squares variance of error terms in random effects specification: $PRICE\_STORE = \alpha + \delta M_{st} + \beta \mathbf{W}_s + u_s + \lambda_t + e_{st}$.

[d] Pooled OLS has been used in favor of a random effects model to estimate the regression(s), as the LM test could not reject the null hypothesis of $\sigma_u = 0$.

Firstly, Equation I, II, and III examine distance as a measure of intensity of competition between stores. Equation I examines the effect of the distance to the nearest competitor, *D_NEARESTCOMP*, on a store's price level. In Equation II we examine if the distance to the nearest rival chain, *D_NEARESTCHAIN*, has an effect on a store's price level, whereas in Equation III price is a function of distance to the nearest competitor within the same format, *D_NEARESTFORM*. We observe that none of the coefficients are significant. Hence, if the exogeneity assumption holds, these results indicate that the distance to the nearest neighbour does not affect a store's price level in the Norwegian grocery retail market.

Equation IV through VI examines how the number of rival stores, chains and formats in the local market affects the price level of the store. We have also included quadratic terms for the number of rival stores and number of rival chains measures, since we expect these measures to be quadratically related to price. From Equation IV we find that the number of rival stores, *NUMCOMP*, and its quadratic term are jointly significant at the .10 level, estimating that price is a decreasing function of the number of rival stores in a local market. Based on the estimated coefficients, a higher number of rival stores decreases a store's price level, although at a lower rate after a store reaches more than four competitors. This result is in line with our expectations stated in Section 5.3.2.

The same relationship with price is estimated for the number of rival chains, *NUMCHAIN*. That is, a store that has two rival chains in the local market will experience a decrease in price level of over 1.4 percent relative to having no rival chains in the market. Furthermore, for the number of formats, *NUMFORM*, the estimated relationship is the contrary, where a store in a local market with two different formats instead experiences an increase in the price level of 1.0 percent. The estimated coefficient on number of formats is strongly significant. This positive relationship between number of formats and the price level can potentially be explained by a differentiation effect, where the intensity of competition is lower when the stores in the market cater to different consumer segments.

Finally, in Equation VII we have estimated how a store's price level changes if its nearest rival operates within the same format. As discussed in Section 5.3.2, we expect to see that intra-format competition between nearest neighbours is particularly strong, affecting price negatively. However, we find no evidence to support this hypothesis.

In summary, when assuming that market structure is exogenous in our model, we find that (1) the distance to the nearest rival does not affect a store's pricing behaviour, (2) the number of rival stores have a negative effect on a store's price level, and (3) prices increase when there is at least one rival format in the local market. However, the causal interpretation of the estimated effects are only valid if the assumption of exogeneity holds. If this is not the case, which there is reason to believe, then the estimated relationships can only be interpreted as correlations.

7 Concluding Remarks

The aim of this paper has been to examine the local competition between grocery retail stores in the Norwegian grocery retail market. Our attention has been on explaining the effect of market structure on prices when controlling for factors that may affect the cost and demand conditions for the store. For this purpose we assemble an original dataset that includes weekly price data for 49 stores within the city of Oslo, over a period of 51 weeks. Based on drive time, distance to store, and the natural boundaries of the typography in the respective areas, we define 15 local markets.

To study the the structure-price relationship, we use the aggregate price level of a store for a market basket of goods rather than using the individual prices of goods, as we argue that the heterogeneity occurs at the store level. Hence, to identify a comparable, homogeneous market basket of goods across all stores, we define a market basket comprised of 99 unique goods within nine grocery categories.

We construct a store-level price index which serves as the dependent variable in our empirical analysis. Since we are interested in analyzing the structure-price relationship, we construct several market structure variables based on different measures. Formally, we use a random-effects estimator on our panel data of stores in the city of Oslo, as there is little or no variation in our explanatory variables over the period. Since variations in prices also will depend on cost and demand factors as well as store characteristics, we include a number of demographic and socioeconomic factors in our model.

Our preliminary results suggest that the main explanation of variation in prices between stores are the chain-concept affiliation of each store. Furthermore, to examine the effect of market structure on prices, we proceed to include structural measures in our model. However, this approach may be associated with various econometric problems, most notably endogeneity. First, price level may feed back into market structure through performance, causing a simultaneity bias. Second, market structure may not be randomly assigned, which is a requirement for any standard regression model to yield consistent estimates in a structure-price model, as argued by Singh and Zhu (2008). There are, however, indications in both directions as to the exogeneity of market structure in our model, although in favor of market structure being endogenous.

When we assume that market structure is exogenous in our model, our main findings are that (1) the distance to the nearest rival does not affect a store's pricing behaviour, (2) the number of rival stores has a negative effect on a store's price level, and (3) prices increase when there is at least one rival format in the local market. However, the causal interpretation of the estimated effects are only valid if the assumption of exogeneity holds. If this is not the case, which there is reason to believe, then the estimated relationships can only be interpreted as correlations.

Hence, the obvious limitation of our paper is the potential endogeneity with regards to market structure in our model. A number of papers examining the structure-price relationship (see Singh and Zhu (2008); Evans et al. (1993)), however, show that ignoring the endogeneity of market structure has a significant downward bias on the effects of market structure on price, with large increases in estimated effects after applying correction procedures. Whether this could be the case in our model depends on the nature of the error terms and the non-structural form of the regression model, as argued by Zhu et al. (2009); this makes it difficult to determine which way the bias goes.

Thus, further research needs to take into account the potential endogeneity of market structure when estimating the structure-price relationship in the Norwegian grocery retail market, since data limitations prohibits us from using relevant methods to deal with the endogeneity in our price-structure model.

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Appendix

A Product Categories and Market Basket of Goods

Table IX—Product Categories in Market Basket of Goods

Category	No. of Goods in Market Basket	Mean Price	Std. Dev.	Urban Area: Mean Regular Price	Urban Area: No. of Obs.	Suburban Area: Mean Regular Price	Suburban Area: No. of Obs.
Frozen Pizza	9	50.20	27.10	49.53	8,763	50.81	9,513
Cream	5	19.79	2.01	19.56	5,264	19.99	5,902
Margarine	7	25.04	3.91	24.66	7,106	25.38	8,073
Dry Dinner Dishes	10	28.50	8.33	28.38	8,901	28.61	10,330
White Cheese	9	42.92	23.54	42.46	8,384	43.34	9,383
Chocolate Bars	11	32.45	10.94	32.83	9,719	32.11	10.504
Candy	1	140.43	21.09	139.89	1,054	140.93	1,114
Laundry	18	45.00	13.13	44.77	15,965	45.19	18,363
Yogurt	29	17.18	5.46	16.90	27,481	17.42	30,996
Total	99 (71)*	—	—	—	92,637	—	104,178

Table IX. Notes to Table IX. In the table we present the different product categories which constitutes our market basket of goods. Of the 99 unique goods in our market basket, 71 are food items. The prices are listed in NOK, and the number of observations are on article-level.

B Other Structure-Price Models

TABLE X—ESTIMATION EQUATIONS EXPLAINING THE PRICE LEVEL OF GROCERY RETAILING STORES IN OSLO WITH ADDITIONAL STRUCTURAL MEASURES

			Explanatory Variables								
	Est.	Structural Measure Variable	Structural Measure	Store Size (thousands)	Per Capita Income (ten thous.)	Population Density (thousands)	Intercept	Additional Variables[a]	Overall R^2 No. of Obs.	GLS [c] σ(c)	GLS [c] σ(u)
I.	GLS	*NUMCOMP*	.0015	-.0078	.0026*	.0006	4.4662***	Yes	.9370	.0171	.0118
			(.0011)	(.0064)	(.0015)	(.0009)	(.0456)		2,303		
II.	GLS	*NUMCHAIN*	-.0003	-.0083	.0024	.0009	4.4819***	Yes	.9361	.0171	.0125
			(.0014)	(.0071)	(.0015)	(.0007)	(.0428)		2,303		
III.	GLS	*NUMFORM*	-.0026	-.0089	.0025*	.0011	4.4761***	Yes	.9363	.0171	.0123
			(.0046)	(.0074)	(.0015)	(.0007)	(.0416)		2,303		
IV.	GLS	*NUMSAMEFORM*	.0006	-.0079	.0023*	.0011	4.4847***	Yes	.9361	.0171	.0122
			(.0.0011)	(.0067)	(.0013)	(.0009)	(.0373)		2,303		
V.	GLS	*NEAREST_SAMECHAIN*	-.0003	-.0117*	.0028*	.0016	4.6335***	Yes	.9414	.0159	.0125
			(.0002)	(.0071)	(.0015)	(.0012)	(.0409)		1,662		
VI.	GLS	*HHI*	-.0010	-.0082	.0023*	.0004	4.4882***	Yes	.9366	.0171	.0121
			(.0008)	(.0067)	(.0014)	(.0009)	(.0375)		2,303		
VII.	OLS[d]	*PRICE_NEARESTCOMP*	.0770**	-.0120*	.0029**	.0016*	4.1133***	Yes	.9381		
			(.0353)	(.0061)	(.0013)	(.0009)	(.1957)		2,048		
VIII.	OLS[d]	*PRICE_NEARESTFORM*	.4905***	.0020	.0055*	.0192*	2.1256***	Yes	.8975		
			(.0916)	(.0060)	(.0029)	(.0101)	(.4818)		1,328		

Robust standard errors clustered around stores are presented within parentheses.

***, ** and * denote significance at the .01, .05 and .10 levels, respectively.

[a] Additional variables included are dummies for each store, concept affiliation dummies, and temporal dummies on year-week level.

[c] Generalized least squares variance of error terms in random effects specification: $PRICE\_STORE = \alpha + \delta M_{st} + \beta \mathbf{W}_s + u_s + \lambda_t + e_{st}$.

[d] Pooled OLS has been used in favor of a random effects model to estimate the regression, as the LM test could not reject the null hypothesis of $\sigma_u = 0$.