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Measuring the impact of nutritional and socioeconomic factors on meat and fish demand in Norway

An empirical study on the demand of beef, pork, lamb, poultry, fish, and plant-based alternatives within the Norwegian food retail market

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Abstract

Consumers decide which food products to purchase in a complex ecosystem that evolves around ever-changing individual preferences, profit-seeking food retailers, and regulatory frameworks. This research study aims to isolate a part of intricacies by estimating the effect that nutritional and socioeconomic factors have on the demand of food. We focus specifically on meat and fish, as they are the highest grossing food categories in the world and in Norway. We study consumer purchasing patterns of meat and fish products using NorgesGruppen sales data from [redacted] to [redacted]. As basis for this study, we provide an overview of the Norwegian grocery market and explain the role of government regulation. Additionally, we explore different theories and studies behind food purchasing behavior. The effects are estimated using discrete-choice models with instrumental variables for price. Our results suggest that fat, protein, and carbohydrates have a significant impact on demand, in terms of nutritional characteristics. The dynamics of demographics play also a significant role to shape how consumers choose meat and fish products. Lastly, the economic environment of the consumers, measured at the municipal level, also affects demand. The estimates are transformed into willingness to pay measures that provide intuitive results to be used in business and policy decisions.

Keywords – FOOD, meat, fish, demand, economics, retail.

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1 Introduction

National diets have developed through years of cultural history and advancements in global trade infrastructure. At a fundamental level, communities feed themselves using the food resources available to them. For example, Norwegians have been historically dependent on fish due to the country's geographical location. Nevertheless, in the modern age, the purchasing habits of consumers are shaped by a variety of factors including price, dietary concerns, nutritional information, socioeconomic background, government regulations, labels, advertising, among others. On the supply side, food retail groups adjust each store to serve a variety of customer segments. They choose the product mix, promotions, displays, and location. All these factors come into play when we analyze how Norwegian consumers choose food products.

This study estimates the effect of different factors on the demand of meat and fish. For simplicity, throughout this study we include fish under the title of 'meat'. Meat has become a staple in the development of human civilization. It is recommended by most governments in the western world (Gonzalez Fischer and Garnett, 2016). In Norway, meat carries a high symbolic value and is at the center of most dinner preparations (Ueland et al., 2022). Nevertheless, in this complex food retail environment, we question how the demand of meat products evolves given the external environment. What factors are the most important to consumers? How do we measure these effects? Our goal for this study, and research question, focuses on estimating the effect of nutritional content and socioeconomic characteristics on the demand of meat products. We use a robust methodology following a seminal study on product choice by Berry that estimates the elasticity of these factors on the demand of meat while minimizing common demand estimation concerns, such as reverse causality and endogeneity (Davis and Garcés, 2010). To this end, we use NorgesGruppen data on weekly store sales of all meat products from [redacted] to [redacted]. The data includes information of [redacted] stores, encompassing [redacted] chains, across [redacted] municipalities in Norway.

This master thesis is structured as follows. Chapter 2 presents an overview of the grocery market in Norway, providing context on the history of food retail and the market composition of its retail market. Here, we dive deeper into the portfolio of NorgesGruppen

and explain the differences between the chains, providing information on the market that each one serves. Chapter 3 defines the scope of our research, specifically, the products that are considered *meat* for the analysis. In addition, Chapter 3 presents the various regulations and recommendations made by the Norwegian government. Nevertheless, regulations and recommendations are not the only, or the strongest, forces shaping meat demand. Chapter 4 provides a literature review of food purchasing behavior and, more specifically, the demand of meat. In this chapter we define which nutritional content and socioeconomic characteristics are the most relevant to the analysis. The next chapters put emphasis on the empirical aspects of the study. Chapter 5 describes the data, from the source of information to an overview of each variable. We present sales indicators and how they relate to the variables of our research question: nutritional content and socioeconomic characteristics. Chapter 6 presents the methodology for our two discrete-choice models; Chapter 7, the results; and Chapter 8 concludes the thesis.

The results suggest that demand of meat is affected by price, nutritional content of the product, demographic profile, and economic activity within the municipality. The magnitude and direction of the effects depend on the assumptions of the model. The estimated coefficients can be transformed into willingness-to-pay measures that are more easily interpreted. For instance, the analysis can provide clarity on how much consumers are willing to pay for an increase in fat content or a decrease in carbohydrate content. This has relevant operational and policy implications. In terms of day-to-day operations, the estimation of demand of meat can provide insights into the categories or products that generate higher returns. In contrast, the analysis also has consequences for policy makers that are trying to alter demand or extract more consumers surplus. In both cases, elasticities provide a quantifiable measure on the reaction of consumers when it comes to their demand of meat. Finally, we close with a discussion about the results and limitation of the study.

2 Grocery market in Norway

This section provides important context regarding the Norwegian grocery market and its unique characteristics. Although Sweden, Denmark and Norway are often grouped together under the regional label of Scandinavia, it is essential to understand how the Norwegian grocery market works at a fundamental level. To do so, we briefly review the history of grocery stores, specifically how the current self-service model came into occurrence, and the importance of marketing in the grocery retail space. Furthermore, we touch on the competitive landscape of the Norwegian grocery market, dive deeper into the portfolio of NorgesGruppen, and discuss the characteristics of its concept chain offerings. Our goal is to explain the Norwegian grocery market and introduce NorgesGruppen as its key stakeholder.

2.1 History of grocery stores

A grocer is described as an entity that sells food and small household goods. In their early stages of development, the business model was focused on full service. Food items were not pre-packaged and, as a result, shopkeepers were responsible for fetching each individual item from the shelves, weighing, and measuring each quantity of goods according to the requests of the customers (Klassen, 1994). This process was time and labor intensive. As populations began to grow, store footprints expanded, and labor costs increased uniformly. The Industrial Revolution brought forth a new age of manufacturing for the masses, two important, and often overlooked, innovations were the tin coated iron cans and the corrugated cardboard box (Stanton, 2018). These major advancements in food packaging and increased customer demand caused a shift in the grocer's business model. Grocery stores adapted from full service to mostly self-service business concepts. The self-service model is still thriving today. Customers walk through grocery aisles and select products on their own. Employees focus on optimally stocking shelves and efficiently checking out customers at payment kiosks near the store exit. Fragments of the old full-service model are still present in cheese and meat sections within premium grocery chains.

Marketing plays a massive role in modern day grocery stores. Major food retailers have segmented their business to better serve customer groups, linking marketing with different

pricing models (Wood and McCarthy, 2014). These groups are mainly categorized based on household income and geographical location. This has allowed major chains to brand their stores in four general segments: convenience, best value, supermarkets, and hypermarkets (Kamel, 2016). All four are present in the Norwegian retail landscape. Convenience stores offer the smallest range of products, mainly focused on everyday items. Best value, also referred as discount format, focuses on low prices while trading off a larger range of product selection. Supermarkets and hypermarkets offer a wider range of goods, especially fresh produce, with the latter being a one-stop shop for all retail purchases including non-food products. The focus on customer demographics provides an environment that optimizes specialized product mixes and prices. It also allows for efficient economies of scale throughout the value chain of each concept. A recent development in food retail is the focus on private label goods. A retailer would contract a third-party manufacturer to produce food items under the retailer's brand. The retailer can use their unique knowledge of their customer to specify what goes into the product, how its packaged and what is displayed on the package label. Major grocery retail brands have implemented this business model successfully, such as Walmart, with their Great Value private label, and Carrefour, with Classic (Colla and Dupuis, 2002). This is especially relevant as it allows for grocery stores to have more control over the pricing of specific goods and provides competition to some of their suppliers. Furthermore, private label items can be considered a form of vertical integration along the value chain of the grocer.

2.2 NorgesGruppen

The Norwegian food market serves a relatively stable population of roughly five million citizens. United Nations population data gathered over the past 73 years reports the Norwegian population has grown by a yearly average of only 0.7% (Nations, 2023). As of 2022, this population is serviced by four major grocery competitors that make up the Norwegian food retail market. The four being Bunnpris, Rema 1000, Coop and NorgesGruppen. As of 2020, these organizations hold roughly 3.3%, 23.3%, 29.3% and 44.1% of the market, respectively (Ridder, 2022). There is also a small number of independent grocers present in the Norwegian market, specializing in foreign food products such as Asian, Middle Eastern and Eastern-European food.

NorgesGruppen is Norway's leading grocery retail corporate group. The current structure is the result of a merger wave of several wholesalers and independent food chains. The group experienced substantial growth shortly after World War II from the acquisition of many regional and local wholesalers (NorgesGruppen, 2015). The company, as it is known today, was founded in the year 2000 through a merging of the food wholesaler *Joh. Johannson* and NorgesGruppen ASA. ASKO is also part of the portfolio, specializing in the effective distribution of food products to the grocery, convenience, and catering sectors in Norway. According to its website, ASKO operates 13 regional warehouses and eight B2B stores (2022). These vertically integrated business activities provide the company with a major advantage in comparison to its competition.

Currently, the group consists of 2,140 stores throughout Norway (NorgesGruppen, 2021). Close to sixty percent of its stores are owned and operated by independent merchants who are also often shareholders of NorgesGruppen (Ekberg, 2022). These stores are broken up into six food retail chains: Kiwi, Meny, Spar, Eurospar, Joker and Nærbutikken. The group also operates Deli de Luca, Mix, and Jafs, as part of their convenience food service business. The next paragraphs provide a brief overlook of the five retail chains relevant to our analysis, while Table 2.1 includes revenue and footprint information of each chain.

Meny

Meny is Norway's premium grocer that prioritizes the full-service supermarket concept, offers a larger variety of fresh and high-quality products in comparison to the low-cost/value chains in the portfolio, and provides the best shopping experience (NorgesGruppen, 2021).

Kiwi

Kiwi is NorgesGruppen's best performing chain in terms of revenue. It specializes in a strong balance between price and product offerings, which has resulted as being labeled Norway's best-liked grocery chain in a YouGov survey for the 6th year in a row (NorgesGruppen, 2021). It is a best value format, operating as NorgesGruppen's low-price concept store, with a product range between larger Meny supermarkets and smaller convenience stores, such as Joker and Nærbutikken.

Spar

Spar is originally a European chain that was established in Norway during the 1990s by

Johan Johannson (Ekberg, 2022). Today, it's positioned as a best-in-value food retailer with prices that fall in between those of Meny and Kiwi. They continue to work diligently on differentiating themselves from low-cost competition by providing a hot pre-made food section and freshly baked goods (NorgesGruppen, 2021).

Joker

Joker is NorgesGruppen's leading convenience chain in Norway holding 70% of the market share in 2021, offering a small selection of essential products to local communities across Norway (NorgesGruppen, 2021). Joker stores have a smaller footprint than the other concept stores.

Eurospar

Eurospar stores are grouped within the Spar portfolio. Eurospar presents a supermarket concept, considerably larger in terms of store footprint than Spar, and specializes in a deeper product range of ready-made and local food (NorgesGruppen, 2021).

Table 2.1: Selected NorgesGruppen grocery chains

	Meny 2021	Kiwi 2021	Spar 2021	Joker 2021	Eurospar 2021
Number of stores	186	689	265	615	27
Annual revenue (kr, millions)	22,000	45,800	14,300	8,200	*
Avg. store revenue (kr, millions)	118	66	49	13	

Note: *Financial information of Eurospar included under Spar.
Source: NorgesGruppen (2021)

3 Definition of meat and government regulation

3.1 Meat

This section focuses on defining what we consider a 'meat' product, which ultimately decides the animals that are included in our study. This is a fundamental exercise since the implications of the definition could substantially change the results of the analysis. We follow the definition by the American Meat Science Association, which classifies meat as edible animal tissue consumed as food (Boler and Woerner, 2017). The same study mentions the most common animal sources of meat include beef, pork, lamb, poultry, and fish. Fish is an essential component of this study because most Norwegian consumers plan their dinners around one of either red meat, poultry, or fish (Ueland et al., 2022).

A more detailed definition includes the parts of the carcass and non-carcass biological material, but this is mainly used for natural science studies. For our analysis, we focus on meat from the most common sources that are sold in the NorgesGruppen product offering. Table 3.1 presents the scope of our analysis in terms of categories and animal sources.

Table 3.1: Meat categories and animal sources

Category	Animal-sources
Poultry	Chicken
	Goose
	Turkey
Beef	Cow
Pork	Pork
Sheep and Lamb	Sheep
	Lamb
Fish	Salmon
	Tuna
	Cod

3.2 Regulation

We consider policy choices through two main channels: government dietary recommendations and regulations. Government dietary recommendations focus on what constitutes a good diet. This is especially important for a country since a healthier

population will likely lead to reductions in the use of medical resources per capita. Although changes in behavior through dietary recommendations can take time, the effects can be significant. Rickertsen et al. researched how the link between a cholesterol heavy diet and an increase in the probability of heart disease affected national diet programs around Europe and, with time, how consumption decreased for eggs, red meat, and milk (2003). The Norwegian government provides a national action plan which outlines relevant figures about the typical Norwegian diet. A brief list of the recommendations concerning meat are included in Table 3.2. How relevant are these recommendations for the population? According to the Norwegian National Action Plan, only 15% of men and 13% of women eat the recommended quantity of vegetables (Norwegian Ministries, 2017). While 45% of men and 67% of women eat the scientifically recommended amount of red meat (2017). Despite this gap, Norway is a leader in terms of health indicators and among the top countries in relation to life expectancy.

Table 3.2: Diet recommendations related to meat consumption

Recommendations:
– Enjoy a varied diet with lots of vegetables, fruit and berries, whole-grain foods and fish, and limited amounts of processed meat, red meat, salt and sugar.
– Eat fish two to three times a week. You can also use fish as a spread on bread.
– Choose lean meat and lean meat products. Limit the amount of processed meat and red meat.

Source: Norwegian Ministries (2017)

Regulation and import duties can significantly affect the grocery retail market in terms of product offerings and prices. An open economy, with low product restrictions and tariffs, will benefit from higher competition and lower prices. The opposite is also true, high product restriction and tariffs will decrease competition and push for relatively higher prices. Norway is on the latter's side of the spectrum. It experiences a high level of government regulation in several industries, including food (USDA, 2022). Norway enforces its own import regulations and standards, including labeling, packaging, permitted ingredients and other factors. Nevertheless, since Norway is a member of the European Economic Area (EEA), it has adapted many of the European Union (EU) rules in. In terms of differences, one example is genetically modified food and organisms, Norway established three additional requirements on top of the EU regulations: products must be ethically justified, provide benefits to society, and align with sustainable development goals (USDA, 2022). Despite some differences, the EEA agreement fully harmonizes the import

of animal and seafood products with EU regulations. Animal products imported from countries outside the area require approval from the Norwegian Food Safety Authority before they can be brought into the market.

Food prices in Norway are relatively higher compared to other European countries. A study on comparative European food prices by Eurostat discovered that Norway was one of the most expensive grocery markets in Europe. The study concluded that Norwegian grocery prices for food and non-alcoholic beverages were 63 percent higher than the European average, with Norway having the second most expensive meat products out of all EU/EEA nations Eurostat (2022a). This can be explained by higher taxes, import tariffs, higher wages, and an overall high cost level. Norway has strict domestic agricultural protection laws. These laws are unique as they apply heavy duty costs to imported food products to help protect domestic sellers. The World Trade Organization calculated on 2020 that Norway levied a 50 percent or higher tax duty on over 20 percent of all agricultural imports (WHO, 2022). The value of affected imports is almost 4 times higher than that of the EU. Nevertheless, regulation is in place to help keep food supply consistent nationally. For example, no import duty is enforced when fruits and vegetables are imported outside their respective season (USDA, 2022). To add, a study by Pettersen investigated the additional costs brought forth on food products by Norway's regulatory environment compared to other Scandinavian nations. The study concluded that Norway had the highest food prices compared to their Scandinavian neighbors, due to the increasing use of import protection laws (Pettersen in Steen and Pettersen, 2020). Another factor contributing to higher prices is the relatively high wages in the country, which impacts the grocers' value chain. A study conducted on the estimated hourly labor costs across Europe featured Norway as the top country, with an average hourly labor costs of 55.6 euros, only being followed closely by Luxembourg and Denmark (Eurostat, 2022b).

In this chapter we defined the scope of our analysis and briefly described the environment in which the stores operate. We introduced our definition of meat and, with it, the animal sources included in our demand estimation. We described the importance of the Norwegian government dietary recommendations, as well as few examples of how meat should be consumed. Lastly, we mentioned how regulation, tariffs on imported products, and high wages make Norway an expensive country in terms of food prices.

4 Food demand and meat purchasing behavior

Purchasing behavior can be influenced by a variety of factors, not only related to the intrinsic characteristics of the product, such as quality or ingredients, but also external features, like packaging and where the item is displayed within the store. Additionally, there is growing evidence that beliefs and biases affect how people consume. In this section, we go through the relevant theory of consumer choice. To start, we analyze the nutritional properties of food and how it can affect demand, briefly mentioning the nutritional benefits of meat. We then dive into how cultural differences lead to different purchase patterns. Furthermore, we investigate packaging and its effect on consumer perception. Price is also discussed as a relevant economic factor affecting demand, alongside bundles and discounts. Also, we investigate how the socioeconomic environment of consumers can influence their purchasing habits. Finally, we mention insights from psychology studies on how past experiences influence consumers in day-to-day actions within the grocery shopping context. All these studies contribute to establishing the relevant factors and variables that are considered when mapping out the demand of food, and more specifically of meat.

Despite the vast quantity of nutritional research, there are mixed results regarding the effect of nutritional information on consumer demand. The results are inconclusive as they do not address entirely how consumers make their choices. This is relevant to our study because to investigate the demand of meat in Norway, the first step is to focus on the quality and taste of the product as a relevant explanatory variable for quantity demanded. Product quality is reflected in the nutritional content of the product and what the consumer expects to obtain from consumption. Taste is subjective to the preferences of the individual consumer, thus harder to analyze in this setting. This rationale follows the standard utility maximization problem, given that a higher nutritional quality product should experience higher demand than a lower nutritional quality product. Regarding recent research, one study distinguishes the effect on the perceived risk of eating unhealthy food and the actual purchase of unhealthy products. Garretson and Burton use an experimental setting to determine that consumers perceive fat as a disease risk, but this perception does not affect the product's evaluation or purchase intention (2000). A note must be added that already perceiving fat as a disease risk is in line with the dietary health recommendations made by governments, mentioned in Chapter 3. A different

study, using surveys, suggests in contrast that nearly half of consumers use nutritional information to make their purchasing decision (Blitstein and Evans, 2006). The surveys were taken six years apart and there were some differences in the survey responses, this might indicate that the perception of consumers to nutritional values has evolved with time. Recent studies have focused on the reasons why this could be the case. Kiesel et al. determine that consumers facing a purchasing decision will not read the nutritional labels because of the time and effort it takes to understand and compare it to other products (2011). In the case of meat, three significant nutrients associated with it are zinc, iron, and protein (Boler and Woerner, 2017). The inconclusiveness of the research literature provides an increased motivation to understand how other nutritional content, such as fat, saturated fat, carbohydrates, protein, sugar, or salt, can influence the demand of meat in the Norwegian context.

Demand might also be affected by specific preferences of consumers due to their geographical location and culture. From a continental perspective, Europeans have different preferences compared to Americans, Asians, Australians, and Africans on how they choose food. A study focused on answering what are the most important factors that Europeans consider while shopping for groceries. It showed that Europeans are highly concerned about pesticides, inorganic additives, and genetic manipulation of products (Torjusen et al., 2004). Pesticides are mainly associated with negative health risks, both to the person consuming the product and the environment, but in the case of inorganic additives and genetic manipulation, the public concern is driven by cynicism of producers (Torjusen et al., 2004). In other words, the general population believes that additives benefit the producers to generate more profit, as opposed to improving the quality or availability of food. Another study, conducted in Norway, found that its citizens prefer a healthier diet featuring a higher quantity of organic rather than less processed, refined products (Torjusen et al., 2012). In terms of meat consumption, Norwegians prefer meat as a central part of their dinner (Varela et al., 2022). This means that most consumers purchase meat products for everyday consumption. On top of this, cultural traditions around the holidays mark an increase in the consumption of certain food staples, such as pork belly and cured lamb ribs during Christmas (Matprat, 2022).

Packaging also plays a significant role in how people choose their food. Food manufacturers

invest heavily in the presentation of their products with the goal of attracting consumers, creating awareness, and generating demand. Finding relevant literature to this topic presents a higher degree of complexity due to the changing landscape of food choices and trends through time. As an example, in recent years society has experienced a shift towards more health-conscious eating (Sadler, 2004). A survey study conducted in Germany found that people usually prioritize products with environmental packaging and analyze only two other factors, price and taste (Van Birgelen et al., 2009). One recent field study tested participants on their perception of food based on packaging. They were given samples of the same product with different packaging designs in terms of shape and color, participants perceived the one with healthier package details as a healthier choice despite it being the same product (van Rompay et al., 2016). Producers might also emphasize nutritional claims on their packages. Nevertheless, the nutritional claims in the packages might not be accurate. A study of food products conducted in Australia, found that the majority of products displaying nutritional information on their packages had a high degree of misleading or inaccurate statements (Pulker et al., 2018). Unfortunately, we are not able to control for packaging information, but acknowledge its significance in purchasing behavior. Further research is needed in relation to how specific elements of package design affect the demand of meat.

Standard economic theory explains how consumers choose products. The simplest model includes an inverse relationship between price and quantity, from which we can derive an elasticity. Gallet perform a meta analysis of 419 studies to analyze the effect of price on the demand meat. The authors find that the demand of beef, lamb, and fish is usually more elastic to price than poultry over several studies, although, the results are sensitive to the different methodologies and modeling characteristics (2010). The authors use the results to construct their own predictions of elasticity and conclude that price elasticities are not significantly different among meat categories (Gallet, 2010). This points an important aspect of our analysis regarding the purchase decision of consumers. On the one hand, meat can be analyzed as one category, with no segmentation for the animal source. This means that a consumer considers all meats in their purchasing decision. On the other hand, it can be argued that each category is analyzed separately. In this sense, a consumer can choose first a meat category and within the category chooses a product. This issue will be explored further in the next chapters. The price elasticity on the demand of meat

also varies by region, with a higher value in North, West, and East Europe, compared to South Europe and North America (Gallet, 2010). Thus, we must be careful to interpret the results from other countries, but highlights the relevance of our study specifically targeted to estimate the demand of meat in Norway.

A consumer's sensitivity to food prices is also influenced by their income and household wealth. Price changes are not experienced in a vacuum, the socioeconomic environment of the consumer also influences purchasing decisions. We expect consumers from a low-income background to be more susceptible to price decreases, or best value purchases, than high-income consumers, as modeled in standard economic theory. The problem arises on how to measure consumer's income precisely. One option is through surveys, although they might suffer from noise in the answers due to respondents filtering personal information or selection bias (Davies, 2020). For instance, a study conducted in The Netherlands, estimated the impact of pricing strategies on different levels of income (Steenhuis et al., 2011). The authors used data collected from surveys outside of supermarkets and fast-food restaurants, and acknowledge the limits of the results because of the inherent characteristics of a survey. Another option is to approximate the population information by using the geographic location of the grocery retail store. Various studies on food consumption and discrete choice modeling use the administrative definition of where the store is located to account for socioeconomic characteristics of its consumers, using counties, municipalities, and postal codes (DellaVigna and Gentzkow, 2019; Allcott et al., 2019a; Simora, 2017; Pessoa et al., 2015). This option aligns better for our analysis due to the structure of the data being used. We use municipal information on socioeconomic characteristics, including median income, to account for consumers characteristics.

Besides the simplest form of discounts and bundles, grocery stores and producers use a variety of tools to incentivize purchase. This heterogeneity makes it harder to measure the effects of discounts on demand. As an example of how complex the issue can be, a study uses an experimental setting to test the difference between discount and a bundle (a basket of goods at a reduced overall price) (Mishra and Mishra, 2011). Their results indicate that behavioral patterns and biases are present at the moment of purchase. A bundle will not work for vice foods (products that have a high content of salt, saturated far, or sugar), as consumers are not able to justify the purchase; while a discount that equals the

average price per item of the bundle is more appealing (Mishra and Mishra, 2011). In terms of income, low-income consumers might also respond with higher urgency when signals of scarcity are present. Peschel found that low-income individuals increased their demand of products when there were signals of scarcity, such as "last units" or "limited edition" (Peschel, 2021).

Our research question expands on how other parts of the economy interlink with the food retail sector and, specifically, to meat consumption patterns. In this case, we focus on the real-estate sector due to the availability of information and its role as an instrument in the accumulation of wealth. Statistics from the housing and construction sector are often used as leading indicators for economic performance of country or region by central banks and other institutions interested in macroeconomic forecasting (Leamer, 2015). One key benefit is the high-frequency collection of information, which ultimately leads to a faster public availability. The question arises if these indicators can be used for microeconomic decision making studies. At the micro-level, the majority of households in the developed world retain most of their wealth in the form of private real-estate instead of other financial assets (Zhu, 2014). We would expect that a downturn in the economic situation of these agents would result in the sale of property, increasing the number of property transactions at reduced prices. This was experienced during the Great Recession, although the main drivers of the recession were significantly tied to the housing market (Leamer, 2015). This downturn should also negatively affect the retail purchasing behavior and limit the purchase of high-price foods, such as high-quality meats.

We expand further on the role that psychological influences and biases have on the demand of food. Grocery consumption behavior is formed and changes throughout the lifetime of each person. These habits reflect their culture and personal experiences. Even when individuals are committed to diet changes, they do so within the scope of their cultural influences. Klem et al. found that only 20% of people that start a diet maintain it long-term despite a perceived increase in energy level and physical health (1997). This demonstrates that, on the aggregate and in the long term, people tend to stick to previous behaviors despite internal or external motivations. Furthermore, Lusk et al. use data from different experimental studies to establish the significant relevance of beliefs in consumers' willingness-to-pay for food attributes (2014). Beliefs include the link between food and

wellness, for example, people can picture a direct link between what they eat and their health. Beliefs also include the view on hormones and antibiotics usage, for instance, people could be less open to eating meat from mass factories if they are concerned about the side effects of hormones and antibiotics used in the production process. Although an experimental setting would be more appropriate for understanding this relationship, we can still make inferences about how consumers shop since we benefit from actual purchase data.

Our research question focuses on determining the factors that influence the demand of food and, more specifically, meat. The literature review discussed so far has explained the factors at play behind consumer's decisions. At first, we introduced the concept of food quality and presented that higher nutritional content is not always correlated to higher demand of products. Nevertheless, the mixed results encourage us to look for new evidence on how consumers demand of meat changes. Next, we reviewed how cultural differences impact the availability of products and preferences. More specifically, we covered characteristics unique to European and Norwegian consumers that affect the demand of meat products. Then, we presented recent results on the elasticity of demand with regards to price for meat products, which raised an important issue of the model specification when analyzing demand. Price is also not isolated from the context of the consumer. The wealth of a consumer and other socioeconomic factors surrounding the person are essential to understand demand. Following standard economic theory, low-income workers are more susceptible to specific types of discount strategies. Finally, we explored the relationship between psychology and economics. We stated that food purchasing behavior reflects past experiences, beliefs, and values, which are not easily changed and might not stick in the long term. In this case, a cross-section analysis might not reveal the real demand of meat, but a multi-season and multi-year study can reflect better the preferences of consumers. We will use these insights to guide our empirical analysis to answer our research question, what is the effect of nutritional content and socioeconomic factors on the demand of meat.

5 Data

In this section we describe the data used for estimating demand of meat products. Our analysis uses three sources of data. The main source is weekly store-level data of [redacted] grocery chains owned by NorgesGruppen. It includes information on the value and units sold of all meat products sold during the week. The secondary data sources correspond to the nutritional content of each product and socioeconomic information about each municipality. In the next paragraphs, we dive deeper into each source, as well as present the variables under analysis. Then, we perform an exploratory correlation analysis to understand the relationship between the variables. We investigate each variable before estimating the effects of nutritional content and socioeconomic factors on the demand of meat.

The weekly store-level data of [redacted] grocery chains was provided by NorgesGruppen, under the NHH's FOOD Research Project. The information corresponds to sales of each meat product during the week. The information included the name of the store, chain, postal code, week, year, different category levels, product name, product identification number, units sold, gross sales, and net sales. The period covers from [redacted] to [redacted], which provides a relevant number of observations, in terms of week under analysis and number of products. We benefit from having access to sales of [redacted] distinct chains since they provide representation of the overall food retail offering of NorgesGruppen. In terms of sales, we mainly use kilograms sold and gross sales. Kilograms sold was obtained from the units sold and the unit size of each product. Gross sales correspond to the value paid in Norwegian krones (kr), including tax. Both values represent the total purchases during the week.

We use two secondary sources of information. The first one includes the nutritional content of each product. The nutrients included in the analysis are fat, saturated fat, carbohydrates, sugar, protein, and salt measured in percentage terms. As mentioned in Chapter 4, nutritional content can be used as measure of quality since it provides a standardized tool to analyze the products. For example, using fat and saturated fat content we can distinguish between lean and fatty meats. The information for each product is associated using a product identification number, which can be merged with the store-level

data. The second source of information corresponds to public information obtained from Statistisk sentralbyrå (SSB). For our analysis, we use demographic and economic data. All the data retrieved from SSB is used at the municipality level ("kommune") and merged to our primary data source based on the location of each store. As a result, we create a customer profile for each store at the aggregate level in terms of income, gender, age, population growth, among other characteristics.

In the next paragraphs, we present a deeper look into the data. We start at the municipality level, in which we provide details about the municipalities covered by the sample. Then, we describe municipalities in terms of demographic and economic characteristics. Finally, we explore how sales evolve at a chain-level, store-level, and, ultimately, category-level.

5.1 Demographic and economic variables

The data includes information of [redacted] grocery chains of NorgesGruppen covering [redacted]. It consists of a representative sample of NorgesGruppen food retail business with information from [redacted] stores. As mentioned in Table 2.1 of Chapter 1, the grocery arm of NorgesGruppen consists of 1,782 stores, of which Meny accounts for 186; Kiwi, 689; Spar, 292; and Joker, 615. This means that the sample we are working with represents [redacted][1]. The stores are located across [redacted] municipalities. A detailed overview of each municipality, the number of stores, and chain are included in Table 5.1. The number of municipalities included in the sample corresponds to [redacted] of all municipalities in Norway (356). In terms of the distribution of stores, [redacted] has the greatest number of stores, with [redacted]. Followed by [redacted] with [redacted], [redacted] with [redacted], and [redacted] with [redacted] each one. [redacted] chains out of [redacted] are represented uniformly in the sample with [redacted] stores each. [redacted] is the only chain with only [redacted] store in our sample, located in [redacted]. Overall, the chains, stores, and municipalities included in the sample represent the overall business of NorgesGruppen, and we can assume that the sales information is representative of the Norwegian meat consumer.

Our efforts to analyze the effect of socioeconomic factors on the demand of meat are based

[1]According to NorgesGruppen, the information is representative of their grocery market portfolio.

Table 5.1: Municipalities and chains

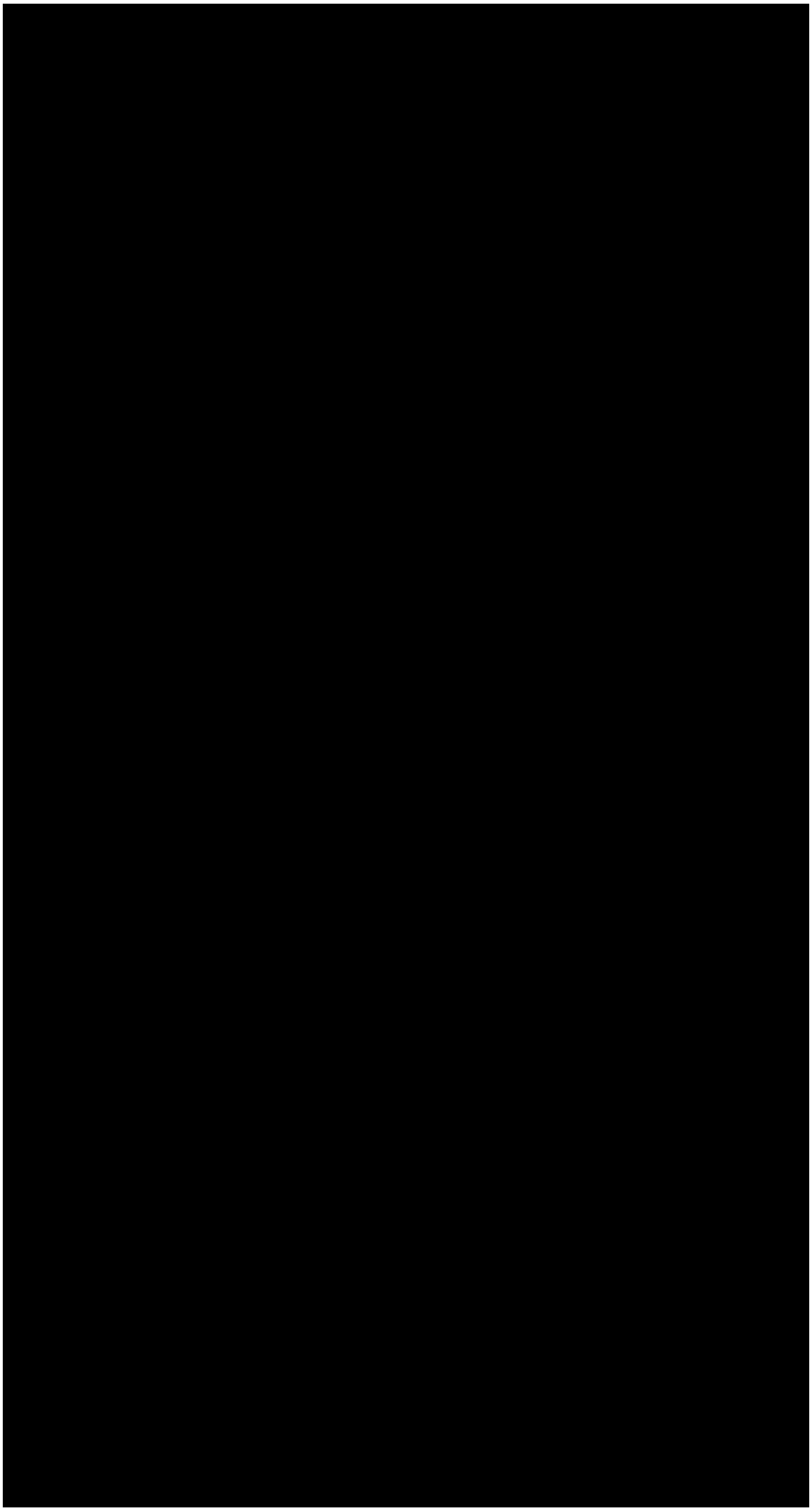


Table 5.2: Description of demographic variables

Variable	Smallest	50th percentile	Largest	Average	Standard Deviation
Population	3,117	24,017	699,827	63,570	120,270
Male proportion (%)	49.72	50.58	52.011	50.56	0.58

on municipal-level information of their residents. An ideal scenario would be to have information on each customer and transaction. Nevertheless, we assume that municipality information is representative of the customer profile that purchases her/his meat product on a NorgesGruppen grocery store. Table 5.2 presents descriptive statistics for different demographic variables in the year 2022. The first row presents population data (SSB, 2023c). The average municipality in our sample has 63,570 people. The difference in terms of population between municipalities in the sample is significant. The smallest municipality is [redacted] with 3,117 people, meanwhile the largest municipality is [redacted] with 699,827 people. Almost 10 times the average value. Of all the municipalities, [redacted] have less than 144,699 people. Nevertheless, the three biggest municipalities in Norway are included in the data: [redacted]. In terms of population growth, as we will see in the next sections, there has not been any swift changes in municipalities under analysis.

To analyze the demographic composition of the municipalities, we center our attention in the proportion of males and females in each municipality. The second row in Table 5.2 includes information about the proportion of males. We do not distinguish any significant outliers in the data (more than 3 standard deviations from the mean). The range among the municipalities is around 2.3 percentage points. The focus on gender distribution among the municipality captures the different diet and consumption patterns of males and females. According to Stamm, in Norway, females consume less kilograms of food on average than males (2015). Our demand estimation analysis will include a gender proportion variable to calculate the effect it might have if the proportion of males increases.

As mentioned in Chapter 4, the consumption of food and meat varies according to where the consumer is on her/his lifecycle. For example, a family consisting of two parents and two children will demand different amounts of meat than a couple of retirees living without children. To answer our research question and determine the effects of lifecycle characteristics on the demand of meat, we use age profiles of each municipality as a proxy for its effect. Figure 5.1 presents a graphical summary of the age profiles in each

municipality for the year 2022. The municipalities are ordered from smallest to largest according to proportion of 24 years and younger. The difference in range is of almost 10 percentage points between the municipalities with the lowest and highest values. This means that age demographics can vary significantly among municipalities. Unfortunately, the proportion does not provide enough information about household composition, so we need to be careful on how we frame our results. Oslo, Bergen, and Trondheim highlight as outliers, with an increased proportion of people between 25 to 34 years old. Overall, there is enough variance between municipalities that can provide relevant insights to our research question.

From Chapter 4, we know that the strongest effects on the demand of food are caused by changes in price and income of the household. To capture these effects in our estimation, we use information of economic characteristics at the municipality level. Specifically, we use median income and two variables related to property transactions. Table 5.3 includes descriptive statistics of the three variables. Median income refers to after tax income for all households, not including household types "living alone", "couple without resident children", "single parent with children" (SSB, 2023b). The average value of income among the municipalities of our sample is 734,307 kr, with a standard deviation of 70,613 kr. The range between highest and smallest median income corresponds to 328,000 kr. The municipality with the lowest value is [redacted] with a median income of 613,000 kr, while the highest corresponds to [redacted] with a median income of 941,000 kr.

Regarding property transactions, we use two indicators. One is the number of dwelling properties sold in a free market sale (SSB, 2023a). The summary of the data is included in the second row of Table 5.3. The average number of property transactions is 1,248 per year, with a standard deviation that is almost two times higher than the mean. This points to highly dispersed observations. This is indeed the case as the lowest 25% of the observations have less than 162 transactions per year, while the largest 25% makes over 1,175 transactions per year. As a second indicator for property transactions, we use the average purchase price per transfer (SSB, 2023a). It follows a similar pattern as the previous variable, with high dispersion among the municipalities. The average property transfer between municipalities is 3.7 million kr with a standard deviation of 1.47 million kr. We expect that these three variables can capture the effect the income of consumers

Figure 5.1: Population distribution

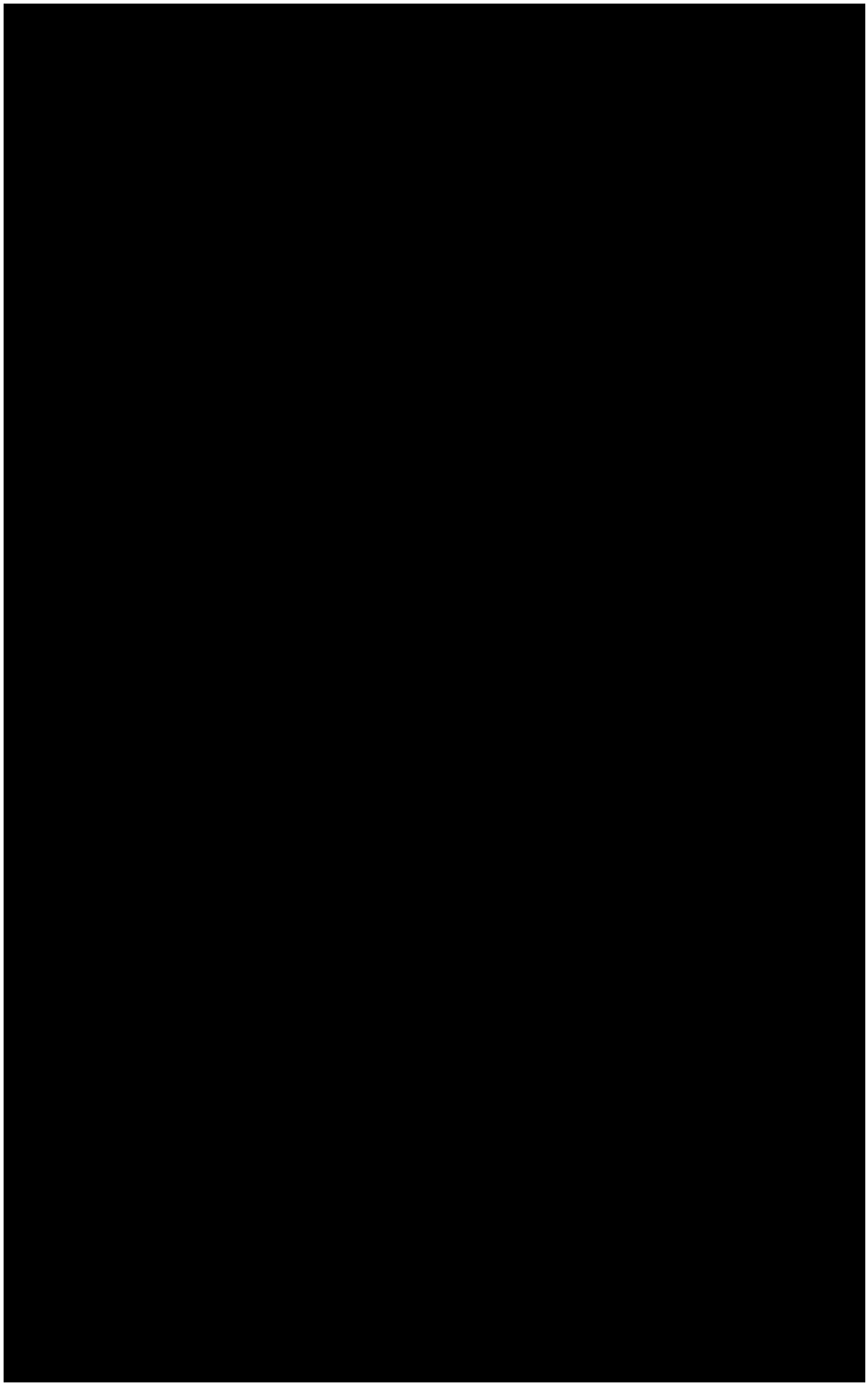


Table 5.3: Description of economic variables

	Smallest	50th percentile	Largest	Average	Std. Dev.
Median income	613,000	712,000	941,000	734,307	70,613
Number of property trans.	43	421	12,107	1,248	2,218
Avg. price of property transfer	1,958,333	3,375,829	8,455,722	3,720,947	1,476,091

and economic activity of the market on the demand of meat products. A first look at the effects will be presented in the next section using the correlation between purchased kilograms and economic indicators.

5.2 Sales information

After reviewing the information of each municipality, we bring our focus back to sales of meat products, in line with our research question. Meat products consists mainly of animal tissue of beef, pork, lamb, poultry, and fish. Nevertheless, it is relevant to include plant-based meat-like products in our study due to the higher degree of awareness and increase purchases of sustainable foods in the world (Bugge and Alfnes, 2018). This definition leaves out other products that might be used to substitute meat sporadically, but not on a regular basis, for example, eggs, beans, dry vegetables, and frozen meals. Although they can be substituted sporadically, we do not consider these items are suitable alternatives to meat products. In the next paragraphs, we will analyze meat sales information including its evolution and characteristics.

Figure 5.2 shows the average sales of meat that a store experiences per week. This graph indicates that the first week of 2017, an average store sold around [redacted] kr of meat. The highest peak during the same year occurred in December, with average sales per week surpassing [redacted] kr. There is additional seasonality during the year, marked by festivity celebrations or holidays. It is possible to distinguish a peak during Christmas and Easter, and a trough during the summer break. During the Covid-19 pandemic there was an increase in the volatility and in the overall amount of meat sales per week. The peak during the Christmas season decreased substantially in 2022 compared to previous years. This might be related to more people traveling abroad to celebrate the holidays after a couple of years limited by the pandemic. However this assumption is inconclusive and requires further research outside the scope of this thesis.

Figure 5.2: Average sales of meat products per store (kr)

Although it is informative, Figure 5.2 does not provide direct information on the quantity sold of meat. The original data from NorgesGruppen included information on the units sold of each product. For example, 10 units of 'salmon without skin, 1kg' or 5 units of 'chicken breast, 300gr.' We transformed this information to obtain kilograms sold of each product. In the case of the previous example, 10 kilograms of salmon were sold and 1.5 kilograms of chicken breasts. This allows for easier comparison between products. Table 5.4 includes a list of the 10 most sold products on average per week in terms of number of kilograms sold. The first column corresponds to the value sold on average per store, the second column presents the average number of kilograms sold, and the third column is a calculation of the price per kilo. Under these characteristics, the most sold product in kilograms sold is [redacted] in a package size of [redacted] kilograms from the brand [redacted]. On average a store sells [redacted] kr per week of the product, which amounts to [redacted] kilograms, with a price per kilo of [redacted]. The other entries on the list correspond to [redacted] (2), [redacted] (3), [redacted] (4), and [redacted] (5).

The information of kilograms sold weekly on average per store is presented graphically in Figure 5.3. Unsurprisingly, it follows a similar pattern as the previous graph regarding value sold. The most pronounced peak occurs in the last week of each year, while seasonality follows the same trend. A difference between Figure 5.2 and Figure 5.3 is that quantity follows a less pronounced positive line. This points to an increase in price (i.e.,

Table 5.4: Most sold products

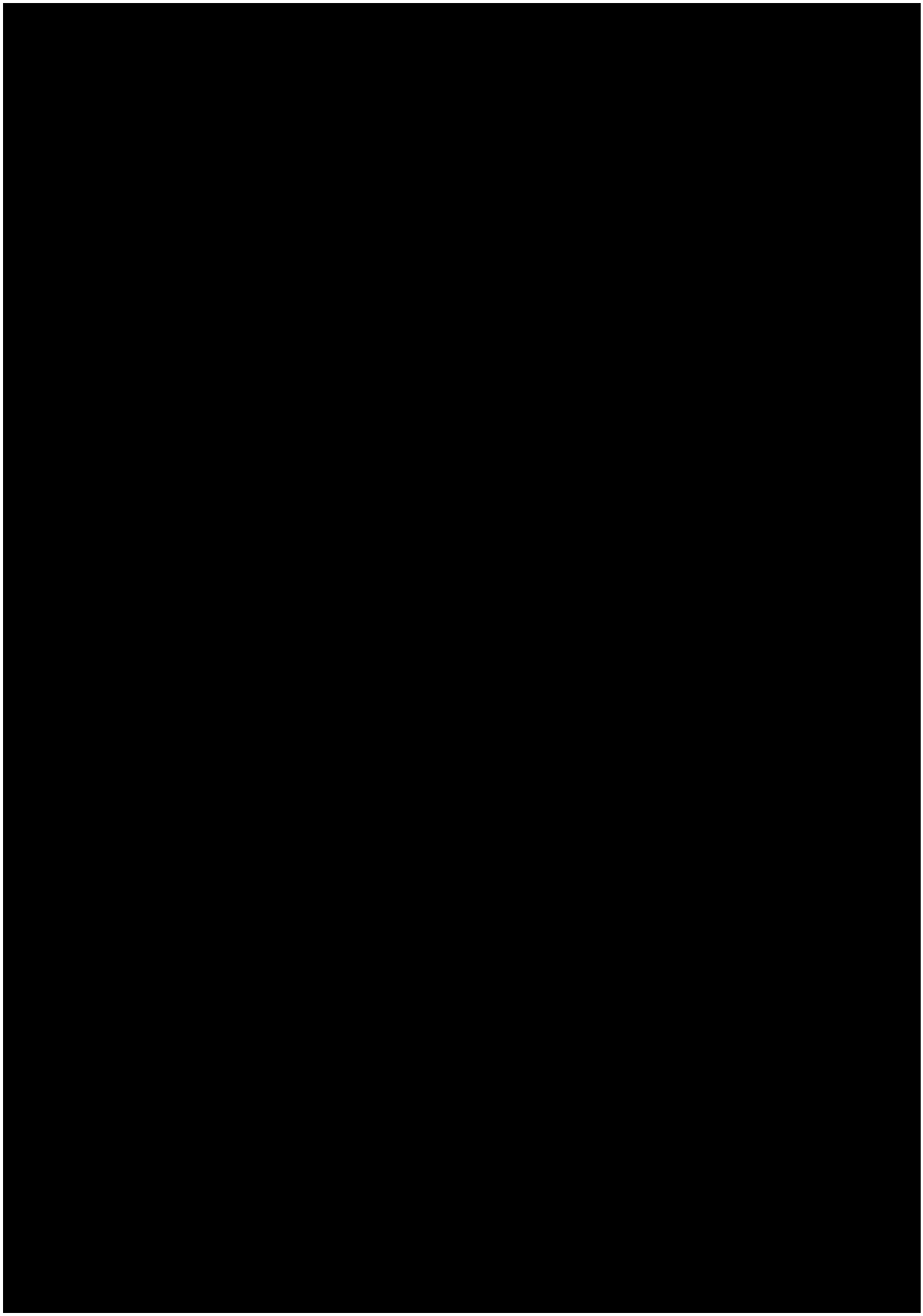
[redacted]

inflation) and quantities increasing slightly. On average, a store sells between [redacted] to [redacted] kilograms of meat per week. Nevertheless, there are significant differences among chains. Figure 5.4 presents the average kilograms sold per week for each chain. Following the retail concept of each chain, [redacted] and [redacted] stores sell more kilograms of meat per week than [redacted] (in order of quantity sold). The peaks are most notable in [redacted] and [redacted], while being less visible in the other three chains. One reason for the variance is the chain concept. Kiwi is aimed at low cost, whereas supermarkets such as Eurospar and Meny are more exposed to weekend, monthly, and holiday variation, such as Easter, Christmas, among other celebrations. Joker is a convenience store concept serving local customers buying only a small part of their groceries due to urgency and thus probably less exposed to weekly/seasonal variation.

Figure 5.3: Average kilograms sold of meat per store

[redacted]

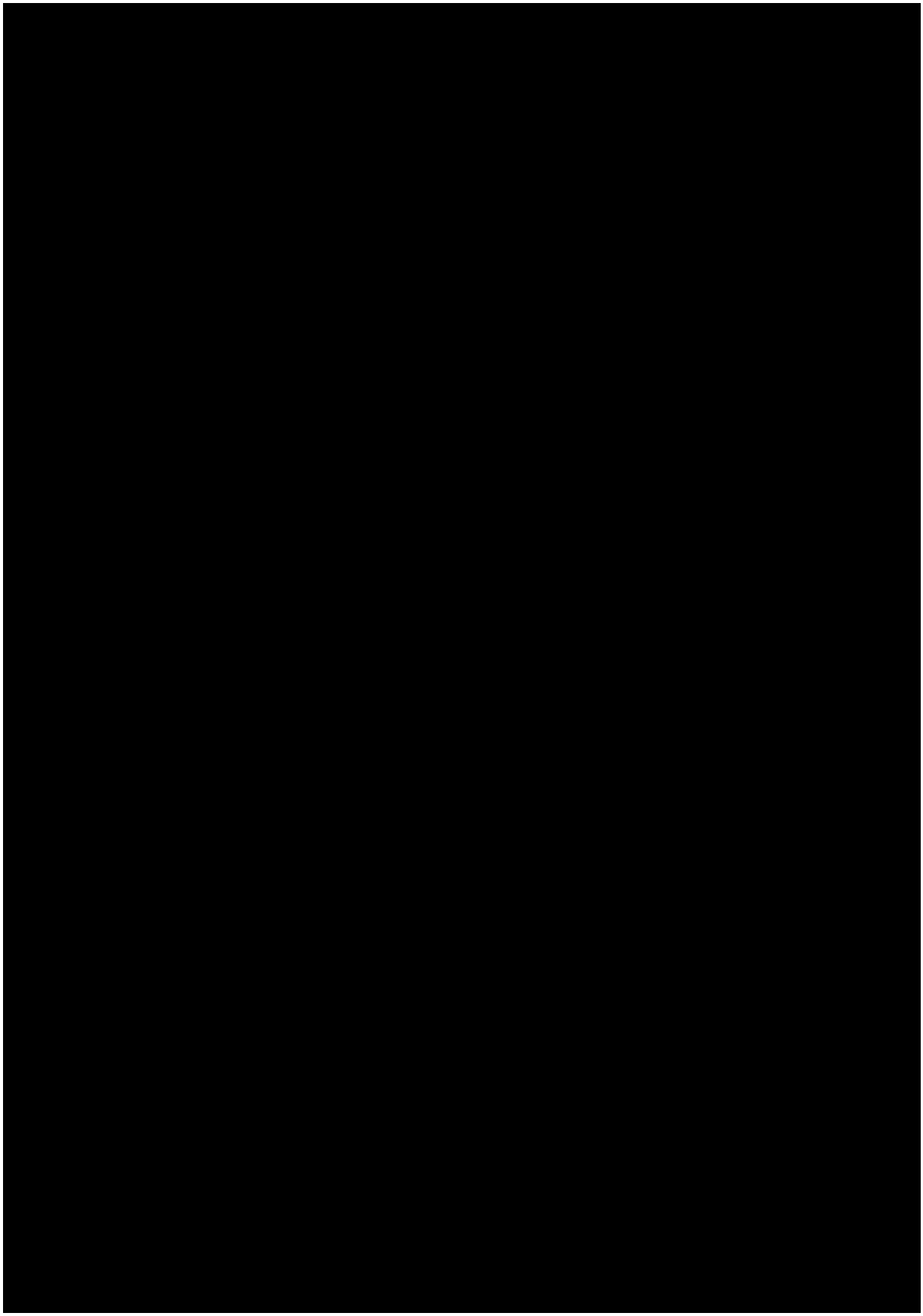
Figure 5.4: Average kilograms sold of meat per store, by chain



Now, we move from chain to product indicators, in terms of product categories. Figure 5.5 shows the kilograms sold of each category per store. Almost year-round, fish is the category with the highest kilograms sold compared to other meats. A store sells on average [redacted] kilograms of fish each week. It is followed by poultry, pork, beef, sheep and lamb, and, lastly, plant-based meats. In terms of seasonality, pork surpasses fish as the most sold food category during the Christmas holidays, despite fish and poultry also experiencing a seasonal increase. This is not the case for beef, which does not significantly increase its sales during the last weeks of December. Sheep and lamb experience two interesting peaks during the year. The first one in Easter and the second in the first weeks of October. This might be due to the use of sheep and lamb in traditional dishes (Matprat, 2022). Lastly, plant-based meat-like products do not perform as high as animal meats, kilograms sold are trivial compared to the other products. In the Annex, we expand on kilograms sold by category between different chains.

This section expanded on the value and quantity sold of meat products. Our goal was to present how much meat is demanded in weekly-store terms. This analysis pinpoints the seasonality that meat experiences, in overall terms and specifically to each food category. This creates the need for time fixed effects, given that results can be over or under-estimated due to assigning too much weight to larger seasonal purchases. In terms of chains, sales vary significantly between the different retail concepts. This is in line with the characterization of each one in Chapter 2. As a results, chain fixed effects will be introduced in the regressions.

Figure 5.5: Average kilograms sold of meat per store, by category



5.3 Nutritional content

As previously discussed, and following our research question, nutritional content can have an effect on the demand of food. In this section, we describe its distribution among our meat products sample. Figure 5.6 illustrates boxplots for each of our selected nutritional characteristics. The y-axis represents the nutrient quantity, in percentage points, of the product. The box plot is a graphical simplification of all the products under analysis. In the case of fat, ■% of the observations have less than 10% fat. When it comes to saturated fats, almost all products in our sample have less than ■% as can be seen in each respective top whisker. Protein content is relatively high among meats. This was expected as it is probably the most common attribute associated with meats. Excluding outliers, the maximum and minimum values among meat products lies between ■% to ■%. Carbohydrates, sugar, and salt content among most meat products have values close to zero.

Figure 5.6: Nutritional content among all products

Figure 5.7 presents the same analysis for each meat category. We distinguish that pork, as well as sheep and lamb products, feature a higher fat and saturated content. While poultry, beef, and fish feature in the lower end of the spectrum in terms of fat. Regarding carbohydrates, sugar, and salt, most categories follow the same pattern as in the aggregate. High protein content is present in all categories. In contrast to the aggregate box plot, the percentage of protein content is specific to each animal. For instance, the protein

content of beef products is less dispersed than that of fish. Visually, this is concluded from the top and bottom whiskers and their closeness to the median value.

Figure 5.7: Nutritional content by product category

5.4 Relationship between quantity and other variables

In the next paragraphs, we explore the relationship between quantity and how it is affected by different variables. This advances the discussion of our research question since we have a first look at how factors, such as price, fat content, protein content, income, among others, are related to the quantity demanded of meat. Our analysis is mainly graphical using scatter plots and fitted lines to uncover the relationships between products. Although this does not provide conclusive evidence, it serves as a tool to generate insights to construct our estimation models.

5.4.1 Quantity and price

The weekly sale information indicates that the majority of products sold have a price per kilogram of less than [redacted] kr. Similarly, on average, a store sells less than [redacted] kilos per week of each product. Figure 5.8 plots the relationship between price per kilo on the x-axis and kilograms sold by store per week on y-axis. A dot represents each one of the meat products in the sample. The left-side plot showcases a negative relationship between quantity and price but suffers from a lower boundary limit (no price or quantity

can be lower than zero). Thus makes the resulting fitted line harder to interpret. For instance, what will happen to products with price of 2,000 kr per kilo? We manage this issue by transforming our variables to natural logarithms, shown on the right side. The fitted line on the logarithm of quantity and price is also negative implying that a higher price per kilo is associated with a lower number of kilograms sold. This is unsurprising, as the reasoning follows standard economic theory. Figures A1.1 and A1.2 in the Annex document the relationship between price and quantity for each of the meat categories.

Figure 5.8: Average kilos sold per week and price per kilo

5.4.2 Quantity and nutritional content

Next up, we explore the relationship between nutritional content and quantity purchased. We begin with the relationship between kilograms purchased and fat content. Figure 5.9 shows the correlation graphically. We performed the same transformation as before to natural logarithms. For the beef category, a higher fat content is correlated with higher kilograms purchased. For a product in the sheep and lamb category, the correlation is also positive but weaker. Visually, the demand of fish and pork meats does not appear to be correlated with fat content. And lastly, the relationship for poultry and plant-based categories appears to be negative. A related, although distinct nutrient is saturated fat. As explained previously, Norwegian government dietary recommendations define high saturated fat content as negative for health. Based on this, we would expect a more elastic demand with respect to saturated fat content. Figure 5.10 provides a graphical exploration

of the relationship. Surprisingly, there is no discernible visual evidence that saturated fat affects demand more than fat content. The most relevant change is experienced by the fish category, with a negative correlation between the variables.

Figure 5.9: Average kilos sold per week and fat content

Figure 5.10: Average kilos sold per week and saturated fat content

In contrast to fat, which is sometimes associated with negative health outcomes, protein has a more positive association. Despite of this, a high-protein meat is usually a tougher

meat (Harper, 1999). The effects play differently depending on the category as displayed in Figure 5.9. In the case of beef, protein content does not appear to be correlated with kilograms purchased per week. The highest positive correlation is experienced by poultry, where a higher protein content is correlated with more kilograms purchased per week. On the other hand, the relationship for fish is negative, which is surprising given the relative in-store display of high protein fish, such as tuna. Overall, protein content appears to be a significant factor when we consider the demand of meats, in line with our research question.

Figure 5.11: Average kilos sold per week and protein content

With respect to other nutritional characteristics, Figure A1.3, A1.4, and A1.5 in the Annex present visually the correlation between kilograms purchased per week in each store and carbohydrates, sugar, and salt content, respectively. A high content of carbohydrates appears to be related with an increase in kilograms purchased of fish. The opposite is true for beef and pork, with an inverse relationship for each category. Likewise, the inverse relationship between kilograms purchased and sugar content appears visually for the beef and pork category. There is no apparent correlation for the other meat categories. Lastly, in terms of salt content, the correlation with the demand does not appear to be significant.

5.4.3 Quantity and socioeconomic characteristics

As established previously, socioeconomic characteristics can influence the amount, value, and types of food products purchased. We use municipality information on socioeconomic characteristics in order to measure these effects in the aggregate. Store information is provided in the sample, including postal code, which we merged with government data on each municipality obtained from SSB for the years [redacted] to [redacted] [2]. With this segmentation in place, we analyze how changes in population, gender, age demographics, median income, average property transaction value, and number of property transactions affect the number of kilograms sold.

The quantity of kilograms sold of meat is affected more by the chain concept than by population when comparing between stores and municipalities. Figure 5.12 (left side) includes a visual representation of the relationship. Each dot represents a store in the sample and the values correspond to the year 2021. Overall, there is no apparent trend between stores and population size. Fitting a linear through all the points would be straight, showing no relationship. Within each chain concept, following the colors, there are also differing trends. This is depicted graphically by dispersed points and contrasting fitted lines due to population. Nevertheless, the consistency is kept within stores of the same chain. For instance, [redacted] stores sell within [redacted] to [redacted] kilograms of meat each week. While [redacted] stores sell [redacted] to [redacted] kilograms per week. There is not enough overlap between chains and municipalities that can shine more light into the relationship. The main instance of overlap is [redacted], which has [redacted] stores of [redacted] different chains: [redacted] (the circles are located in the right side of the x-axis). The average number of kilograms sold in each fits well within the band of each chain. This is surprising given that it is the most populated city in our sample.

In terms of growth, an increase in the population of the municipality is not correlated with an increase (or decrease) in the number of kilograms sold. Figure 5.12 (right side) includes a visual representation of the relationship. Each dot represents a store, with the color denoting the chain of the store. The x-axis measures the compound annual growth rate of population. While the y-axis measures the compound annual growth rate of the

[2]Municipality information follows the administrative division of 2020. Information from previous years was approximated to reflect these changes.

kilograms sold on average in each store per week. Both rates were calculated for the sample period, from [redacted] to [redacted]. The pattern from the left side, in terms of chains, is no longer discernible. It appears that the growth of the stores is not affected by the chain of the store. There is also no identifiable trend either at the overall level, as represented by the fitted line. In terms of population growth the municipalities do not present any outliers. Nevertheless, this is not the case for growth of kilograms sold in each store. [redacted] stores experienced over a [redacted]% average year growth, with three of them belonging to the [redacted] chain. From this first look at the relationship between population and quantity of meat sold, there is no significant evidence of a strong correlation between the variables. Although, in agreement with the previous chapters, the effect of chain concept must be taken into account when estimating the demand of meat.

Figure 5.12: Correlation between population and kilos sold per week

[redacted]

Gender plays a significant role in the quantity of food purchased. A study conducted in Norway indicates that females consume, on average, a lower number of kilograms compared to males (Stamm, 2015). This applies to food in general, but also specifically to meat. The difference in consumption patterns from male and females is also seen at the aggregate level, in this case by municipality. Figure 5.13 (left side) includes a visual representation of the relationship. Each dot represents a store in the sample and the values correspond to the year [redacted]. The x-axis indicates the proportion of males in the municipality, while the y-axis shows the average number of kilograms sold in the store per week. Overall, there are is no discernible relationship between stores. In a similar fashion

as before, store performance is highly influenced by the chain concept. Within each chain, the correlation between male proportion and quantity is positive. As the proportion of males increases, the average number of kilograms sold of meat per week in a store also increases.

Within each municipality, an increase in the proportion of males is associated with a higher annual growth in the quantity of kilograms sold. Figure 5.13 (right side) shows the relationship. As before, each dot represents a store. The x-axis measures the change in the proportion of males in a municipality from [redacted] to [redacted]. In this case, a value of 0 would indicate that the municipality has not experienced a change in the in the proportion of each gender. A value of 0.5 indicates that the proportion increased by 0.5 percentage points. For instance, from 49.4% of males to 49.9% over the course of four years. The y-axis measures the compound annual growth rate of kilograms sold on average in each store per week. There is no apparent effect particular to each chain, their growth rates do not follow any specific pattern. Nevertheless, at the overall level, there is a positive relationship between the change in the proportion of males in a municipality and a higher annual growth in the quantity sold of meat. This means that if in a municipality the proportion of males increases, the annual growth rate in meat sales is higher than otherwise. From the figures, it appears that the relationship between the proportion of males in a municipality and the quantity of meat sold is positive. In the aggregate, using municipal data, the sample observations follow the theory of males consuming a higher quantity of meat than females.

Figure 5.13: Correlation between proportion of males and kilos sold per week

As discussed in Chapter 4, standard economic theory explores the link between income measures and quantity of meat sold. For our analysis, our goal is to determine the statistical significance and magnitude of their effect on the purchase of meat across Norway. The expectation is that quantity demanded will increase as the income of the consumer increases. We expect the trend to be the same using aggregated information, in this case household median income of the municipality. Figure 5.14 (left side) presents the relationship between median income and kilograms sold per week. As in previous figures, dots and colors represent different stores and chains, respectively. The x-axis measures household median income in the municipality, while the y-axis shows the average number of kilograms sold in the store per week. Both axis represent [redacted] values. As before, the chain plays a significant role in the dispersion of stores. [redacted] stores (and one [redacted]) out sale the rest of the chains, followed by [redacted]. Store size and concept appear to be more important than income of the municipality. When all stores are analyzed, no correlation is distinguished between median income and quantity of meat sold. Within each chain, there is slight positive correlation for [redacted] and [redacted] stores, but no relationship for the other chains.

At the municipal level, higher growth of median income is not associated with an increase in the annual growth rate of meat sales. Figure 5.13 (right side) indicates the relationship with each dot representing a store. The x-axis measures the average annual growth of

median income from [redacted] to [redacted]. All of the municipalities in our sample grew on average 2% or more in terms of median income. The y-axis measures the compound annual growth rate of kilograms sold in each store per week. There is no apparent effect at the chain level, nor at the overall level. It appears that there is no relationship between the annual growth rates of income and quantity. From the figures, we can assume that the relationship between median income measured at the municipal level and the quantity of meat sold is true for specific chains, like Kiwi and Spar, but not at an overall level when grouping all stores together.

Figure 5.14: Correlation between median income and kilos sold per week

As reviewed in Chapter 4, one measure that signals high economic activity is the sale of property, in this case, the number of property transactions in each municipality. How does this affect the grocery retail sales? And, more specifically, meat? Figure 5.15 explores the relationship. As explained in the previous paragraphs, the left side of the figure presents the relationship between the number of property transactions and kilograms sold. Each dot represents a store. The x-axis measures the number of property transactions in [redacted]. While the y-axis indicates the number of kilograms of meat sold on average per week in the store in [redacted]. The dispersion follows a similar pattern than that of Figure 5.12. In this sense, a community with a large number of people will present more property transfers. As before, there is no clear overall trend or correlation. At a chain level, the patterns are similar to Figure 5.12.

Growth rates of consumption and economic activity can shed more light into the relationship. Figure 5.15 (right side) presents the correlation between the annual growth rate of property transactions and kilograms sold of meat over the [redacted] period. Each dot representing a store. The x-axis measures the average annual growth in the number of property transactions. For instance, a municipality that experienced 1,000 property transactions in [redacted], with a 5% annual growth will report approximately 1,215 property transactions in [redacted]. The y-axis measures the compound annual growth rate of kilograms sold in each store per week. The figure shows that some municipalities experienced a reduction in the number of property transactions in the 4-year period. Since some observations are to the left of zero in the x-axis. The overall trend including all stores and chains is positive. This indicates that an increase in the growth rate of property transactions is associated with an increase in the growth rate of kilograms sold over the years. At the chain level, there is no clear relationship. Given the similarity of the left-side graph with the population variable, we expected to reach the same conclusion on the right-side graph (i.e., not a clear correlation between growth rates). Nevertheless, it shows that the relationship is not only driven by the size of the store and population of the municipality, but also the dynamics of the economy.

Figure 5.15: Correlation between property transactions and kilos sold per week

The second measure of economic activity related to real-estate is the price at which properties are transferred. Figure 5.16 illustrates this relationship. The left side of the figure presents the relationship between the average transaction value and kilograms sold.

Each dot represents a store. The x-axis measures the average transaction value in [redacted]. While the y-axis indicates the number of kilograms of meat sold on average per week in the store in [redacted]. As before, there is no clear overall trend or correlation. At a chain level, there is more variability among stores. Graphically, this means that the dots are more dispersed than previously. Within chains, the patterns are similar to Figures 5.12 and 5.15.

As previously, we examine the growth rates to perhaps identify another relationship. Figure 5.16 (right side) presents the correlation between the annual growth rate of property price and kilograms sold of meat over the [redacted] to [redacted] period. Each dot representing a store. The x-axis measures the average annual growth in the price of property transfers. The y-axis measures the compound annual growth rate of kilograms sold in each store per week. The figure shows all the municipalities experienced growth in the purchase price of property. All observations are to the right of 0 in the x-axis. The figure does not show any trend between growth rates, either analyzing all chains overall or separating them. This last real-estate indicator presented more variability than previous graphs, nevertheless, the results were not surprising. We expect the effects to be more clearly defined in the regressions since they are fully analyzed.

Figure 5.16: Correlation between price of property transacted and kilos sold per week

This section explored how the quantity of kilograms sold in each store is related to the main variables of our study. We used the average number of kilograms sold per week in a store as indicator of sales to maintain consistency throughout our analysis. In relation to

price, as standard economic theory, there is negative correlation between unit price and quantity. The relationship between quantity and nutritional content was more identifiable within each product category. In terms of fat content and kilograms sold, the relationship is positive for beef; slightly positive for sheep and lamb; negative for poultry; slightly negative plant-based; and, nonexistent for fish and pork. When it comes to saturated fat, the relationship with the number of kilograms sold follows the same pattern as before, except for the fish category. The relationship is inverse, a higher content of saturated fat is associated with lower number of meat sold. On the other hand protein content changes the dynamics observed so far. The relationship is positive for pork and poultry; negative for fish; and no correlation exists for beef, plant-based, and sheep and lamb categories. Carbohydrates appear to be related with a decrease in kilograms sold for beef, pork, and poultry. Meanwhile fish, sheep and lamb experience a positive relationship. Salt content is associated with a decrease in the quantity sold for almost all categories, except for fish. Lastly, sugar content appears to have no relationship in the sales of meat. Mainly because meat products are less likely to have high sugar content, as shown in the box plot of nutritional content by category.

The last part of the section explored the relationship between socioeconomic variables and quantity sold. Information about socioeconomic characteristics correspond to municipal-level data, in this sense, the relationship is studied in the aggregate. The analysis also focuses on the evolution through time of the relationship by examining the correlation between growth rates. In terms of population, there is no correlation between size of the municipality and quantity. Gender appears to have a positive relationship, stores belonging to the same chain appear to sell more kilograms in municipalities where the proportion of males is higher. This relationship also applies to growth rates, an increase in proportion of males increases the annual growth of meat sales. Median income does not appear to be correlated with kilograms sold of meat, although a slight positive relationship exists within specific chains. The number of property transactions provides a measure of economic activity of the municipality. Although it does not appear to have a correlation with kilograms sold at the municipal-level, the growth rate in the number of property transactions appears to be correlated to the growth of the kilograms sold. This points to stores increasing the sales of meat when the economic activity in the municipality increases. The preliminary exploration provides a starting point before diving deeper in

the demand estimation models. The previous studies on food purchasing behavior, and specifically on meat, point to similar results as the ones discussed so far. Nevertheless, we must be careful interpreting these values since the cannibalization from bordering stores is not measured. We are not controlling for distance to stores in other countries such as Sweden, which according to a study by Steen and Pettersen, cross-border shopping is a significant characteristic of Norwegian regions closer to the border (2020).

6 Methodology

In this section we explain the methodology to estimate demand and, in line with our research question, calculate the effect nutritional factors and socioeconomical factors have on the purchase of meat. We use a discrete-choice model of demand, also referred to as multinomial logit model, following the seminal paper by Berry (1994). We use instrumental variables to deal with endogeneity with an approach used by DellaVigna and Gentzkow (2019), Hausman (1996) and Nevo (2001). We also present the demand estimation analysis using a nested multinomial logit model. This section is structured as follows. First, we explain why a multinomial logit is needed to estimate demand. Next, we dive deeper into the models and assumptions. Lastly, we talk about the use of instrumental variables to reduce inherent endogeneity in the model.

The ideal case to study how quantity demanded for one product changes requires that the product experiences price changes while nothing else relevant occurs. This is related to the ceteris paribus concept, maintaining the rest constant we can analyze the specific effect of one factor. Unfortunately, this occurs infrequently, and it is especially rare in food product categories. There is high competition from producers, substitute products, discounts, loyalty programs, new recipes, among other factors that have an effect on demand. Fortunately, over the past few decades, new theories and applications have emerged allowing researchers to estimate demand acknowledging this context. For our study, we use a discrete-choice model, also referred to as multinomial logit method, to estimate demand of meat products. This methodology is well suited to measure elasticity regarding price, product characteristics, and, in the case of research question, demographic and economic variables.

Estimating demand using an ordinary least squares (OLS) regression without any transformations can create significant issues and bias the estimated coefficients. Two significant concerns are endogeneity and reverse causality. To avoid part of these issues, we follow Berry (1994) and use a discrete choice model of demand. As stated by Davis and Garcés, using this model allows us to work with different consumer types, accounting for heterogeneity, and arrive at interesting analytical results (2010). To study how people make choices on meat we start with a conditional logit model. We define the probability

that a person i chooses a product j over a set of products k is given by:

$$Pr(i\ chooses\ j) = \frac{exp(V_j)}{\sum_{k=1}^{J} exp(V_k)} \tag{6.1}$$

Where V represents the utility of purchasing a product. This equation applies to all consumers; thus, the probability of choice converges to market shares. In our case, market shares of different products in the meat category. The general case of this is presented in Equation 6.2.

$$s_j(p) := \frac{exp(V_j)}{1 + \sum_{k=1}^{J} exp(V_k)} \tag{6.2}$$

The relationship to our research question comes from the utility function, V. We establish the following utility specification for meat consumers that purchase product j:

$$V_j := \alpha p_j + \mathbf{N}_j\gamma + \mathbf{E}\lambda + \xi_j \tag{6.3}$$

Where p represents price, $\mathbf{N}$ is a vector of nutritional factors, and $\mathbf{E}$ is a vector of socioeconomic factors, including demographic and economic indicators of the municipality. Lastly ξ represents the error term. Replacing in Equation 6.4:

$$s_j(p) := \frac{exp(V_j)}{1 + \sum_{k=1}^{J} exp(V_k)} = \frac{exp(\alpha p_j + \mathbf{N}_j\gamma + \mathbf{E}\lambda + \xi_j)}{1 + \sum_{k=1}^{J} exp(\beta_0 + \alpha p_k + \mathbf{N}_k\gamma + \mathbf{E}\lambda + \xi_k)} \tag{6.4}$$

Next, following the conditional logit model assumptions, an outside good will generate the following market share:

$$s_0(p) := \frac{1}{1 + \sum_{k=1}^{J} exp(\alpha p_k + \mathbf{N}_k\gamma + \mathbf{E}\lambda + \xi_k)} \tag{6.5}$$

Where the outside good represents all products that a consumer might purchase. In the case of meat demand, we estimate the outside goods as all other products other than meat that can be purchased. To calculate the size of the outside good we use the number of kilograms of food that the average Norwegian consumer demands (Stamm, 2015). The number of daily kilograms is multiplied by seven to obtain the weekly kilograms consumed, and further multiplied with the number of people in the municipality. Thus, we have

a relevant comparison between the quantity sold at store-level of meat and an assumed quantity of kilograms sold of other products.

$$\begin{aligned}\text{Weekly kilos per person} &= \text{Daily consumption} \times 7 \text{ days} \\ &= 2.464 \text{ kg} \times 7 \\ &= 17.248 \text{ kg}\end{aligned}$$

The ratio between product j market share and outside good market share equals:

$$\frac{s_j}{s_0} = exp(\alpha p_j + \mathbf{N}_j\gamma + \mathbf{E}\lambda + \xi_j) \tag{6.6}$$

We can take logs to arrive at a linear equation:

$$ln(s_j) - ln(s_0) = \alpha p_j + \mathbf{N}_j\gamma + \mathbf{E}\lambda + \xi_j \tag{6.7}$$

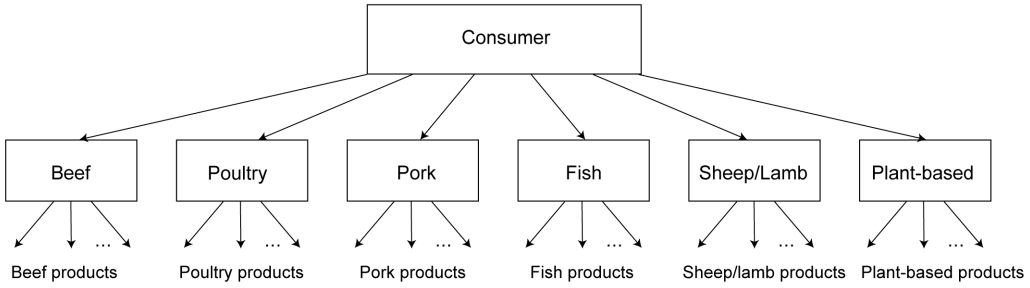
Which allows us to estimate the elasticities of price, nutritional content of the products, and socioeconomic factors. This brings us closer to answering our research question, nevertheless, we should account for endogeneity issues, since price might be correlated with the error term. We will dive deeper into this topic later.

Concerning the research topic, the multinomial logit model, presented so far, assumed that Norwegian consumers choose among meat products without considering the category or animal source. This assumption can bias our estimates. A different scenario separates the problem in stages, first consumers choose the animal source (i.e. fish, beef, poultry, sheep and lamb, pork, plant-based) and then choose within each category the product. Figure 6.1 models how the decision might take place. To account for this, we use a nested multinomial logit model, in which we divide the products in mutually exclusive *nests*, in our case meat categories, following the methodology of Berry (1994). The resulting linear equation is,

$$ln(s_j) - ln(s_0) = \alpha p_j + \sigma ln(s_{j|g}) + \mathbf{N}_j\gamma + \mathbf{E}\lambda + \xi_j \tag{6.8}$$

Where $S_{j|g}$ is the market share of product j in nest g. And σ represents the correlation tastes within nests.

Figure 6.1: Multinomial logit model decision tree



The nested multinomial logit model is more prone to issues of endogeneity than the multinomial logit, nevertheless, both can suffer from it. The type of endogeneity issue to deal with is omitted variable bias. In this case, the correlation between price per kilo and the unobserved characteristics of the products can create biased coefficients. One example of an unobserved variable is the quality of the product brand. It is not possible to observe which brands consumers think are high quality. These unobserved characteristics affect price given that consumers will pay higher prices for food products. At the same time, these characteristics affect the quantity as consumers demand more of this product. This is not homogeneous to all products, since perceived quality can vary from brand to brand. The issue can be addressed using one or various instrumental variables, but they must meet two conditions. They should be exogenous to the structural equation. This means that the instrument is not correlated with the error term. And they should be relevant for explaining the independent variable. In this case, related to the price per kilo. It must be noted that the exogeneity condition cannot be tested, but the assumptions made with economic reasoning must hold. The exogeneity condition is explained for each of our three instrumental variables in the following paragraphs.

We follow the methodology taken by Berry (1994); DellaVigna and Gentzkow (2019); Allcott et al. (2019a,b) to instrument for the price variable and address the endogeneity issue. We use three instrumental variables to account for endogeneity. One is dependent on national prices and the two others are dependent on the characteristics of competing products. The first instrument is a function of the average price of each product across stores of the same chain located outside the relevant market area. More specifically, the function is the unweighted difference between the change in price of a product in the store under analysis and the change in price of the same product in stores of different chains. But to construct the instrument we focus only on the average changes (or deviations)

from the same chain outside of the municipality under analysis. Both assumptions of exogeneity and relevance are met. We assume the instrument is exogenous following the study of Allcott et al., in which it is argued that the chains vary their prices independently from each other (2019b). In our case, each chain of NorgesGruppen applies the same pricing campaigns across their stores. Across chains, the price campaigns are different, although they maintain a relation with the average national price.

We assume the instrument is relevant given that even though the timing in the change of prices and deviation from the national price are not the same for all chains, ultimately price will change accordingly and reflect the average national price. The average values are calculated using the deviations outside of the municipality area to avoid any local demand shocks. The instrumental variable, $ln(p_{jxt,-m})$ represents a function of price p, in chain x, in week-year t excluding the municipality m. The function is the unweighted average of the difference between $ln(p_{jst})$ and $ln(p_{jt})$ at chain x outside of municipality m. The first term, $ln(p_{jst})$, is the change of price p of product j in the store s during the week-year t. The second term represents the change in the average price p across all stores and municipalities in the week-year t.

The second instrument in use is the number of competing products in the same category. In this case, the number of competing products can vary between chains and stores. It provides a measure of competition. This can affect price directly since a higher number of competing products can be associated with lower prices. While a product that faces a reduced competition has a margin to set prices and extract more consumer's surplus. Thus the relevance condition is met. In terms of the exogeneity, the number of competing products is not correlated with the error term. We assume that the number of entrants and participants in the category is random and changes to it come from external forces. As commented in Chapter 4, the trends in food retail can vary substantially. Thus, the appearance of new competing products and reduction of portfolios from all producers follows a random fashion. For instance, the unobserved characteristic mentioned before, perceived quality of the product, has no correlation with the number of competing products, especially when we analyze broadly each meat category. The variable $num_{gst,-j}$ represents the instrument, where num refers to the number of products in category g, sold in store s at the week-year t, excluding the product under analysis, referred to as j.

Lastly, the third instrument is the average unit size of competing products in the same category. We exploit the variation of the unit size between chains and stores. For instance, convenience stores offer lower unit sizes of products thus provide *convenience* in a reduced store size. In the case of supermarkets, the average unit size is larger given their increased product range. The relevance condition is met given that price per kilo has a negative relationship with unit size. A bigger unit size is usually accompanied by a lower price per kilo and vice-versa. In terms of exogeneity, we assume the unit size of competing products is not related with the error term. It follows a similar argument as the previous instrument, the unit size is defined by external forces. Producers work on improving their selling proposition, either by reducing the unit size or increasing it. Even though the decision is not random for each producer, in the aggregate, the introduction of products with different unit sizes or removal of products is exogenous. Equation 6.9 shows the instrument calculation for the average unit size of the products in category g, in store s, and week-year t excluding product j. The calculation shows the sum of competing product unit sizes, in these case the sum of unit size of all products n minus the unit size of product under analysis. Divided by $n-1$ to exclude product j.

$$Avg.\ unit\ size_{gst,-j} = \frac{(\sum_{k=j}^{n} unit\ size_{jgst}) - unit\ size_j}{n-1} \tag{6.9}$$

So far, we discussed how to estimate demand. In line with our research question, the effect of nutritional and socioeconomic factors on the demand of meat can be observed in the coefficients of Equations 6.7 and 6.8. Nevertheless, the coefficients are hard to interpret at first glance. Fortunately, we can transform the coefficients, from units of utility to willingness to pay expressed in monetary values. The effect (M) can be obtained as follows,

$$WTP(\mathbf{N}) = \frac{\gamma \times \Delta\mathbf{N}}{-\alpha} \tag{6.10}$$

$$WTP(\mathbf{E}) = \frac{\lambda \times \Delta\mathbf{E}}{-\alpha} \tag{6.11}$$

In this section, we presented a walkthrough of our methodology on how to estimate demand of meat products and, in line with our research question, obtain the effects of nutritional and socioeconomic characteristics. Our framework uses multinomial and nested multinomial logit models. We explained how these estimators are obtained, as well as how

to deal with endogeneity caused by an omitted variable bias using instrumental variables. Lastly, we showed how to transform the coefficients of the product characteristics and socioeconomic factors into monetary values, which, at the end, demonstrate how changes, for example in fat content or protein content, affect the willingness to pay.

7 Results

This section presents the results of our research question which aims to determine the effects of the nutritional content and socioeconomic characteristics on the demand of meat products. First, we estimate the coefficients for the multinomial (MNL) and nested multinomial logit (NMNL) models, with and without the use of instrumental variables to account for price endogeneity. We discuss the results of each model and establish which one is more relevant. Then, we transform the obtained values into willingness to pay measures for each of the variables relevant to our research question. The transformed coefficients provide intuitive results for decision-makers in business or government institutions.

The estimates offer two distinct results based on the assumptions of each model (MNL and NMNL), specifically on how consumers purchase meat products. Chapter 4 establishes that Norwegians are consistently consuming an animal meat every day of the week. The assumption of the model depends on how consumers choose a product. Do they choose between all available options of meat products or do they first select a meat category to then focus on the product? We will leave this question open for the moment and get back to it and the end of this chapter. Table 7.1 presents the results of six regression models. The first three columns correspond to a multinomial logit model specification, in which it is assumed that Norwegian consumers choose between different meat products directly, without an intermediate step of choosing the meat category. The last three columns show the results of the nested multinomial logit model specification. The main assumption of the latter is that consumers first select the animal category before choosing the product. The next paragraphs provide a detailed description of how the models differ from each other within the specifications.

All model specifications in Table 7.1 use fixed effects for time, and varying characteristics of fixed effects. As mentioned in Chapter 6, irrespective of the model, the use of instrumental variables is fundamental to avoid endogeneity. The columns with IV distinction in Table 7.1 show the results when we use our instrumental variables for price[3]. The effect of using instrumental variables has a significant impact on the price per kilo coefficient.

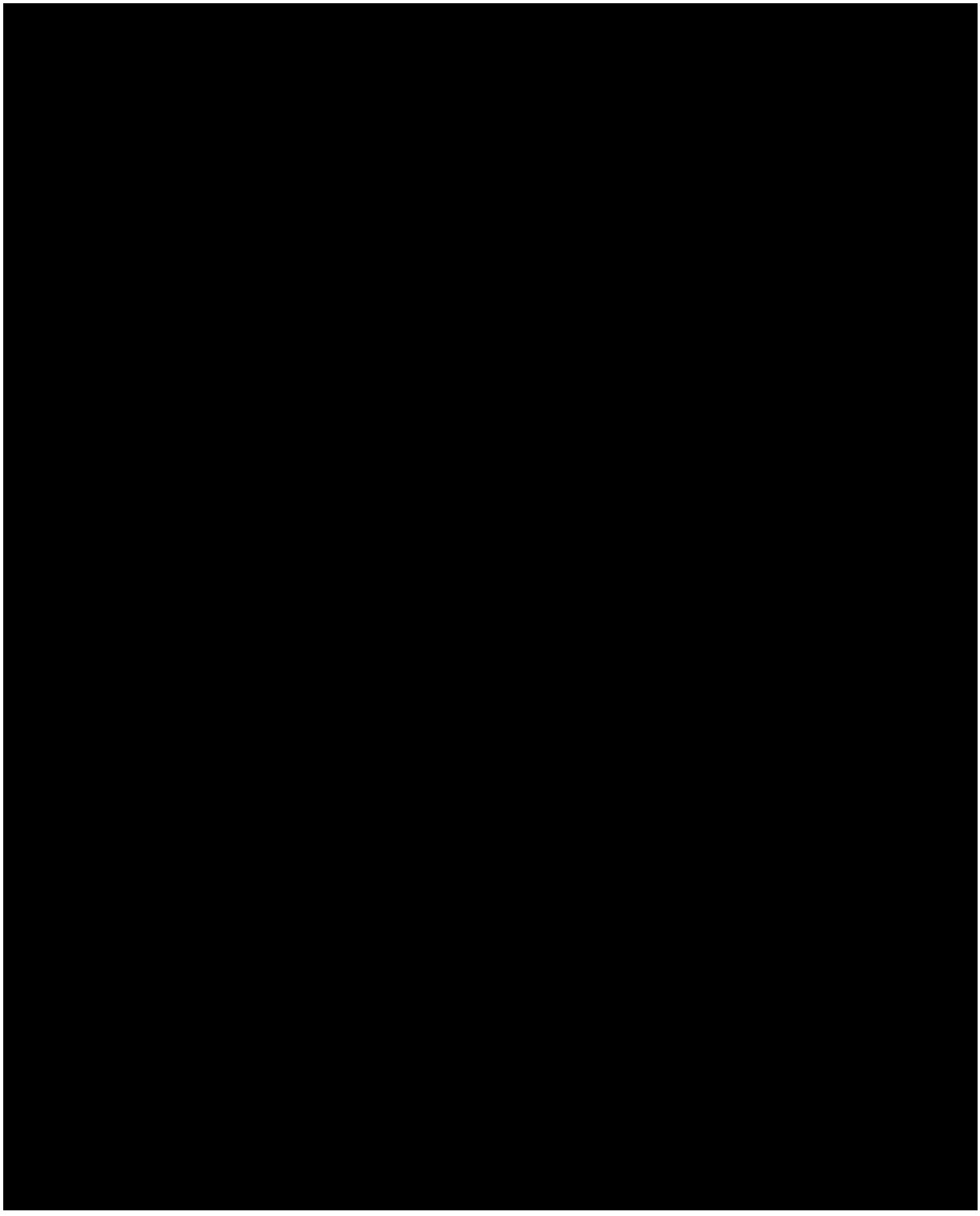
[3]The first stage results are included in the Annex in Table A1.1. In the MNL models, the price deviation coefficient is statistically significant, while the number of competing products and average unit size are not. This situation reverses in the NMNL models. The dynamics are probably driven by the inclusion of product category fixed effects, which are not present in the NMNL models.

The magnitude of the coefficient is approximately [redacted] times when we compare columns 1 to 2 and 3. And almost five times when comparing columns 4 to columns 5 and 6. The difference between columns 2 and 3 is related to the use of fixed effects, although both use fixed effects for week-year and food category. In the case of column 2, fixed effects are established for each chain; while in column 3, for each store. Likewise for columns 5 and 6. In terms of coefficients, adding fixed effects for chains provides insight into how different stores perform across municipalities. This specification can estimate more reliable coefficients for demographic and economic characteristics, since they vary between municipalities. In contrast, working with store fixed effects estimates more reliable results for nutritional content, since we treat each store as a separate market, with the trade-off of diminished precision on the municipal-level variables. For the description of the main results, we use columns 3 and 6 as our preferred specifications. Both use store fixed effects. We prefer to work with unbiased estimators when it comes to product characteristics because of the quality of data in that respect, demographic and economic variables correspond to aggregate information which has limits to how exactly it reflects the customer base of the store.

7.1 Multinomial logit results

As expected from standard economic theory, an increase in price per kilo has a negative effect on the utility of purchasing meat products. The coefficient implies that the utility of consumers decreases by [redacted] (column 3) as the price per kilo increases by 1 kr, the effect corresponds to the MNL model, i.e. when consumers choose between all products. In the NMNL model, the utility of the consumer experiences on average a reduction of [redacted], when the price increases by 1 kr in a product of their category of choice. For easiness of explanation, utility units will be sometimes referred as *utils*. The instrument price coefficient provides an encouraging result, as we are able to capture the standard economic theory effect. The next paragraphs provide a description of the rest of the coefficient results. First on the MNL model and then focused on the NMNL model.

Table 7.1: Regression results



7.1.1 Nutritional content

The coefficients of our preferred MNL model (column 3) reflect the effect on utility of a consumer that chooses a meat product without selecting the animal category first. The fixed effects at the category level capture the preferences of each animal source, but do not

imply that consumers are selecting first an animal source. Nutritional content effects are analyzed through six nutrients. Fat, saturated fat, protein, carbohydrates, sugar, and salt. Fat is made of saturated fat and unsaturated fat. For easiness of comparison, we decided to calculate separately the effects of saturated fat and unsaturated fat for more intuitive coefficients. Unsaturated is significant at the 1% level, thus we are able to reject the null hypothesis that the coefficient is different from zero. In this sense, an increase in the unsaturated fat content of meat product increases utility. A 1 p.p. increase in unsaturated fat (for instance from 7% to 8%) is associated with an increase in utility of [redacted]. This is reasonable since consumers prefer fattier cuts of meats. Specially unsaturated fat, since it does not have the negative health implications of saturated fat, which, as explained in Chapter 3, are discouraged by health agencies. Saturated fat also has a positive effect on utility, but the coefficient is not statistically significant. Protein content is statistically significant. This result highlights the fit of the model, since the main source of protein for diets comes from animal sources. The coefficient indicates that a 1 p.p. increase in protein content, will increase utility by [redacted] utils. The largest effect for a relevant nutrient, since the average value of protein content is 19% in the sample.

Continuing on the nutritional content analysis, carbohydrates affect negatively the utility of consumers, an increase of 1 p.p. will decrease utility by [redacted]. The negative impact follows dietary guidelines, as consumers try to avoid products with high-carbohydrate content. Nevertheless, the magnitude of the effect should be interpreted carefully, as most of the meat products are already low-carbohydrate products. Sugar is statistically significant under the model assumptions, a 1 p.p. increase in sugar content increases utility in [redacted]. Lastly, salt is not statistically significant. The effect of salt content in utility is negative. An increase of 1 p.p. of salt will reduce utility in [redacted]. Nevertheless, as explained in the case for carbohydrates, salt and sugar nutrients are lightly featured in the majority of meat products. The results discussed so far, in terms of nutritional content, are reasonable. The most surprising is the positive effect of unsaturated fat given that it is the opposite of dietary recommendations, nevertheless, it was not statistically significant. The effect of protein is captured precisely. The size and magnitude of the coefficients follow the exploration of the data performed in Chapter 4. The choice of a consumer of a meat product will be mainly based on the protein content and saturated fat, not only are they valued higher than other nutritional characteristics, but are also

featured heavily in the content of meat products.

7.1.2 Demographic characteristics

Aggregate demographic characteristics of each municipality affect the utility that consumption of meat products generate. The regressions include three variables of demographic variables: population, gender proportion, and age groups. The coefficient estimates included in column 3 indicate a varied relationship for the demographic variables. An increase in the total number of people in the municipality decreases the utility obtained from meat products. An increase of 10,000 people is associated with an utility increase of [redacted]. This coefficient is statistically significant. Nevertheless, it is the opposite sign of our estimates in column 2, using chain fixed effects. We prefer to be careful in the interpretation from this result and suggest an increase of the sample or the use of micro-level information on the customer base of each store before we make any relevant conclusions. In both models, the significance of the coefficient is unexpected due to the findings in Chapter 5, which pointed to a weak relationship between population and quantity sold of meat. Nevertheless, the previous analysis was a snapshot in time and time is controlled better in the regressions due to the week-year fixed effects.

Following the discussion about the results of demographic characteristics, the proportion of males coefficient is statistically significant. The coefficient indicates that an increase in the proportion of males of 1 p.p. would increase the utility of meat consumption by [redacted] (column 3). This is reasonable since as explained before, males are more likely to consume higher quantities of food than females, including meat. The magnitude of the effect is large, nevertheless, none of the municipality in the sample experienced a change in the proportion of males of 1 p.p. in a four-year period. Generally, the change range is between [redacted] and [redacted]. Assuming the latter case, the effect on utility is, on average, [redacted].

Likewise, the proportion of different age groups is relevant to the consumption of meat products according to the MNL model in column 3. The magnitude of the effect varies for each age group, but stays positive in all cases. In terms of estimation, the base group is the proportion of 24 years old or less. A 1 p.p. increase in the proportion of 25 to 34 years old is associated with an increase in meat consumption of [redacted] in utility compared to the base group. A similar increase in the proportion of 35 to 44 years old increases

utility of purchasing meat products by [redacted]. An increase in the proportion of 45 to 69 years old, increases the consumption of meat by [redacted] compared to the base group. The effect for the the 70 to 79 years old group is [redacted]. And raises further with an increase in the proportion of 80 years old or more to [redacted]. These effects are consistent with the food consumption behavior detailed in Chapter 4. Older age groups are more likely to stick to their diets, while younger demographics might be more inclined to try new products. In the case of new trends, younger demographics might be more likely to be vegetarians thus reducing their overall consumption of meat.

7.1.3 Economic characteristics

Next, we explore the coefficient results for the economic variables. The variables under analysis are median income, number of property transactions, and average price of the property transfer. The results continue to represent the case for the consumer that chooses between all products, without selecting an animal category first (MNL). As expected, a higher median income is associated with a higher utility derived from meat consumption. An increase in 100,000 kr of median income in the municipality will increase the utility of meat purchasing by [redacted]. This is reasonable in terms of the sign, as meat products are not inferior goods.

On to the next estimate, an increase in the number of property transfers will increase the utility derived from the meat purchase. The expectation is that higher meat consumption will take place when the number of property transfers increases. Nevertheless, it must be noted that the coefficient for the same variable is negative in column 2. As with population measures, we must be careful to derive significant conclusions of this result. From the literature review in Chapter 4 and data exploration in Chapter 5, we expected a positive effect as a an active retail estate market is a positive sign of economic activity. An increase of 1,000 in the transfers of property is on average associated with an increase of [redacted] in utility.

Lastly, the average price of the transfer is negatively related to the utility of meat consumption. If the transfer price increases by one million, utility decreases by [redacted]. It must be noted that this result is not statistically significant. Despite of this, the sign of the estimate could indicate the effect of living in a large city where the real estate prices

are higher. Chapter 5 showed that the distribution of population, number of transfers, and average price of the transfer follow a similar pattern, driven mainly by the size of the municipality. This might indicate that controlling for the effect of population size and median income on the analysis of meat consumption, municipalities that feature more activity in the real estate market are consuming more meat. In contrast, when they are paying high prices, households are investing in property and have a tighter budget, thus spend less on meat products.

The use of these three different measures of economic activity allows us to increase the prediction of the model, but the trade-off are biased estimates due to possible multicollinearity. The three economic measures might experience similar trends since income is related to how much people are willing to pay for a property and how many properties are transferred. A high correlation between the variables would indicate that the estimates are biased. The correlation between median income and the real estate characteristics indicates a low correlation with both variables ([redacted] for property transfers and [redacted] the average price of the transaction). These results point to a low probability of multicollinearity between median income and the real estate characteristics.

This concludes the analysis of our preferred specification of an MNL model (column 3) with instrumental variables and store fixed effects. Most of the coefficient estimations are consistent with the literature review and the data exploration, except for some variables already mentioned and discussed. The next paragraphs describe the change in results assuming that consumers select first a meat category and then choose the product within that category.

7.2 Nested multinomial logit results

The NMNL model assumes a different behavior by consumers. In this case, the behavior is split in two stages. First, choosing a category and then selecting a product. The NMNL specification is used in the last three columns of Table 7.1, all of them include week-year fixed effects. Column 4 calculates the coefficient estimates, on top of week-year fixed effects it uses chain fixed effects but does not instrument for price. Column 5 uses instrumental variables for prices and the same fixed effects as before. Our preferred specification is column 6, which uses store fixed effects. As discussed before, this provides more reliable

results at the product characteristic level with the trade-off of being less precise regarding estimates, for demographic and economic data. The interpretation is similar as in the previous MNL specification. We will focus on the major differences between the models. In terms of nutritional content, almost all the variables present the same effect as before. Increases of unsaturated fat, protein, sugar, and salt increase utility of meat consumption. While there is a negative utility associated with saturated fat and carbohydrates. The estimate of unsaturated fat is smaller than previously described, thus pointing that once consumers choose a category they have already decided approximately the amount of unsaturated fat they will consume so the effect of increases are smaller. Under these new assumptions, saturated fat is negatively related to utility and statistically significant, in contrast with the previous model. Nevertheless, the estimate now follows the result of previous literature from Chapter 4 and the exploratory analysis from Chapter 5. The effect of protein on utility diminished substantially, a 1 p.p. increase now associated with a [redacted] increase in utility, rather that [redacted]. Overall, the main changes are in a reduction of the effect of unsaturated fat, protein and carbohydrates; while accounting now for a negative relationship between utility and saturated fat content.

The estimates of demographic characteristics follow the same pattern as the MNL model in column 3, but the effect is lower in almost all variables. The exception is the proportion of the age group 80 years old or older that has a similar effect as before. Again, we note that the estimates of aggregate characteristics are less precise due to the use of store fixed effects. The main differences, besides lower estimates, are related to the statistical significance of the results. The proportion of 35 to 44 years old is no longer significant at the 5% level, thus is not different from the base group of 24 years old or younger. In the case of the 70 to 79 years old group, the result is now only significant at the 1% level. As explained in the previous paragraph, the trends follow the results from the literature review on lifecycle consumption and stickiness to diets.

Finally, in terms of economic variables, the coefficient estimates of our preferred NMNL model have the same sign as the MNL model. The magnitude of the effect is lower for median income and the number of property transactions. In contrast, the coefficient of price of property transfers is now statistically significant and its effect is larger than the MNL model (column 3). In the previous explanation of the model we discussed the

economic thought of these estimates. The main explanation for the difference in the magnitude of the effect is the inclusion of the market share within each category, thus the estimates were overestimating the effect of the economic characteristics.

In summary, the main differences between our preferred MNL and NMNL models are that the NMNL model presents lower coefficient estimates, changes the statistical significance of some coefficients, and inverts the sign of one variable. The changes are driven mainly to the inclusion of the natural logarithm of market share within the category. Which means that the effect of selecting first the category is included in the regression. In terms of coefficient estimates, the variables in the NMNL model that have a lower effect than before are unsaturated fat, protein, carbohydrates, sugar, population, male proportion, distinct age groups, median income, and the number of property transactions. Saturated fat changed to statistically significant with an inverted effect. It went from positive to negative. While the price of property transfer also became statistically significant with a larger effect on utility.

In terms of which model represents better consumer behavior, the answer depends on the context of the consumer. In some instances, consumers purchase products after selecting the category first. For example, if they want to buy fish, consumers go to the fish display and choose the product that fits their preferences. According to our estimates, the choice will likely be a fish high on unsaturated fats and protein content and low on saturated fats. In this case the NMNL model reflects better the behavior of consumers. We can expect this behavior to be present during the holidays. In other instances, consumers purchase various products for the following days. In this case, we assume consumers are not thinking about a specific category, they are purchasing various meat products. Although the products should provide some variety (the minority of people eat the same protein every day), it is not necessarily that the consumer selects a category first. The decision is likely based on price and other relevant nutritional characteristics. Both models are valid. The NMNL model provides a reliable framework for holidays and purchases that do not involve other meat products. While the MNL model is a framework for the household's routine purchases.

7.3 Willingness to pay

So far, the analysis and estimation results discussed the effects in terms of utility. Chapter 6 explains how these coefficients are transformed to willingness to pay measures. The results are based on the coefficients of our preferred models from the previous section. One is the MNL model with instrumented price and week-year, category, and store fixed effects. The other is the NMNL model with instrumented price, week-year and store fixed effects. The store fixed effects in both models offer reliability for the estimates of the nutritional variables, with the trade-off of less precision on the estimates of the demographic and economic variables. As explained in Chapter 6, we use the price coefficient of the regressions to bring *utility* measures into monetary values. The results offer insight into the applicability of the analysis and methodology, and at the same time answer our research question about the effect of nutritional content and socioeconomic characteristics on the demand of meat in Norway.

Willingness to pay measures depend on the coefficient of price and the coefficient for each variable. Table 7.2 presents the obtained values using Equation 6.10. The column 'Change' indicates the change in the variable for the calculated effect. The previous explanation of the regression results discussed how the NMNL model had coefficients with a lower value than the MNL model in terms of utility. This is no longer true for all willingness to pay measures. Due to the inverse relationship between the price coefficient and willingness to pay calculation, the willingness to pay results can be higher in the NMNL model.

7.3.1 Nutritional content

In terms of results, the MNL model indicates that an increase of 1 p.p. of unsaturated fat content increases by [redacted] kr the price per kilo consumers are willing to pay. The effect increases in our second specification to [redacted] kr. The magnitude of the effect is relevant given that unsaturated fat has an average value across the sample of approximately 8%. The difference between both models might indicate that once the consumer selects a meat category, he/she is willing to pay more unsaturated for a product within that category.

A 1 p.p. increase of saturated fat content decreases the willingness to pay by [redacted] kr per kilo under the NMNL model assumptions. The effect of the MNL was not statistically

Table 7.2: Willingness to pay per kilo

significant in the regression model. This result highlights the effect of dietary and health recommendations, which aim to reduce the appeal of unhealthy nutrients in large quantities.

As we saw previously, protein content is highly relevant to consumers with one of the highest coefficients in terms of utility. The willingness to pay measures follow this result. Consumers are willing to spend from [redacted] kr more per kilo for an increase of 1 p.p. of protein content in the product. The effect is lower in the NMNL model. The effect of carbohydrate, sugar, and salt content is lower in terms of kr per kilo than the previous nutrients. The economical relevance of the results is lower than it seems since the average value of these nutrients in meat products is lower than 2% with reduced variance.

7.3.2 Demographic characteristics

In terms of demographic and economic characteristics, the results can be interpreted as willingness to pay increases (decreases) due to the characteristics of the municipality. The estimated coefficients are less precise given the choice of store fixed effects, nevertheless, they still provide valuable information. An increase in population decreases the willingness

to pay for meat products in both models. This could be related to the diversity of people and trends in bigger cities which could set the path for distinct diets, for example, veganism or vegetarianism. An increase in the proportion of males increases the willingness to pay for meat. The estimate seems large, but the variable is associated with small changes. Over the sample period, from [redacted] to [redacted], most municipalities experienced a change of -0.5 to 0.5. Although highly unlikely, the results point in the right direction since a highly male concentrated area would be willing to pay more for meat products given their higher consumption needs compared to females. The effect of proportion of age groups indicate an increase in the willingness to pay compared to the under 24 years old or under group. This is reasonable since the group is made up of children that require a lower calorie intake.

7.3.3 Economic characteristics

Continuing with economic characteristics. An increase in median income is associated with an increase in the willingness to pay. The results indicate that an increase of 10,000 kr of the median income at the municipal-level results in an increase in the willingness to pay of [redacted] kr per kilo. This follows standard economic theory. Although the effect might seem small, municipalities might experience bigger changes. For instance, a municipality with a median income of 700,000 kr might experience an increase of 50,000 kr per year, resulting in an average increase in the willingness to pay of [redacted] kr per kilo. The number of property transfer has an impact of [redacted] kr per kilo when the value increases by 1,000. A dynamic real-estate market appears to generate more appetite for consumption. Nevertheless, when it is associated with higher transfer prices, the result is neutralized, even resulting in a decrease of a willingness to pay for meat products. This variable is not statistically significant in the MNL model.

In summary, the results of the regression and the willingness to pay calculations show reasonable estimates. The effect of each variable on utility and on the price per kilo follows economic reasoning, previous literature, and the data exploration. The models are sensitive to our assumptions of how consumers select products and fixed effects, in terms of chains, stores or categories. Our preferred specifications for the MNL model include year-week, store, and category fixed effects. While for the NMNL model includes year-week and store fixed effects. We selected store over chain fixed effects to better

control for differences between each store. This decision allows for more reliable estimates for price and nutritional characteristics, although the estimates for demographic and economic characteristics suffer from less precision. The use of instrumental variables for price is also critical to arrive at unbiased estimates. Overall, the magnitude of the effects in monetary values are reasonable and present interesting insights for applicability of the results. The next chapter concludes the analysis and discusses what should be taking into account to improve the precision of the results and how it can be expanded.

8 Conclusion

This study provides an empirical framework to estimate the effects of nutritional characteristics and socioeconomic factors on the demand of meat and fish in Norway. We provide a relevant and modern analysis to measure how fat, saturated fat, carbohydrates, protein, salt, sugar, demographics, income, and other economic variables affect the purchases of meat in NorgesGruppen stores. This is relevant due to the highly differentiated food retail market and its regulatory context, while carrying significant insight towards day-to-day operations. Although the results are applicable, limitations still exist regarding the overall predictability due to necessary assumptions that were made.

This study presented the evolution of the grocery store concept and market in Norway. NorgesGruppen was introduced as the best source of information for this study as it holds positions in the production, distribution and sale of food products at a national level. The company operates various grocery store chains directed at different segments of the population. NorgesGruppen provided us with the detailed store level data required to carry out this research. Unique qualities of the Norwegian food market and its respective laws are explained to provide readers with the appropriate foundation of knowledge for this study.

Next, we thoroughly examined existing research on food related decision-making patterns of customers. We start from a normative standpoint, focusing on the recommendations and regulations that Norwegians encounter from their government and public agencies. The recommendations are mainly directed at encouraging a healthier lifestyle, while the regulations focus on establishing tariffs and ingredients for food products. Besides external factors that might affect decision-making, we look at studies on the internal motivations that come into play while shopping for groceries. We identify key aspects for people's purchasing behavior, including nutritional quality of the products, cultural differences, absolute and relative price, socioeconomic background, among other characteristics.

The empirical framework introduced and summarized all the different elements used for the analysis. We identified the characteristics that could be incorporated in our empirical analysis, in line with our research question. Then, we presented the evolution of sales using different metrics. We noticed that purchasing patterns differ substantially for each chain

of NorgesGruppen, which is expected since the marketing, product selection, and layout of each concept chain is different and focused on specific population segments. We explored the relationship between sales and the factors under analysis. In our case, nutritional content, and socioeconomic factors. Afterwards, we described the methodology and the assumptions for our regression models. Finally, we estimated the effect of our variables of interest on the demand of meat and transformed these estimates into willingness-to-pay measures. The statistical significance and magnitude of the effect can vary substantially depending on our assumptions of consumers purchasing meat products.

The relevance of this study is that instead of relying on surveys or experiments, we tested the effects of price and product characteristics on the quantity of products that people consume. On one hand, results can be used in a regulatory context, as well as impact day-to-day operations. In terms of regulation, government officials need information on demand elasticity to make more informed decisions on policy changes. The results estimate how much to increase or decrease taxes for a desired outcome. On the other hand, if we consider the impact on day-to-day operations for a food retailer, managers could use the framework from this study to estimate the change in demand as economic conditions evolve. For example, food retailers can adjust the quantities within their product offerings to better match consumer demand in recessionary and growth periods. These decisions could ultimately improve their profitability. Under the same logic, the estimates can provide a proxy of demand of a newly introduced product.

8.1 Limitations and further research

In terms of limitations, the regression models estimated are subject to the assumptions made. Assumptions on how consumers choose meat products or what should be considered the outside goods. The answer to our research question can vary if we assume that Norwegians choose meat products in steps, depending on the animal source, or without steps, considering all products at the same time. We expect that further research can continue exploiting the vastness of the data. For instance, a more detailed look at product characteristics can provide more insights into how consumers shop and, in this case, how demand for meat products is shaped. The characteristics might include packaging, brand, country of origin, location in the store, location in the display, closeness to other related

products, among others. Another limitation of the study is the general applicability of the results to the rest of the world. We assume that the results are representative of the Norwegian grocery market, but, compared to other countries in the world, it might not be the case. For instance, the entry barriers applied to certain products in the Norwegian market limit the choices of its consumers. A more open market might present different results due to the vast product depth of foreign grocery markets.

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Table A1.1: First stage regression - IV

Appendix

A1 Figures

Figure A1.1: Average kilograms sold and price per kilo by category

Figure A1.2: Average kilograms sold and price per kilo by category, logs

Figure A1.3: Average kilograms sold and carbohydrate content

Figure A1.4: Average kilograms sold and salt content

Figure A1.5: Average kilograms sold and sugar content

Figure A1.6: Average kilograms sold and number of transactions

Figure A1.7: Average kilograms sold and avg. transfer price