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The Italian Gluten Free Market

An in-depth analysis

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The gluten-free market in Italy has experienced significant growth in the recent years, driven both by the increasing number of Celiac Disease diagnoses, by the enhanced consumer awareness and by a structured public assistance system for individuals diagnosed with this disease. The public assistance system consists of fixed-value monthly vouchers that the celiac patient can spend to purchase only gluten-free foods, which allow them to neutralize the price premium of gluten-free foods with respect to traditional food. This framework could play a key role in the equilibrium of this "niche" market that, despite the slow but steady growth, showcases serious barriers to the costs abatement that certainly characterizes the mass market of traditional food. This thesis explores the mechanisms and economic factors of this system, primarily focusing on the effect of prices. Furthermore, it will investigate the implications of other economic and non-economic variables that influence the overall demand. To achieve this objective and to gain a deeper understanding of the mechanisms underpinning the gluten-free market, an econometric analysis has been conducted. The Associazione Italiana Celiachia (AIC) provided access to valuable economic data and insights, which form the foundation of this analysis. These data are owned by Nielsen IQ, a global marketing research firm. Furthermore, a comprehensive approach has been adopted, integrating non-economic factors to offer a more holistic perspective on the dynamics of the market. Additional inquiries have been carried out in collaboration with the AIC and will be further incorporated into this dissertation.

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Introduction

This thesis examines the gluten-free market in Italy and its underlying dynamics. The motivation for this research is rooted in personal experience, as I was diagnosed with celiac disease at the age of five. I've sticked to a gluten-free diet ever since and, consequently, I bore witness firsthand to the evolution and growth of this niche market, which is nevertheless growing and reaching a broader audience. Therefore, my intent is to deeply dive into all aspects that characterise this odd market, whether they categorise as economic, legislative and social impacts. The objective of this research is to contribute to greater awareness and to highlight the relevance of this topic within academic and social discourse. Hence, the result I strive to achieve is to provide an analysis of this market that is, as for now, not present in the literature. Most of the studies conducted on this topic have been requested, supported and funded by the Associazione Italiana Celiachia (abbreviated as AIC). AIC is an Italian organization who is proactively engaged into improving the life of people affected by celiac disease. Most of these pieces of research focus on health-related issues, as no definitive therapies are currently available, and the scientific community is striving to develop effective treatments. From an economics standpoint, on the other hand, AIC is constantly monitoring the pricing trends of gluten-free products in the Italian market. In fact, gluten-free products have always been higher than their traditional "gluten-containing" counterparts. Once only available in pharmacies and specialized stores, they are now commonly found in the superstores of various large-scale retail (GDO) chains. Yet, prices have not significantly decreased, contrary to what might be expected from higher sales volumes. Lower prices can be observed only within the GDO distribution channel, which is able to exploit limited economies of scale. These prices are, however, much higher than the traditional foods' prices, and can be challenging to the gluten-free diet adherence.

To alleviate the financial burden associated with the higher costs of these foods, the Italian government provides every month a financial aid to those diagnosed with the condition. This aid is in the form of a fixed amount of money that the celiac patient receives at the beginning of each month, that can be spent only for dispensable gluten-free food products. It resets at the end of the month; therefore, it is not cumulative. The introduction of the voucher dates to 1982. The voucher is available in two formats: digital and paper based. The digital version of the voucher

entails that the sum of money is fully charged on the patient's health insurance card; the paper version instead was the initial form of the voucher and is now present in only a few Italian regions. The digitalized voucher allows for more flexibility while purchasing gluten-free products, since it emulates a normal card payment. On the contrary, the paper-based voucher limits flexibility because it allows for purchases of fixed sub-amounts of the total value (or of the value in toto).

Whether the format of the voucher influences the quantity of gluten-free products sold will be a topic of the analysis. Anyhow, it will be necessary to investigate the other variables that possibly impact this market's overall scale, such as the different distribution channels through which gluten-free foods are made available to the end consumer, and the influence of the brand on the perceived quality and consequently the consumer choice among different gluten-free brands. The geographical area will also be considered, to further break down purchasing patterns throughout the Italian territory. This broad assessment will take place via a linear regression model that will gradually incorporate these variables. The model will be applied to five major food categories: Pasta, Bread, Bread Substitutes, Flours, and Biscuits. The same framework will be employed for a similar regression model utilizing a log-log transformation, to inspect it in the form of elasticities.

Prices confirmed their anticipated strong impact on the demand. The brand variable turned out to be relevant for the Bread category, highlighting a pronounced and well spread preference of the average consumer of gluten-free foods.

Concerning the voucher system, it could be of interest, for future research, to analyse this phenomenon from another standpoint. In fact, the voucher may influence the overall sales and market equilibrium. A broader analysis could be carried out by comparing the Italian gluten-free market (where the voucher mechanism exists) with that of another European country that does not provide such an important economic support. As a matter of fact, the Italian voucher system is one of a kind in Europe.

Chapter 1

What is Celiac Disease and how it impacts the population

Celiac Disease is a chronic autoimmune disease that occurs in genetically predisposed individuals. In fact, people with a first-degree relative with celiac disease (parent, child, sibling) have a 1 in 10 risk of developing celiac disease. It is estimated to affect 1 in 100 people worldwide (1%), but only about 30% are properly diagnosed (Celiac Disease Foundation, n.d.). Gluten is defined as the protein fraction of wheat, rye, barley, Kamut, spelt, and triticale.

Almost 100% of patients with celiac disease possess specific variants of the HLA class II genes *HLA-DQA1* and *HLA-DQB1* that together encode the two chains of the coeliac-associated proteins DQ2 and DQ8, which are expressed on the surface of antigen-presenting cells. The presence of DQ2 and/or DQ8 is a necessary, but not sufficient, condition for the development of the disease. Indeed, prerequisite HLA genes are common in the population, but this does not entail the development of the disease; in fact, celiac disease occurs only in approximately 1% of the population, suggesting that other environmental factors besides the ingestion of gluten are probably important (Lebwohl et al., 2017).

A combination of celiac disease serology testing and duodenal biopsy sampling is required for the diagnosis of celiac disease in adults, as defined in the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) guidelines for the diagnosis of celiac disease. The biopsy consists in a gastroscopy. This is necessary because negative serological findings do not exclude celiac disease with 100% accuracy due to the possibility of seronegative celiac disease (Lebwohl et al., 2017). Concerning children, the ESPGHAN proposed the possibility of avoiding intestinal biopsy in children, but only in those who meet certain criteria in their blood tests and genetic results (Husby et al., 2012). Celiac disease can develop at any age after people start consuming gluten, even in the geriatric population. Cases in which celiac disease is not diagnosed during childhood do not necessarily entail a longstanding celiac disease; it is most likely a *de novo* loss of gluten tolerance. Anyway, most celiacs have developed the disease before the age of 10 (Lebwohl & Rubio-Tapia, 2021).

The ingestion of gluten triggers an autoimmune reaction in the small intestine, as specific antibodies identify gluten as a menace. The reaction occurs in a series of steps, which ultimately damage the villi and prevent nutrients from being absorbed. Improvement and resolution of symptoms typically occurs within weeks and often precedes normalization of serological markers and of duodenal villous atrophy. There is no therapy for this disease, hence the only existing option is a lifelong gluten free diet. The same goes for people with a condition called Dermatitis Herpetiformis, which is a gluten-dependent inflammatory disorder at the skin level, that causes clusters of intensely itchy, red blisters and hive-like swelling. In people with dermatitis herpetiformis, gluten activates the immune system, which attacks areas of the skin and causes the rash and itching. Individuals who develop dermatitis herpetiformis often have celiac disease but may not have the symptoms caused by this disease (Peraza, 2024). The clinical remission can be only achieved through the removal of gluten from the diet, as for celiac patients. Patients suffering from this condition benefit from the same healthcare assistance that is provided to celiacs, meaning they have access to monthly vouchers. There are other gluten-related conditions, such as wheat allergy and non-celiac gluten sensitivity. As for now, people who suffer from (one of) these two disorders cannot benefit from the monthly voucher.

If celiac disease is left untreated serious issues can arise, such as type 1 diabetes, osteoporosis, heart diseases, intestinal cancers, and many others. However, they are quite rare; they concern approximately 5% of patients and predominantly adulthood-diagnosed patients (Ministero della Salute, 2024). The risk of developing one of these conditions increases if there is an insufficient compliance to the gluten-free diet and if the diagnosis gets delayed. The path leading to the diagnosis can indeed be prolonged, as the disease has many clinical manifestations, making it more difficult to spot. Classic symptoms include loss of appetite, chronic diarrhea, weight loss, and failure to thrive, which are mainly predominant in pediatric age. These are called “classic” symptoms as they once were the most predominant symptoms. The most common symptoms in the adult population are the “non-classical” symptoms, which include iron deficiency, bloating, constipation, chronic fatigue, headache, abdominal pain, and osteoporosis. In many other cases the disease can be asymptomatic (Lebwohl & Rubio-Tapia, 2021). This form of celiac disease is called silent, and it is largely spread. In Italy there are almost 252000 diagnosed celiacs (data updated in 2022). This disease is more common in women rather than in men, as a matter of fact in Italy the men-CD to women-CD ratio is 1:2 (Ministero della Salute, 2024).

The Italian normative background

The regulatory framework of the celiac disease saw the light of day on the 1st of July 1982, when the Decree of the Health Minister stated that gluten-free products had to be inserted in the list of the foods provided and paid by the National Health Service (NHS). These foods became part of the already existent definition of "dietetic foods", that was initially provided by the Law 327/1951. This law defined for the first time the concept of a food that requires a specific working process or that must fulfil certain nutritional requirements for particular groups of people, that need specific foods to be healthy.

The 27 January 1992 legislation no.111 enforced the 89/398/CEE European guidelines concerning the definition of "foodstuffs intended for peculiar eating necessities", their labelling, production and the surveillance of standards compliance. As stated by the legislation these are foods that "meet the nutritional requirements of:

- People whose assimilation process or metabolism is disturbed
- People who, in peculiar physiological conditions, can benefit from the controlled consumption of some substances in foods
- Newborns and infants in good health."

This category of foodstuffs that is made specifically for "peculiar eating necessities" has already been circulating since 1977, as stated in the European directive 77/94/CEE. This was the first attempt by the European Council to bring together the legislation of all European countries concerning this food category. The '89 directive and following legislation tried to better define these notions (and this will be happening again in 2009) but the initial aim was never fully reached. Because of the conditions to satisfy the "peculiar eating necessities" foods that were generic and fuzzy and could apply to other kinds of packaged foods, it all resulted in some confusion and misuse of the labelling among EU nations. Better regulations that could homogenize and standardize these categories of foodstuffs and stop their misuse would have to wait until 2013. Before jumping forward to this date, it is important to mention other landmarks of the gluten-free-normative overview, such as the one in 1985, when the Decree of the President of the Republic set off the exoneration of celiacs from the compulsory military service, that existed in Italy until the end of 2004.

Another important step is found in the Ministerial Decree of the 8th of June 2001, that abrogated the decree of the 1st of July 1982 and defined the maximum amount of money (spending ceiling) that the NHS could provide to each celiac patient, based on sex and age. These values considered the daily recommended energy and nutrient intake levels (LARN), calculated by the Italian Society of Human Nutrition (SINU), and the prices of gluten-free foods at that time. This economic aid was provided in the form of monthly vouchers; the products that could be bought with these vouchers could only be found in affiliated pharmacies or at local healthcare centers. Concurrently, the National Register was established (NR); it contains the list of all the gluten-free products that could be purchased at the expense of the NHS. In 2006 the spending ceilings, expressed in lira (£) have been updated to the new currency, the euro. An adult man could spend 140 euros per month, while an adult woman could spend 99 euros per month. It is worth noticing that in 2006 the price per kilogram of bread was 10,33 € and 7,75 € per kilogram of flour, as stated on the 4th of May 2006 Ministerial Decree.

In 2005 (Law 123/2005) the celiac disease was defined for the first time as a "social disease", meaning that it not only affected a person's health but also his or her social life, since it makes taking part and enjoying gatherings more difficult and stressful. This law was intended to protect celiac patients, as it reinforced the importance of early diagnosis, of spreading the education and awareness of the disease, making it easier for a patient to reach the diagnosis in cases of uncertainty, at least in theory. This law introduced a new subsidy, whose objective is to provide training courses to HoReCa personnel and to provide a gluten-free meal in all workplace and school canteens. This subsidy covers a maximum expense of 3.760.000 € per year.

The proper composition and labelling of gluten free products were finally disciplined in 2009, thanks to the EU Regulations 41/2009, that entered into force on the 1st of January 2012. They listed the gluten-containing grains and regulated the threshold of gluten content in products specifically made for celiacs, that is 20mg/kg, in order to label it as "gluten-free". The maximum amount of gluten that a celiac person can tolerate each day is 10mg, with the 20ppm value the possibility of reaching and/or exceeding that 10mg limit is made very difficult (AIC, 2017). This regulation introduced another product category, labelled as "with a very low gluten content", and consists of foods whose gluten content is lower than 100ppm, meaning 100mg/kg. Such kind of products are very unlikely to be found anywhere in Italy, as for now. In any case their consumption should be made cautiously and in much smaller quantities. Moreover, this regulation allowed other normal consumption foods (for example those which are not made from flours) to display the "gluten-free" label if the gluten content is again lower than 20mg/kg.

Anyway, in this very same year, the definition of "foodstuffs intended for peculiar eating necessities" was still effective. A new (and last) attempt was made to clarify this concept, with the European Parliament and Council's Directive 2009/39/CE that abrogated the previously cited '89 Directive.

In 2013 the definition of "foodstuffs for peculiar eating necessities" was finally abandoned. The EU Regulation no.609/2013 abrogated the former 2009/39/CE directive, since it failed to be an efficient solution for internal market regulation. As mentioned before, this classification could be misleading and interfered with food circulation in the EU, as different nations interpreted it in different ways, for example using it to label supplements for sports people. This new regulation confirmed and reinforced the definitions and rules found in the 41/2009 one. Furthermore, it analyzed much more in depth all the dietetic foodstuffs categories and gave a much clearer overall picture, also in terms of their composition, their ingredients and other allowed additions, such as vitamins, mineral salts etc.

The last step of this long normative path took place with the Decree of the 10th of August 2018, when the maximum spending limits of the voucher granted to celiacs have been updated; to be precise they have been reduced. Considering the age range provided in the example before, the spending limits have now become 110 and 90 euros per month, respectively. Their economic value is still based on the daily recommended energy and nutrient intake levels (LARN 2014) and on the prices of gluten-free foods. But it is important to notice that this economic estimate relies only on pharmacy prices (as stated on the Decree), since pharmacies made up the prevailing distribution channel at that time, but this is also due to a worst-case scenario thinking, since the prices found in pharmacies are higher than those that can be found in large-scale distribution. This entails a slight overestimate of the maximum spending cap.

Entailments of a Gluten Free Diet (and life)

From a more pragmatic perspective, the path that a person needs to follow to reach the diagnosis of celiac disease is, in some way, as troubled as the legislative procedure of the celiac disease in the past 40 years. As a matter of fact, on average, the diagnostic process takes up to 6 years ("Il rapporto di Cittadinanzattiva", 2023). Since symptoms can vary a lot from one individual to another, this process is usually scattered by imprecise or totally wrong diagnoses that cause a relevant time dilation. From a personal standpoint, this process spanned a period of two years.

From the diagnosis onwards, the only thing that the celiac person can do is following a gluten free diet (that can be abbreviated as GFD for the sake of conciseness) to feel good again. Anyhow, the post-diagnosis wellbeing level cannot reach the pre-diagnosis one. Reasonably, a "wellbeing loss" can be defined and split into three macro categories, to analyze the three (and probably not thorough) burdens that come with this disease, whereof the third one is to be considered of greater interest for this study.

a. The social burden

The first aspect concerns the social sphere of the individual. As previously mentioned, celiac disease is a social disease; as such it comes with some issues that can undermine the individual perception and feelings about social events and gatherings. Not knowing whether a gluten free meal is available at any given circumstance generates a feeling of uncertainty and can sometimes discourage the person from going out or taking part in events. Anyway, eating out is not a big issue in Italy, compared to other countries. The restaurants that are informed and know how to behave with customers with celiac disease are numerous, thanks also to a network called AFC ("Alimentazione Fuori Casa", which can be translated to Out-of-home Food Program). This program was made possible by AIC, the Italian Association of Celiac Disease. The network consists of restaurants, hotels, bars, fast-food chains, pizzerias and many other types of catering establishments, that voluntarily decide to join this network. AIC provides them with educational courses about the disease and on how to avoid contamination in the kitchen, practical training of the working staff etc. The Association checks the compliance of all the establishments that belong to the network, carrying out an in-depth inspection of the businesses at least once a year.

A survey called "Ristorazione e Celiachia" (AIC, 2023), translated as "Food service and celiac disease", discovered that there still are many misconceptions about entering the network, due to false beliefs about economic and space limitation matters. Economically speaking, there is an initial investment that the business needs to undertake, which can vary from Region to Region. Anyway, an economic return of this expense will be gained via the increased visibility on the market, since the establishment will be present on the mobile app of the AIC, that almost every celiac patient has. Being able of safely welcoming celiacs (and its acquaintances as a result) will expand the consumer base and increase the revenues. Indeed, in 69% of AFC-member establishments, the frequency of gluten-free dishes requests occurs daily or almost daily, while it is much less frequent in non-member establishments. About half of the non-AFC establishments in the sample have no celiac clientele at all. In conclusion, a higher return in terms of reputation can accrue from joining the AFC network, that can be considered as a source of differentiation in the market.

Many studies analyzed the psychological effects of the diagnosis on children and their families. They all found out that parents "might avoid such circumstances to reduce the risk of their child consuming gluten" (Bacigalupe et al., 2015). Moreover, "alienation, shame, fear of eating something that contains gluten, and a feeling of being a nuisance are some of the factors related to celiac disease" that children start to develop at a very young age (Byström et al., 2012). In the same study they found out that the Health-Related Quality of Life (HRQoL) of celiac children depends on the age of the diagnosis; "age at diagnosis was negatively correlated with the HRQoL score. The children who received the diagnosis before the age of five scored higher than those who were five years old or more. [..] The young children have probably not been accustomed to the taste of gluten-containing food, which may result in a better compliance to the gluten-free diet". Anyway, this study has been conducted in Sweden, so the overall results computed with this method may not be perfectly transferable on Italian celiac children, due to differences in culture and habits; nonetheless the same study could be conducted in Italy too.

Moving on to celiac teenagers and adults, a US study (Wolf et al., 2018) found out that their overall quality of life is quite good. This study brought the attention to the fact that, despite being a strict gluten-free diet adherence symptom of a good quality of life for a celiac patient, the hypervigilance that this strict diet can bring along can lead to a decrease in the perceived quality of life, especially in terms of eating out, constantly checking beforehand whether there are gluten free reliable restaurants, having limited choices etc.

Adults face this issue in more ways: not only in social and leisure times but also at work. Workplace canteens are not always prepared to provide a gluten-free meal, and the issue can also arise, for example, in case of frequent business trips. It is important to notice that, as for now, celiacs cannot join the Armed Forces, meaning the Army, the Navy, the Air Force and the Carabinieri corps, but also the Italian Police and Finance Police (*Draft Law S.894*). On the other side there are no prohibitions for the celiac population to join the Penitentiary Police, the commercial Air Force and the Firefighters (AIC, n.d. *Forze Armate*).

b. The health burden

The second aspect to be considered is the physiological and health spheres, that can be analyzed by providing an overview of the nutritional aspects of a GFD, its benefits and drawbacks. This analysis is very important since the number of people that start following a GFD constantly increases, due to more awareness of the disease and consequently more diagnoses, but also due to the increase in gluten-related syndromes like Non-Celiac Gluten Sensitivity (NCGS) and other gluten allergies, wheat intolerances etc. A recent Italian study (Fiori et al., 2022) focused on the nutrient intake differences of a GFD and a Gluten-Containing one (GCD), considering a weekly timeframe Italian reference menu, and discovered that the nutrient composition of the gluten-free menu is very similar to the gluten-containing one. This is true for both micro- and macro-nutrients. Little differences were found in micronutrients like vitamin E and zinc. Overall, the nutritional quality of gluten-free foods has improved a lot in recent years, thanks to major advancements in research in this field. Indeed, it highlighted that all food categories, like biscuits and sweets, bread and pasta, showed improvements in fiber, protein, calcium and other micronutrients content, with respect to the data that was already available in the literature. A big drawback was found in the salt content in all bread items, that is significantly higher than the World Health Organization benchmark. In addition, fats quantities tend to be a little higher with respect to gluten-containing foods, this is why gluten-free sweets, instant meals and snacks consumption should be controlled and limited, more than it is already recommended for gluten-containing foods. All things considered, a GFD does not cause micro or macro-nutrient deficiencies anymore, since the quality of this food has significantly improved in the last decade. The physiological wellbeing of celiacs is now as good as non-celiac and healthy people, with all necessary precautions. Indeed, zinc and iron intakes need to be addressed, since their deficiency in celiacs is still very common, even if following a healthy and balanced diet.

For the time being, gluten-free foods are perceived as healthier (due to the "free-from" current, which promotes foods that do not contain certain ingredients that are considered unhealthy, without proper scientific background that confirms their unhealthiness) and are bought and consumed by non-celiacs, spreading the idea that GFD is a dietary choice, for instance to lose weight, lessening the importance of these foods as a lifelong treatment for the celiac disease (Prada et al., 2019). This trend also increases the demand for gluten-free foods.

c. The economic burden

This leads up to the last aspect to be considered, meaning the economic sphere. Gluten-free foods' prices have always been much higher than their gluten-containing versions. Because of this, celiacs may not strictly follow the GFD, depending on their wealth status. In Italy this issue was addressed with monthly vouchers, whose value depends on the sex of the celiac patient and on the age range he/she falls into, but it does not depend on income. Therefore, for every category, the amount of money received every month is fixed. Table 1 shows how the voucher value changes depending on the age and sex of the person.

MONTHLY SPENDING CAPS FOR THE PURCHASE OF FOOD THAT CAN BE SOLD TO CELIACS FROM THE NHS

Males	Females	Age groups
€56		6 months – 5 years
€70		6 – 9 years
€100	€90	10 – 13 years
€124	€99	14 – 17 years old
€110	€90	18 – 59 years old
€89	€75	>= 60 years old

Table 1: monthly spending caps of celiac disease vouchers (Source: celiachia.it)

The vouchers do not intend to fully cover a person's monthly food expense, their aim is to provide for the price mark-up of gluten-free foods, in order for celiacs to have access to the same daily amount of carbohydrates sources as a non-celiac person. These carbohydrates sources were evaluated as 35% of the total daily macronutrients' intake, as shown in Figure 1. Another 20% of carbohydrates (to make up the 55% of the total share of daily macronutrients ascribed to carbohydrates) can be assimilated through naturally gluten-free foods such as tubers and vegetables, and they are not covered by the voucher (AIC, n.d. *Assistenza alla dieta*). The vouchers can therefore be spent to buy only certain types of food, meaning pasta, bread and its counterparts (such as focaccia, breadcrumbs etc.), certain flours and flour mixes, snacks, biscuits and other sweets.

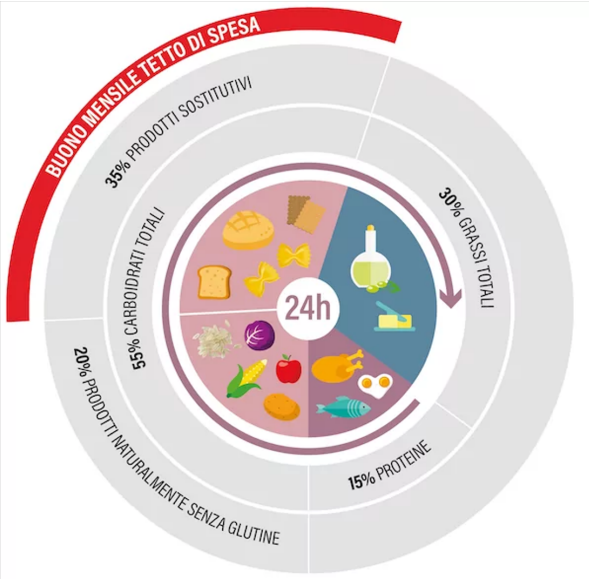

Figure 1: daily macronutrients' intake (Source: celiachia.it)

In Italy there is an association called AIC, the Italian Association of Celiac Disease ("Associazione Italiana Celiachia"), that has already been mentioned in this study, that has had a big and positive impact on celiacs' lives since 1979. I asked for, and obtained, its collaboration and cooperation on this paper. Together with the Association I had the possibility to garner information and data

about the gluten-free market in Italy of current and past years. All the data have been provided to AIC by NielsenIQ, a global marketing research firm.

With these data I firstly analyzed the price situation in the two most important gluten-free foods distribution channels: GDO and pharmacies. In fact, together with AIC, I had the possibility to work on a prices report, considering a snapshot of the Italian context in the years 2016 to 2024. 2016 has been chosen as the baseline year for this comparison because the state-provided spending caps had been calculated taking into consideration 2016 gluten-free foods prices. The food categories that we considered are Bread, Pasta and Flour, as these are the staple substitute foods that were considered when sizing the monthly spending caps.

Firstly, we made a simple comparison among gluten-free prices in this timeframe, considering the two most important distribution channels. (For brevity's sake Gluten-Free will, from now on, be abbreviated as GF and Gluten-Containing as GC).

In 2016 the average price of GF bread was 13,88€/kg in pharmacies and 10,68€/kg in the GDO, the average price of GF pasta was 6,32€/kg in pharmacies and 5,04€/kg in the GDO, the average price of flour was 6,51€/kg in pharmacies and 3,80€/kg in the GDO.

In 2024 the average price of GF bread was 15,73€/kg in pharmacies (+13,33% with respect to 2016) and 11,90€/kg in the GDO (+11,42%), the average price of GF pasta was 8,35€/kg in pharmacies (+32,12%)and 6,20€/kg in the GDO (+23%), the average price of flour was 7,61€/kg in pharmacies (+16,9%) and 4,80€/kg in the GDO (+26,32%).

It is important to highlight that the monthly voucher value has not changed since its 2018 revision. This, with the constant increase in prices, results in a loss of purchasing power of the celiac.

The second result that clearly emerges from this simple comparison is that the price difference between the two most important distribution channels is quite high. This is due to the different scale of operations of the two actors, hence the economies of scale that characterize the GDO channel, that pharmacies cannot exploit by any means. In addition, the private label phenomenon plays an important role in costs abatement. This phenomenon, largely present in all GDO chains, allows the end consumer to access a bigger number of products of various brands while saving money. Private labels in the GDO sector are chain-owned labels which sell products produced by third party firms. They can anonymously produce for the chain brand or be publicly mentioned on the product's label (Wikipedia contributors, 2024). On the other hand,

prices found in pharmacies are arbitrarily decided by the person responsible of each storefront, up to a limit maximum price. This threshold is found in a database called Farmadati (https://www.farmadati.it); pharmacies can only price products up to the indicated price.

Figure 2 makes it easier to visualize the wide price gap that the celiac consumer faces while purchasing GF foods.

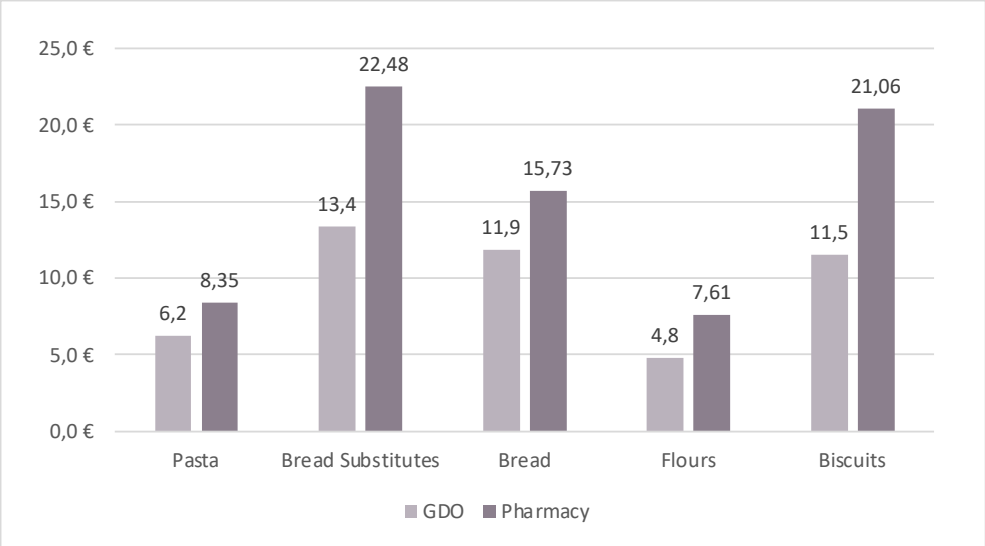

Figure 2: *Author's elaboration;* prices (€/kg) comparison between GDO and Pharmacy distribution channels (year 2024)

Another comparison was carried out to contextualize GF prices in the overall current food price scenario, with the GC counterparts of the considered staple foods. The data used refers to the month of June for both years considered, for both GF and GC products. The average prices of GC products for 2024 were obtained from the National Price Observatory of the Ministry of Economic Development (https://osservaprezzi.mise.gov.it/), with which the average prices for June 2024 were calculated for each of the three product types considered, using data from all available Italian provinces in the database. All prices are expressed in euros per kilogram.

It is important to clarify that, regarding GF products, the bread considered is packaged bread, that can come as pre-sliced. For what concerns GC products instead, the bread considered is fresh wheat bread; the considered pasta is classic semolina pasta; the considered flour is wheat flour.

The choice to compare fresh GC bread to packaged GF bread is not arbitrary. Fresh GF bread is still rare, only available in specialized bakeries, unlike fresh GC bread. We chose to make the comparison based on consumption patterns (and not on the food type), as fresh bread represents the daily choice for a non-celiac, just as packaged bread represents the daily choice for a celiac. Pasta and flour do not present significant differences in this regard, as the availability of these products is the same for both diet types.

	Bread price (pharma)	*Bread price (GDO)*	*Pasta price (pharma)*	*Pasta price (GDO)*	*Flour price (pharma)*	*Flour price (GDO)*
GF 2016*	€ 13,88	€ 10,68	€ 6,32	€ 5,04	€ 6,51	€ 3,80
GC 2016*	-	€ 2,82	-	€ 1,91	-	€ 0,73
GF vs GC (%)	-	+278%	-	+164%	-	+420%
GF 2024*	€ 15,73	€ 11,90	€ 8,35	€ 6,20	€ 7,61	€ 4,80
*GC** 2024*	-	€ 4,04	-	€ 1,90	-	€ 0,98
GF vs GC (%)	-	+194,5%	-	+226%	-	+390%

Table 2: *Author's elaboration;* comparison between GF and GC staple foods prices

As Table 2 shows, GF prices per kg are much higher than GC prices. The average GF food product in 2016 was of circa 287% more expensive than its GC counterpart, and in 2024 it was of circa 270%. This means that the mark-up on GF products may have fluctuated in the past 8 years but in general it did not move away from its starting point.

In other terms: GF flour's price was, in 2024, 4.9 times higher than GC flour's, bread's price is 2.9 times higher, and pasta's price is 3.3 times higher.

This analysis confirmed the overall existing knowledge on the price phenomenon around the GF foods world. To dive deeper into this phenomenon and its causes it is necessary to address the

GF foods production processes and what they entail for producers. The main cost-impacting phases are:

1. Raw materials selection. Flours and many other ingredients need to be GF-labeled to be used in production, so the suppliers and the supply must be trusted and fully checked. This implies more costs for the supplier and consequently for the producer. Moreover, the availability of these ingredients, flours in particular, is not so widespread. More mainstream gluten-free flours like corn or rice flours are now extensively farmed, but there are a lot of other gluten-free flours (and more nutritionally complete than corn or rice flours), that are way less known and therefore way more expensive. Examples are Sorghum, Teff or Quinoa flours.
2. Research and Development costs. New recipes for gluten-free foods are constantly being studied, because of the lack of gluten, the most crucial ingredient when it comes to baking foods like bread. Mimicking its effects on the structure and quality of the final product using other ingredients has always been a challenge, due to gluten's unequalled network forming properties in the dough (El Khoury et al., 2018) but there have been major advances concerning palatability, texture and taste issues (Tóth et al., 2022).
3. The actual production. Every firm that wants to start producing GF foods must add new lines, since their production in already existing lines and units cannot be conducted due to high cross-contamination risks. Expanding the productive space of the facility entails additional expenses to be faced.
4. Safety controls. Many tests and controls need to be carried out after the production, to ensure that the required quality is met, and that the final product contains less than 20 ppm of gluten.
5. Lack of economies of scale. The demand for gluten-free products has risen in the last years but it remains somehow a "niche" market that cannot therefore exploit the economies of scale of the standard alternative products. Therefore, the batch sizes that firms economically need to choose are smaller.

The high costs associated to production affect the packaging of GF foods too. In fact, the basis weight differs from that of GC counterparts. GF pasta is usually sold in 400g (or less) packs; the 500g traditional format can be found in the GDO distribution channel only. GF sliced bread is sold in 300/330g packs, while the GC sliced bread is sold in 400g packs. GF biscuits come in 200g or 300g packs, while their counterparts can be found in different formats, the smaller ones can be of 350g but the 700g pack can be found too. It is important to notice that the price difference

is not limited to prepackaged food, but also to eating out, since a mark-up on the price of GF courses can be found in almost every restaurant.

Monthly vouchers, (un)easiness of use

Italy stands out among all European countries because it is the only European country that provides such a significant economic aid to celiac patients. Other forms of assistance that can be found in Europe are in the form of tax refunds (e.g. Ireland), partial reimbursements (e.g. France), small economic aid only for children (e.g. Greece). The Italian aid is the highest in terms of money (AOECS, 2022). Nevertheless, there is a constraint: vouchers can only be spent in the region of residence. In case of relocation to another region (for example for work or study reasons) there exists the possibility to transfer the voucher to the new domicile, but a long bureaucratic process needs to be undertaken (AIC Piemonte, n.d.).

Originally, they were physical paper vouchers and gradually became digital. This digital transition started in 2018, after the Decree of the 10th of August 2018, when the Regions were asked to convert the voucher into a digital one. The dematerializing did not happen all at once and is still not completed since two regions, namely Molise and Sicily, are still using paper vouchers, but Sicily is currently undertaking the digitalization process of the vouchers, that will be available in the nearest future (Regione Sicilia, 2024).

The amount of the voucher is charged to every celiac patient's health insurance card ("tessera sanitaria") every month. This card becomes, for all intents and purposes, a debit card. The patient can therefore buy gluten-free products paying with that card. This method is not effective throughout all Italian territory, since two regions do not use the health insurance card as the mean to provide the voucher: in the Trentino Alto Adige Region the amount of the voucher is added directly to the celiac patient bank account on a three-month basis, while in the Basilicata Region the monthly amount is charged to a prepaid card, provided by the local healthcare service. Figure 3 represents the current context of the voucher digitalization in Italy.

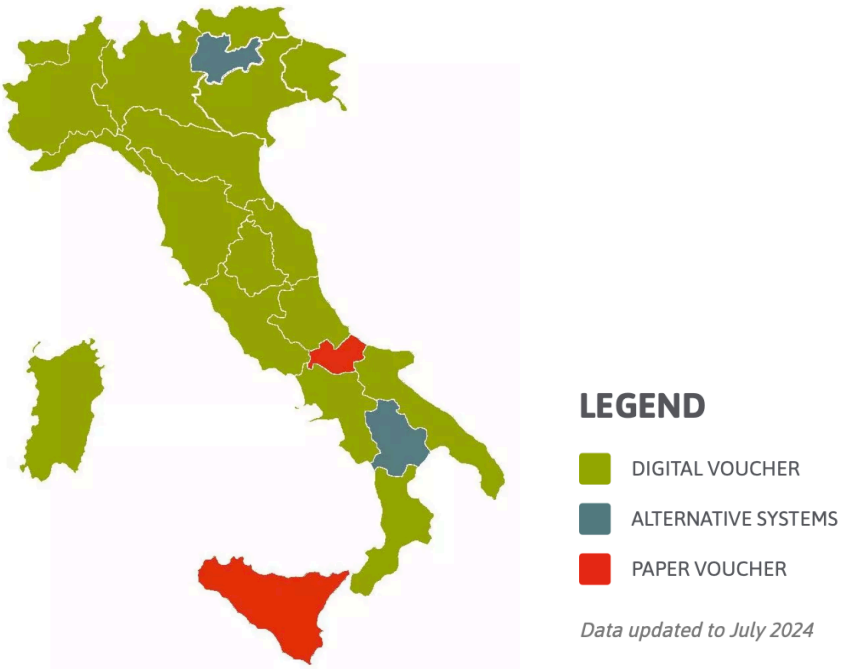

Figure 3: 2024 snapshot of the voucher format landscape (Source: celiachia.it)

In addition, the softwares used to manage the vouchers vary from one region to the other. Some regions employ softwares that are made available to reuse from Public Administrations of other regions, but others have developed their own software. Reusing an already existing software is a recommended practice, since it entails shorter implementing times (since the design and development parts are already completed) and lower costs. The software is, as a matter of fact, acquired free of charge; the administration that reuses a software must only bear the costs of adaptation to its needs (AGID, 2019). With a view to extending the usability of the voucher on all Italian territory, this variety of voucher management systems is a big obstacle to its standardization.

Chapter 2

Current Italian gluten-free foods demand and supply context

Supply side

Gluten-free foods are sold in four different distribution channels, namely online, pharmacies, specialized shops and large-scale distribution (commonly known as GDO). In order:

The biggest e-commerce site for GF products in Italy, in terms of assortment, is called Farmacie Gluten Free (https://www.farmacieglutenfree.it) and it offers the possibility to pay via monthly voucher, but it is not in-site implemented. The customer purchases its basket of GF foods on the website and selects its closest pharmacy as delivery point, where the payment via voucher will be carried out. Prices are similar to those in specialized stores and pharmacies, but frequent discounts and offers are available. Monthly sales account for a value of 200.00€, and the average number of orders, on the same time basis, is 300. It is the "monopolist" of the gluten-free online shopping in Italy; there are some other websites, but their service is limited to specific and small local areas. When this business started, in 2022, the average number of orders was 60-70 (monthly) and it has never stopped growing. Pharmacies need to adhere to this project, for it to work properly. This website is the only one featured on the Italian Association of Celiac Disease (AIC) mobile app. (A. Marinelli, personal communication, September 12, 2024).

Pharmacies were the first distribution channel for gluten-free products to ever exist was and is still the most widespread. It has been the first way for celiac patients of accessing gluten-free foods as soon as the disease was acknowledged and regulated by the National Health Service and the Government. Gluten-free products have gradually lost their medical connotation and their prevalent placement in pharmacies, conquering ever-increasing shares in the world of mass consumption.

Specialized shops are dedicated to gluten free and other special dietary foods. They may have a wider selection of brands and products with respect to pharmacies. Their presence varies depending on the area very much; they usually can be found in bigger residential areas, i.e. in cities.

Large scale distribution consists of all types of stores, such as supermarkets, superstores, minimarkets, discount stores etc. Gluten-free products that are sold in the GDO channel may differ from those that can be found in pharmacies and specialized shops, due to the increasing presence of chain-proprietary gluten-free product lines, whose products are manufactured by third parties and named after the GDO chain that than puts these products on the shelves. The Private Label phenomenon is indeed well spread across GDO chains.

Not all pharmacies on the Italian ground sell gluten-free products and neither do all GDO chains. The number of GDO chains that are present in the network depend on the region and on the affiliation with the local healthcare system. In some regions it is still not possible to spend the monthly voucher in the GDO channel, as shown in Figure 4. On the contrary, the network of affiliated pharmacies is widespread across all Country.

Figure 4: Italian snapshot of GDO affiliation (Source: spigabarrata.it)

Demand side

The report on Celiac Disease of the Ministero della Salute (2024) states that, according to the latest available data of 2022, there are 251.939 diagnosed celiacs in Italy, but the expected number is circa 600.000. On average, the number of diagnoses is around 9000 units per year (Istituto Superiore di Sanità, 2024). In 2022 the total expense of the Health Minister for the support of the gluten-free diet amounted to €237.626.251,98, with an average expense of €943,19 per capita (Ministero della Salute, 2024). Table 3 (in the next page), that has been extracted from the just mentioned report, shows the 2022 data concerning the number of celiac patients per region, the regional disbursement and the per capita expense of the Health Minister of that year.

It is interesting to notice the case of Puglia, where the average per capita expense (494,39€) is very low with respect to the averages of all other regions and the overall Italian average.

In the time lapse of four years, from the introduction of the digital voucher to 2022, the expense was expected to be of 26 million euros, since the number of diagnoses increased by 26.521; the actual expense was of 16 million euros. This can be due to a better efficiency in managing the monthly balance from the celiacs' side with the digital voucher. As further proof of the fact that the paper voucher had to be spent in its entirety (Faiella, 2018), while the digital voucher offers maximum flexibility. Dematerializing the voucher results then in a reduction of public resources. Nevertheless, the total expenditure incurred by the State continues to rise annually due to the increasing prevalence of celiac disease diagnoses.

The demand for gluten-free products is indeed constantly growing and, as a recent market survey found out, 21% of the Italian population regularly buys GF products (Alliney, 2024). This means that the share of the population that purchases GF products (but that does not need this kind of food for medical reasons) is increasing. Consumers may be interested in buying GF food because they're acquainted to or friends with celiac persons, or because of personal health beliefs or taste preferences.

The gluten-free market in Italy reached a value of 400 million euros in 2023, and it is esteemed to grow at a rate of +6% every year ("Senza glutine, un mercato sempre più caro", 2024), making it less of a niche market.

Tabella 7. Spesa per l'erogazione degli alimenti senza glutine in esenzione - anno 2022

Regione/Provincia autonoma	Celiaci	Spesa	Spesa media pro-capite
Abruzzo	5.755	€ 6.150.681,49	€ 1.068,75
Basilicata	2.241	€ 2.357.018,67	€ 1.051,77
Calabria	6.784	€ 6.557.935,81	€ 966,68
Campania	24.395	€ 24.903.628,51	€ 1.020,85
Emilia Romagna	20.776	€ 20.905.514,00	€ 1.006,23
Friuli Venezia Giulia	4.638	€ 4.351.749,00	€ 938,28
Lazio	25.351	€ 24.857.901,82	€ 980,55
Liguria	6.174	€ 5.988.090,79	€ 969,89
Lombardia	46.433	€ 43.974.583,18	€ 947,05
Marche	5.135	€ 5.407.093,41	€ 1.052,99
Molise	1.121	€ 1.222.323,00	€ 1.090,39
Bolzano	2.219	€ 2.031.577,17	€ 915,54
Trento	2.918	€ 3.154.069,74	€ 1.080,90
Piemonte	17.151	€ 17.369.522,00	€ 1.012,74
Puglia	15.033	€ 7.432.112,64	€ 494,39
Sardegna	7.050	€ 7.355.674,04	€ 1.043,36
Sicilia	17.683	€ 14.000.716,54	€ 791,76
Toscana	19.599	€ 18.290.350,02	€ 933,23
Umbria	4.175	€ 3.944.365,86	€ 944,76
Valle D'Aosta	659	€ 680.252,29	€ 1.032,25
Veneto	16.649	€ 16.691.092,00	€ 1.002,53
Totale	**251.939**	**€ 237.626.251,98**	**€ 943,19**

Table 3: regional and per capita GF expense in 2022

Chapter 3

Gluten-free Market Analysis

Empirical Strategy

The reference framework that has been previously analyzed serves as a foundation for the study that will now be conducted. The focus will be shifted to the economic aspects that concern the Italian market for gluten-free products. To do it, I could access price data covering the past 4 years, thanks to the collaboration of the Italian Celiac Disease Association (AIC, "Associazione Italiana Celiachia") on this study. The data have been previously provided to the Association by NielsenIQ. The datasets cover the time interval from 2021 to 2024. The data distinguish the two main types of distribution channels, namely the pharmacy and the GDO channels. The datasets don't contain any information about online shops and specialized stores. For each given year of that timeframe the data provide, for each channel and for each food category, the national average prices and quantities sold in the first half of the year. These broad data are then further detailed for every Italian region, with six-months averages. All these data are provided for five food categories, namely Pasta, Bread, Bread Substitutes (such as flatbread, breadsticks etc.), Flours and Biscuits. In particular, the 2021 dataset goes in more details because, for each food typology and for every region, the data provide the average price and quantity sold of the 5 most bought products (for both distribution channels). Because of the greater availability of data, the 2021 dataset will be used for the following analyses.

The regression analyses will be performed for each of the five above-mentioned product categories, taking into consideration the quantity and the price of the five most sold items in every Italian region, concerning both distribution channels: GDO and Pharmacies.

Due to the biannual nature of the data the "product type - average volume sales" pair, on a six-months basis, will serve as the unit of analysis.

The first introduced variable will be the price variable (indicated as P). Price is indeed forecasted to have a considerable impact on the dependent variable "sales volumes" (indicated as $GF\ Sales$). The predicted impact is, in fact, a negative effect on the overall gluten-free sales, as the higher prices do not incentivize the purchase of gluten-free foods. The following variables will all be defined as dummy variables, as they are all categorical values.

Then, a variable concerning the distribution channel will be added, due to the price difference among the Pharmacy and the GDO distribution channels. Due to the price differences that these two channels provide to the end consumer it is of interest for the study to analyse whether this ultimately impacts the quantity of products sold. Since they are the two main channels (and the only ones that the data provide), the newly introduced variable will be a dummy called D_{GDO}. This variable will assume a value of 1 if the corresponding price data refers to the GDO channel, and a value of 0 if the price comes from a Pharmacy distribution point. The reference category is therefore represented by the distribution channel being a pharmacy.

After that, a set of dummy variables will be added to the model. As emerged in Chapters 1 and 2 the monthly voucher works differently across regions and the spending habits of celiacs across the Italian territory can vary. Due to this peculiarity, this set of variables will regard the main macro areas of the Italian peninsula. These macro areas are called Partitions and are defined by the Nomenclature of Territorial Units for Statistics. They group Italian regions into 5 clusters: North-East Italy, North-West Italy, Central Italy, South Italy and Insular Italy. North-East Italy consists of Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia, Emilia Romagna; North-West Italy consists of Piemonte, Valle d'Aosta, Liguria, Lombardia; Central Italy consists of Toscana, Umbria, Marche, Lazio; South Italy consists of Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria; Insular Italy consists of the two isles, Sicilia and Sardegna (Nomenclatura delle unità territoriali per le statistiche dell'Italia, 2024). The set will therefore associate a distinct variable for each partition. It will be necessary to construct four variables, as the fifth one will mandatorily serve as the baseline. Each variable will assume the value of 1 if the corresponding price in the dataset refers to a region contained in that partition and 0 otherwise. In this model, South Italy has been selected as the reference category, primarily due to its representation of the highest number of observations, since this partition includes the highest number of regions. This arbitrary choice was made purely because of the data availability and does not stem from any specific hypothesis related to the research question itself. This set will hence be made of the variables: $D_{NorthEast}$, $D_{NorthWest}$, $D_{Central}$ and $D_{Insular}$.

The other relevant aspect that can be affecting the demand of gluten-free products is brand recognition. The market for gluten-free goods is relatively concentrated, with a limited number of producers, and they could be outshined by the prominent brand leader Schär. Hence, it can be of interest to discover whether the brand too plays a role for the end consumer in its purchasing decisions or if its presence remains second to the previously introduced variables. The variable that serves this purpose will be a dummy whose value is equal to 1 when the corresponding data refers to a product of the brand Schär and 0 otherwise. The variable will be indicated as D_{Schaer} in the models while the baseline will be any other brand which is not Schär. The only exception will concern the "Pasta" category: in this case a brand leader can't be identified as the number of brands is greater and it encompasses very well-known brands that generally produce traditional pasta. The variable set for this category will be composed of two dummy variables, called D_{Rummo} and $D_{Barilla}$, while the baseline will be any other brand which is neither Rummo nor Barilla. The reference category for these two variables serves the same purpose as that established for the other categories, to ensure consistency in all the models' structures. Barilla and Rummo are two of the most relevant Pasta manufacturers in Italy; as soon as they approached the production of gluten-free pasta, their products were quickly perceived as superior in terms of both quality and taste. On the contrary, Schär's gluten-free pasta has not enjoyed comparable recognition and widespread appreciation.

The last variable that will be added to the models will take into consideration the two formats of the monthly voucher, the digital and the paper-based format. Indicated as $D_{Digital}$ in the model, this variable will show the value of 1 whenever the corresponding price data belongs to a region that, in 2021, made use of the digitalised voucher and 0 otherwise (the reference category is therefore the presence of the paper version of the voucher). To do so, thanks to the cooperation of AIC, I was granted access to the 2021 voucher dematerialisation framework, and I could properly assign the values to the variable while constructing it. In recent years the number of regions that had implemented the digital voucher has increased so the information presented in Figure 3 (Chapter 1) could not be representative of the 2021 landscape. Indeed, the situation in 2021 was the one portrayed in Figure 5. Up to that year, the regions still utilizing the paper-based voucher were Abruzzo, Sardinia, Calabria, Molise, and Sicily. The inclusion of this variable in the model will allow for an assessment of whether the specific format of the voucher has an impact on the sales of gluten-free food products, to determine whether the transition from paper-based to digital vouchers influences purchasing behavior in this market segment.

Figure 5: 2021 digital vs paper-based voucher framework *(Source: AIC)*

Finally, each one of these consequential five integrations to the linear regression model will represent a Specification, as they will be designated in the following output tables.

All these five models that present variables in levels will be later replicated with a logarithmic transformation, using a log-log model. This will allow for an estimation of the elasticities. The logarithmic transformation will be applied to all continuous variables.

Empirical model

The main hypothesis that the model will cover concerns the price effect on the sales volumes. A second hypothesis was formulated to analyse the price effect in the presence of the digital voucher. This additional model would introduce an interaction between the price variable P and the dummy D_{GDO}. Unfortunately, a collinearity issue arose, and the resulting outputs could not be considered reliable. Therefore, only the first hypothesis will be carried out.

The baseline of the linear regression model will then be of the type:

$$GF\ Sales_i = \beta_0 + \beta_1 P(i) + \boldsymbol{X_i} + \varepsilon$$

Where i refers to the combination of brand and region. All analyses will be conducted for the five food categories: Pasta, Bread, Bread Substitutes, Flours, Biscuits.

$\boldsymbol{X_i}$ stands for, in a matrix notation, the above-mentioned dummy variables that will be added step by step.

ε stands for the standard error of the regression.

The baseline for the log-log model will be of the type:

$$\ln(GF\ Sales_i) = \beta_0 + \beta_1 \ln(P) + \boldsymbol{X_i} + \varepsilon$$

Where the only changes concern the continuous variables ($GF\ Sales$ and P), that are now transformed with logarithms.

The analysis of all the regression models and their results will adhere to the following order: Pasta, Bread, Bread Substitutes, Flours, Biscuits.

Results

Linear Regression Models

As we'll observe in the following tables, the results of the linear regression models confirmed the presence of a price effect on the volumes of gluten-free sold in Italy, but its intensity varies across the different food categories, and it is influenced by the other variables. As expected, the coefficient of the price variable is negative, as it reduces the overall amounts of gluten-free food items sold. Its intensity varies also among different food categories, due to the impact of other variables like brand or sales channel. Indeed, they proved to be significant for certain food categories. The brand does, in particular, affect Bread's volume sales, while the distribution channel has a stronger impact on Pasta and Biscuits with respect to the other categories.

On the other hand, these satisfactory results contrast with the overall fit of all the models, which is considered "poor", suggesting the existence of additional variables that can influence this market that have not been included in the following analysis.

The five models and their respective results will now be examined one by one.

Table 4: **Linear regression results for the category Pasta** (standard errors)

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	18675***	12147***	7949**	6525	4972
	(2484)	(3445)	(3542)	(4321)	(4575)
Price	-2554***	-1683***	-1489**	-1441**	-1399**
	(494)	(584)	(573)	(617)	(618)
Distribution Channel (Base = Pharmacy)					
D_GDO		4008***	4377***	4748***	4813***
		(1493)	(1457)	(1537)	(1538)
Partitions (Base = South Italy)					
D_NorthEast			3041*	3263*	2135
			(1739)	(1787)	(2094)
D_NorthWest			6547***	6551***	5416**
			(1747)	(1785)	(2096)
D_Central			4013**	3982**	2832
			(1737)	(1769)	(2090)
D_Insular			2844	2641	3791
			(2091)	(2114)	(2389)
Brands (Base = Other Brand)					
D_Barilla				1000	1175
				(1730)	(1738)
D_Rummo				1596	1746
				(1945)	(1950)
D_Digital					2325
					(2250)
R-Squared	0,133701112	0,168552055	0,235835656	0,238972311	0,243863321
Adjusted R-Squared	0,128693604	0,158884056	0,208544072	0,202296278	0,202619502
No of observations	175				

Standard errors are reported in parentheses.

*, **, *** indicate significance at the 90%, 95%, and 99% level, respectively.

Concerning the results of the linear regression model of the first food category, pasta, we can infer that the price effect is remarkable. Indeed, the hypothesis that price is negatively impacting the volumes of sales cannot be rejected, as the p-value for the price variable remained significant throughout all stages of model development. Always well below 0.05, it implies a strong rejection

of the null hypothesis (the null hypothesis being the null influence of the price on the dependent variable, so the coefficient of the independent variable being equal to zero). The price negatively influences the quantity sold, as the coefficient is negative. In Figure 6 it is represented the linear regression equation concerning the first specification of the model. The y-axis represents the prices, while the x-axis represents the volumes of pasta sold.

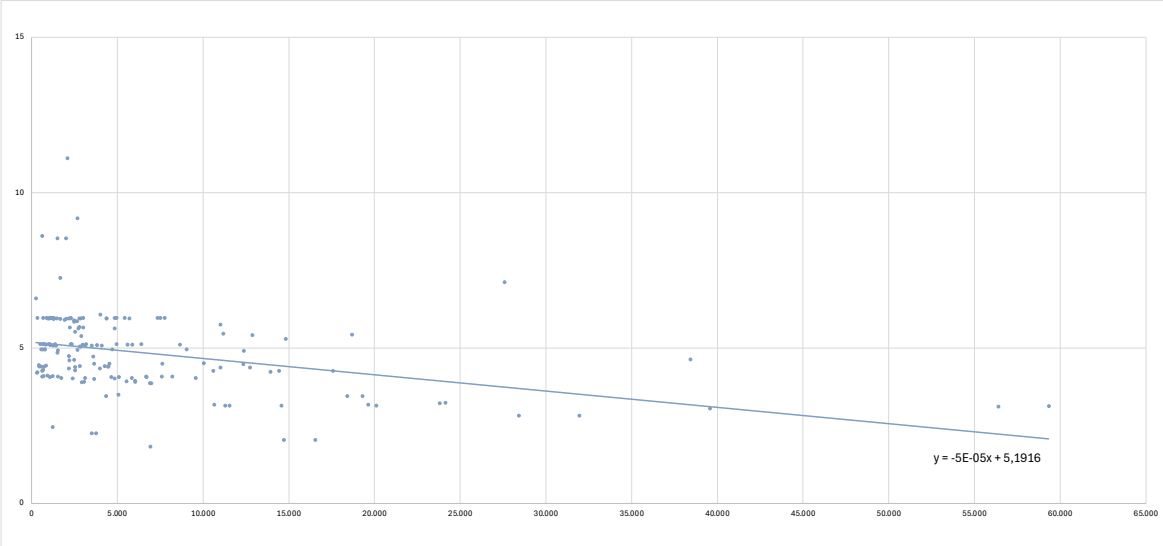

Figure 6: *Author's elaboration*, linear regression line (Spec. 1), Pasta food category

The price coefficient is of the same order of magnitude of the other variables coefficients but is smaller than the coefficient of the other statistically significant variables, such as D_{GDO} and the variables concerning the cluster partitions.

The "GDO-effect" turned out to be highly relevant, but in the opposite direction of the price effect. When the point of sale is a general store, such as a supermarket, discount store or minimarket, purchases of gluten-free food items tend to increase compared to the point of sale being a pharmacy. This result can suggest a consumer preference for large-scale retail chains. This, in turn, confirms the role of price as a barrier to purchase and highlights a preference of a sales point that provides a wider product selection, greater accessibility and more competitive prices. Pasta prices in large retail stores are usually more affordable, thanks to chains' private labels.

It is interesting to notice that, among all the variables pertaining the "Partitions" set, the $D_{North\ West}$ dummy stands out throughout the specifications. With a high and positive coefficient, this variable makes clear that in North-Western Italy (in regions such as Piemonte and Lombardia) the volumes of gluten-free pasta are higher than the rest of Italy.

Regarding the model's goodness of fit, the adjusted R-squared in Spec. 3 improved with respect to Spec. 1 and Spec. 2 but remained stable in the next two Specs (around 20%). This implies that the model fit does not improve after taking in consideration brands and the voucher format, as demonstrated by the statistical insignificance of the variables $D_{Barilla}, D_{Rummo}\ and\ D_{Digital}$.

Table 5: **Linear regression results for the category Bread** (standard errors)

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	9874***	8666***	6383**	4027	3080
	(1958)	(2685)	(2773)	(2778)	(2907)
Price	-395**	-332*	-313*	-383**	-383**
	(156)	(184)	(181)	(176)	(176)
Distribution Channel (Base = Pharmacy)					
D_GDO		762	878	1077	1076
		(1157)	(1135)	(1103)	(1102)
Partitions (Base = South Italy)					
D_NorthEast			1443	1040	90
			(1393)	(1357)	(1609)
D_NorthWest			4066***	3681***	2731*
			(1392)	(1355)	(1607)
D_Central			3519**	3454**	2504
			(1394)	(1353)	(1605)
D_Insular			1610	1503	2453
			(1674)	(1624)	(1840)
Brands (Base = Other Brand)					
D_Schaer				4059***	4059***
				(1196)	(1195)
D_Digital					1900
					(1732)
R-Squared	0,035754303	0,038182589	0,097906084	0,156081282	0,162155535
Adjusted R-Squared	0,030180628	0,026998666	0,065688444	0,120707444	0,121777489
No of observations	175				

Standard errors are reported in parentheses.

*, **, *** indicate significance at the 90%, 95%, and 99% level, respectively.

Moving on to the Bread category, differences with the previous model can be immediately identified. For Bread the price effect is still present, but only on a lower level of confidence (90%). The coefficient of the *P* variable is also of one order of magnitude smaller than all other coefficients. If present, the price effect on the volumes of gluten-free bread is of a smaller scale.

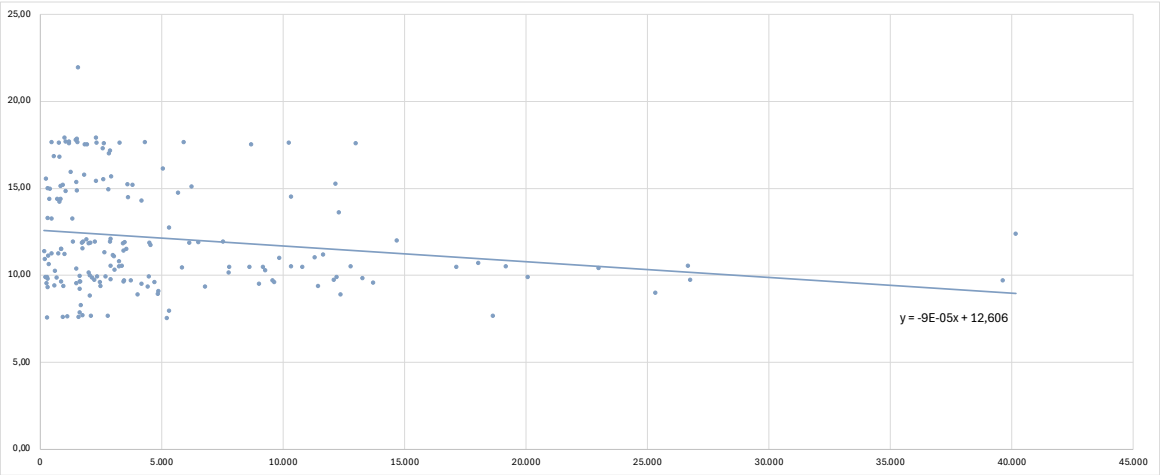

Figure 7: *Author's elaboration*, linear regression line (Spec. 1), Bread food category

The first specification of the model is depicted in Figure 7; prices are on the y-axis and quantities on the x-axis. Since the effect of the price is not so prominent, it is better to analyze the other variables in the model.

Bread is indeed a very peculiar segment in the gluten-free market. The root cause lies in the difficulties and challenges that the gluten-free bread production faces, in terms of ingredients and the baking process itself. The absence of the gluten proteins hinders the normal production steps; replicating the elasticity, porosity and leavening of wheat bread is complicated. This leads to a lowered palatability, different consistency and taste with respect to wheat bread, inducing celiac patients to either eat less bread or bake it at home with the preferred ingredients (Garnweidner-Holme et al. 2023). Consequently, when purchasing bread, the customer is inclined to choose a brand he or she already knows of and that is renowned for making good quality bread. Up to now, Schaer is the gluten-free market leader in Italy, and it has managed to provide a decent substitute for wheat bread. Hence, the analysis confirms that the brand identity of Schaer has a significant influence on the sales volumes of gluten-free bread, when compared to the case where the brand is a lesser-known alternative. The variable D_{Schaer} is statistically significant at the 99% level in the specifications to which it has been added. This is the only instance in the five food categories in which the brand influences the product's sales volumes. The other food groups are also subject to challenges concerning the production process, but the impact will appear to be less pronounced. This is due to the fact that, in food categories such as pasta and sweets, gluten can be replaced more easily and effectively while preserving the overall quality of the end product, ensuring that neither taste nor texture is compromised. Consequently,

brand recognition does not exert a clear effect on their sales volumes. This explanation may offer a plausible rationale for why bread is the only category in which sales are influenced by brand.

This result is confirmed by the fact that the point of purchase being a convenience store rather than a pharmacy does not yield a relevant effect, as indicated by the non-significance of the variable D_{GDO} throughout the model. This suggests that the end consumer's purchasing decision for bread is primarily influenced by brand. Consequently, this behaviour may reflect a relatively low price elasticity of demand among consumers, who appear to be willing to pay a premium price for their preferred brand, regardless of the point of sale.

Looking now at the partitioning of the Italian territory, it is clear to see that it did not exert a strong effect on the dependent variable. The same goes for the $D_{Digital}$ variable, due to its statistical insignificance.

Regarding the model's goodness of fit, the adjusted R-Squared doesn't show improvements after Spec. 4. In fact, in Spec. 4, the introduction of the Brand makes the adjusted R-Squared double (from 6% to 12%), while the introduction of the voucher format variable does not change it, since it is not statistically significant. Moreover, after its introduction, the geographical location saw an increase in the p-value. This implies that sales of Bread are "extensively" explained by the brand, but the R-Squared value is still far from a decent fit for the model.

Table 6: **Linear regression results for the category Bread Substitutes** (standard errors)

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	6723*** (818)	4548*** (1648)	2986* (1652)	3562** (1666)	2811 (1716)
Price	-261*** (55)	-162* (85)	-162** (82)	-109 (85)	-111 (85)
Distribution Channel (Base = Pharmacy)					
D_GDO		1375 (906)	1416 (869)	714 (936)	647 (932)
Partitions (Base = South Italy)					
D_NorthEast			2191*** (801)	2213*** (794)	1359 (939)
D_NorthWest			3460*** (801)	3407*** (795)	2549*** (941)
D_Central			1327* (802)	1252 (797)	391 (943)
D_Insular			1298 (963)	1336 (955)	2193** (1078)
Brands (Base = Other Brand)					
D_Schaer				-1593* (831)	-1670** (828)
D_Digital					1710* (1016)
R-Squared	0,116409946	0,128093911	0,221262695	0,238039303	0,250832031
Adjusted R-Squared	0,111302489	0,117955468	0,193450648	0,20610083	0,214727551
No of observations	175				

Standard errors are reported in parentheses.

*, **, *** indicate significance at the 90%, 95%, and 99% level, respectively.

The Bread Substitutes category shows a different trend concerning the price effect. The *P* variable loses significance in the fourth specification and in the fifth. Its coefficient is also smaller with respect to the previous two categories. These results suggest a lower impact of the price on the demand of gluten-free bread substitutes. In the first specification *P* is statistically significant at the 99% level and its relationship with the sale quantities is represented in Figure 8.

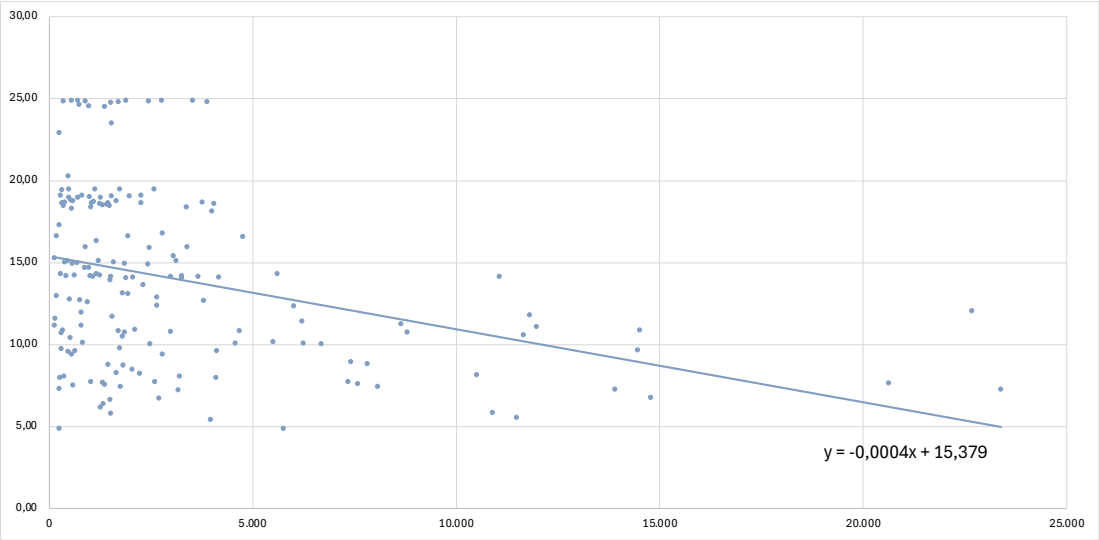

Figure 8: *Author's elaboration*, linear regression line (Spec. 1), Bread Substitutes food category

Since the effect of the price has not produced a significant outcome, it is useful to focus on the other variables and their weight on the demand. Concerning the D_{GDO} variable, the "GDO-effect" cannot be considered for this category, as the variable is statistically insignificant in the whole model. Hence, the sales point does not seem to influence the demand.

Thanks to the fifth specification, more information on this category can be discerned from the model. The $D_{North\ West}$ and the $D_{Insular}$ variables are both statistically significant and the size of the coefficient is also noticeably important. North-Western Italy confirms its significance for the third time; a pattern seems to emerge concerning the "partitions" set of variables.

The D_{Schaer} variable is significant, as observed in the Bread model, but it is opposite in sign. Indeed, the coefficient is now negative and notably large. The Schaer brand takes now on a negative connotation, as it is associated with a decrease in the quantity of gluten-free bread substitutes sold. This suggests that products such as breadsticks or crackers produced by Schaer are poorly regarded compared to similar items from other competing brands.

The $D_{Digital}$ variable is significant (at the 90% level) for the first time in these analyses. Its coefficient is positive, so the effect of the format of the voucher being digital with respect to paper-based has a favorable impact on the sales volumes of bread substitutes.

Regarding the model's goodness of fit, the adjusted R-Squared continuously improved throughout the model, but the increase from Spec. 4 to Spec. 5 has not been particularly relevant (from 20,6% to 21,4%).

Table 7: **Linear regression results for the category Flours** (standard errors)

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	12895*** (1608)	10512*** (2457)	6993*** (2626)	4765* (2838)	4051 (2913)
Price	-1358*** (310)	-1097*** (370)	-1046*** (367)	-900** (372)	-982** (379)
Distribution Channel (Base = Pharmacy)					
D_GDO		2000 (1561)	2226 (1528)	3279** (1606)	3049* (1619)
Partitions (Base = South Italy)					
D_NorthEast			3225* (1837)	2776 (1835)	1516 (2176)
D_NorthWest			6022*** (1838)	5752*** (1828)	4468** (2181)
D_Central			4651** (1838)	4770*** (1824)	3461 (2191)
D_Insular			3215 (2230)	2599 (2233)	3984 (2576)
Brands (Base = Other Brand)					
D_Schaer				2694* (1366)	2533* (1373)
D_Digital					2575 (2389)
R-Squared	0,099903254	0,108409401	0,169756308	0,18865439	0,194289254
Adjusted R-Squared	0,094700383	0,098042068	0,140104748	0,154645892	0,155459821
No of observations	175				

Standard errors are reported in parentheses.

*, **, *** indicate significance at the 90%, 95%, and 99% level, respectively.

Similarly to the Pasta category, Flours present a quite strong price effect on the demand, in terms of size and significance for the model. The relationship between prices and quantities is shown below in Figure 9.

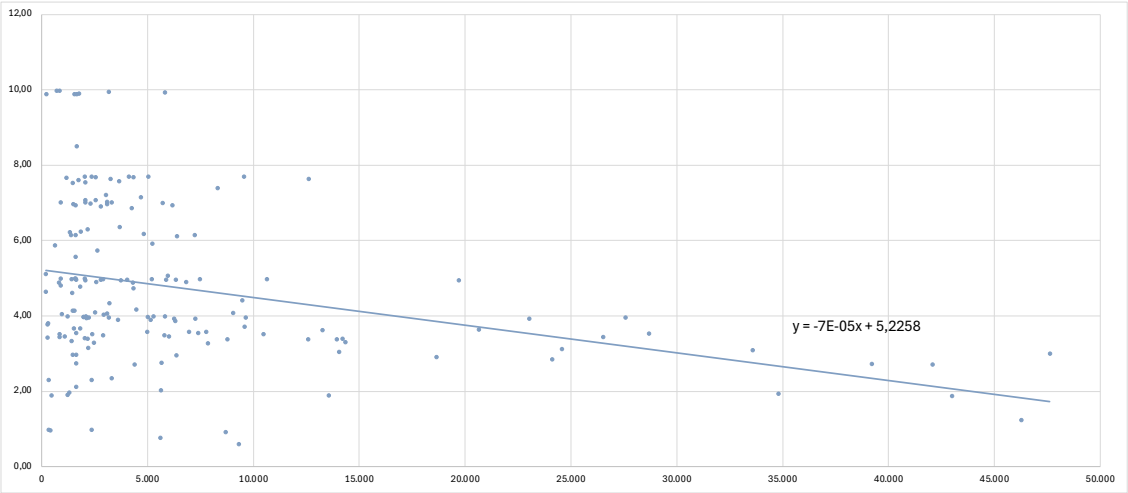

Figure 9: *Author's elaboration*, linear regression line (Spec. 1), Flours food category

The D_{GDO} variable becomes statistically significant only after the inclusion of the D_{Schaer} in the model. This suggests a hidden effect in the model, that gains a more precise estimate. In Specification 4, both variables contribute to a notable increase in the dependent variable value, thanks to their positive sign and relatively large coefficients. Hence, the Schaer brand leads to an increase in flour purchases and so does when the salespoint is a retail store. Their combined effect might likely come from the brand's major presence on the shelves of big retail stores.

The $D_{Digital}$ variable instead, introduced in Spec. 5, does not seem to be relevant for this food category, as its p-value is statistically insignificant and the addition of this variable to the model didn't increase its overall goodness of fit.

In relation to the model's goodness of fit, the adjusted R-Squared is following the same pattern of the model concerning the Bread Substitutes product category, where it increases much from Spec. 2 to Spec. 3, then it slightly improves in Spec. 4 and stagnates in Spec. 5 (15,5%). Again, the value is not satisfying; this can suggest that the model is not very useful for predicting or

explaining the dependent variable, and that most of the variability remains unexplained by the independent variables considered.

Table 8: **Linear regression results for the category Biscuits** (standard errors)

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	3099*** -573	140 (869)	-1196 (899)	-1051 (940)	-1299 (987)
Price	-104** -45	39 (54)	53 (51)	59 (52)	56 (53)
Distribution Channel (Base = Pharmacy)					
D_GDO		2185*** (500)	2295*** (477)	2108*** (590)	2095*** (591)
Partitions (Base = South Italy)					
D_NorthEast			1280** (545)	1309** (549)	1017 (654)
D_NorthWest			2494*** (546)	2534*** (552)	2241*** (656)
D_Central			1241** (546)	1237** (548)	944 (653)
D_Insular			859 (655)	908 (663)	1199 (751)
Brands (Base = Other Brand)					
D_Schaer				-311 (573)	-304 (574)
D_Digital					582 (703)
R-Squared	0,030207977	0,127138161	0,225883121	0,227244104	0,230416284
Adjusted R-Squared	0,024602243	0,116988604	0,19823609	0,194853138	0,193327912
No of observations	175				

Standard errors are reported in parentheses.

*, **, *** indicate significance at the 90%, 95%, and 99% level, respectively.

This product category shows a very different evolution in the results, compared to the four ones already analysed. Price, for instance, is statistically significant in the first specification only. From

Spec. 2 onwards the coefficient of the price variable switches sign and loses significance, while already being one order of magnitude smaller in the first specification and two orders of magnitude smaller in the subsequent specifications. The relationship between prices and quantities is shown below in Figure 10.

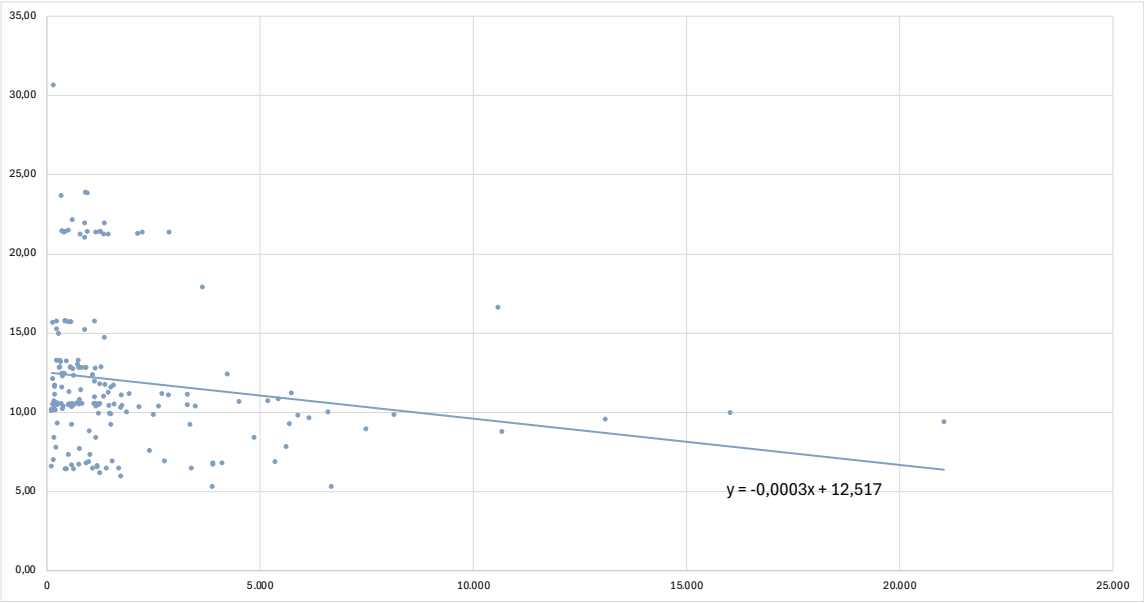

Figure 10: *Author's elaboration*, linear regression line (Spec. 1), Biscuits food category

The "GDO-effect" is very distinct, being the D_{GDO} variable significant at the 99% level throughout all specifications. Hence, the point of sale being a retail store rather than a pharmacy has a noticeable impact on sales. This effect is noticeable from the coefficient of the D_{GDO} variable, that indicates an increase of the quantity demanded of significant magnitude.

On the other hand, the Partitions set follows a pattern which is like the Bread Substitutes and the Pasta categories. In addition to that, the last specification of all analysed models shows only the $D_{North\ West}$ variable as statistically significant. The only exception is the Bread Substitutes category, which presents $D_{North\ West}$ and $D_{Insular}$ as significant for the model, impacting the overall sale volumes.

Regarding the model's goodness of fit, this model has seen a major increase in the adjusted R-Squared from Spec. 1 to Spec. 5, from a value of 2,4% to one of 19%. Differently from the previously analysed models, this product category shows the best "goodness of fit" in Spec. 3 (19,8%).

To summarize, the negative impact of price on the sales volumes of most gluten-free food products is remarkable, as initially hypothesized. The brand impact revealed its significance for three out of the five food categories, but its effect was the most pronounced for bread. Furthermore, the point of sale turned out to be affecting the demand too, for three out of the five product categories, with the GDO having a positive and large effect on the purchased quantities. In addition, the findings suggest that the sales volumes of gluten-free foods are influenced, to some extent, by geographical location. Notably, North-West and Insular Italy emerge as the most significant partitions, as they include the most densely populated areas in the country, which also have a high prevalence of individuals with celiac disease, as previously illustrated in Table 3. The results align with the expectation that both demographic factors and regional characteristics play a role in determining the demand for gluten-free products. Anyhow, it does not take into consideration the way the voucher system works in the different regions. The introduction of the $D_{Digital}$ dummy variable into the model did not yield statistically significant results for all food categories. The only category for which this variable is significant at a 90% level is Bread Substitutes. Consequently, within the scope of this preliminary analysis, it can be inferred that the format of the voucher does not have a discernible effect on gluten-free food sales.

Log-log Regression Models

Now with the logarithmic transformations of the regression models just discussed, it will be possible to analyse the price elasticities for each product category and how the other variables interact in the models.

Table 9: **Log-log regression results for the category Pasta** (standard errors)

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	10,703***	9,542***	9,176***	9,291***	8,745***
	(0,468)	(0,633)	(0,647)	(0,721)	(0,74)
ln(Price)	-1,69***	-1,131***	-1,101***	-1,227***	-1,148***
	(0,298)	(0,36)	(0,357)	(0,375)	(0,37)
Distribution Channel (Base = Pharmacy)					
D_GDO		0,518***	0,551***	0,624***	0,649***
		(0,194)	(0,192)	(0,199)	(0,196)
Partitions (Base = South Italy)					
D_NorthEast			0,255	0,25	-0,104
			(0,224)	(0,229)	(0,264)
D_NorthWest			0,266	0,217	-0,137
			(0,225)	(0,229)	(0,264)
D_Central			0,574**	0,525**	0,165
			(0,224)	(0,227)	(0,263)
D_Insular			0,715***	0,675**	1,036***
			(0,269)	(0,271)	(0,301)
Brands (Base = Other Brand)					
D_Barilla				-0,021	0,032
				(0,216)	(0,213)
D_Rummo				0,283	0,326
				(0,249)	(0,245)
D_Digital					0,73**
					(0,284)
R-Squared	0,157062461	0,190599415	0,23760411	0,247617994	0,276648553
Adjusted R-Squared	0,15218999	0,181187781	0,210375685	0,211358621	0,23719302
No of observations	175				

Starting again with the Pasta food category, it is possible to see that the elasticity of the demand with respect to the price can't be ignored. The $\ln(P)$ variable is consistently significant at a 99% level in all model's specifications. Taking into consideration Specification 5, from now on, it can be inferred that, for a 1% increase in the independent variable, the quantity of demanded pasta decreases by 1,148%. Quantity is therefore highly responsive to changes in prices.

To interpret the coefficients of the dummy variables in a log-log transformed model this formula will be used, to determine the percentage effect these variables have on the dependent variable:

$$Percentage\ effect = \left(e^{\beta} - 1\right) * 100$$

Where β is the coefficient of the dummy variable.

Considering the D_{GDO} variable, its percentage effect on the quantity demanded will result as:

$$Percentage\ effect = (e^{0,649} - 1) * 100 = 91,36\%$$

Hence, pasta sold via stores has 91,36% higher expected sales compared to the same pasta sold via pharmacies, all else equal.

After the logarithmic transformation has been applied to this model, a few differences arose compared to the linear model. Concerning the Italian partitions indeed, insular Italy seems to prevail on the other groups, while in the linear model Northwestern Italy prevailed.

It is interesting to notice that, in this model, the $D_{Digital}$ variable becomes statistically significant at a 95% level. In this setting, the quantity of pasta demanded increases by 107,5% when the format of the monthly voucher is digital. This information was, anyhow, not registered by the linear model. This can be due to a high variance in the quantity demanded, that tends to be resized with a logarithmic transformation. The effect of the voucher format becomes more transparent.

Considering the overall goodness of fit, the adjusted R-Squared is similar to the one in the linear model, reaching its peak in Spec. 5 (23,7%).

Table 10: **Log-log regression results for the category Bread** (standard errors)

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	9,684*** (0,893)	9,597*** (1,128)	9,054*** (1,124)	9,088*** (1,071)	8,727*** (1,073)
ln(Price)	-0,73** (0,36)	-0,701 (0,428)	-0,655 (0,422)	-0,958** (0,408)	-0,946** (0,404)
Distribution Channel (Base = Pharmacy)					
D_GDO		0,027 (0,213)	0,062 (0,21)	0,079 (0,2)	0,082 (0,198)
Partitions (Base = South Italy)					
D_NorthEast			0,524** (0,255)	0,432* (0,244)	0,101 (0,287)
D_NorthWest			0,434* (0,255)	0,348 (0,244)	0,017 (0,287)
D_Central			0,699*** (0,256)	0,681*** (0,244)	0,35 (0,286)
D_Insular			0,688** (0,307)	0,664** (0,293)	0,996*** (0,328)
Brands (Base = Other Brand)					
D_Schaer				0,923*** (0,217)	0,922*** (0,215)
D_Digital					0,662** (0,309)
R-Squared	0,023202621	0,023294309	0,077732555	0,167585122	0,190015856
Adjusted R-Squared	0,017556394	0,011937267	0,044794432	0,13269348	0,150980475
No of observations	175				

For the breakdown of the Bread category, it will be again considered Spec. 5, since it is the one with the highest adjusted R-Squared (15,1%). The ln(P) coefficient reveals that, for a 1% increase in price, the overall demand of gluten-free bread would be negatively affected: precisely it decreases by 0,946%. This variable was not significant throughout the evolutions of the model,

so its results might have to be taken with a grain of salt. Anyway, the price elasticity of demand is not as high as the pasta price elasticity because of the impact of other factors, such as the brand that played an important role in the corresponding linear model.

Indeed, as previously observed, the impact of brand on the demand can't be overlooked. The effect of the brand being Schaer variable is, indeed, an increase in the demand for bread of 151,43%, with respect to any other brand in the market. This result confirms the importance that the brand plays for gluten-free bread products, being (with the price) one of the most valued aspects at the time of purchase.

The D_{GDO} variable, consistently with the linear model, is statistically insignificant throughout the model. The effect of the salespoint can ultimately be neglected for this food category.

The $D_{Digital}$ variable, as happened in the previous log-log model of the pasta food category, becomes statistically significant at a 95% level. The results show that the demand of bread increases by 93,87% when the format of the monthly voucher is digital. Again, its effect was probably concealed in the linear model due to variance and noise in the data.

Table 11: **Log-log regression results for the category Bread Substitutes** (standard errors)

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	9,572***	9,096***	8,519***	8,281***	7,818***
	(0,541)	(0,929)	(0,917)	(0,923)	(0,905)
ln(Price)	-0,849***	-0,698**	-0,669**	-0,442	-0,437
	(0,209)	(0,316)	(0,308)	(0,334)	(0,324)
Distribution Channel (Base = Pharmacy)					
D_GDO		0,16	0,203	0,034	0,002
		(0,254)	(0,247)	(0,265)	(0,257)
Partitions (Base = South Italy)					
D_NorthEast			0,615***	0,62***	0,124
			(0,235)	(0,233)	(0,269)
D_NorthWest			0,702***	0,689***	0,19
			(0,235)	(0,234)	(0,269)
D_Central			0,631***	0,613***	0,113
			(0,235)	(0,234)	(0,27)
D_Insular			0,757***	0,768***	1,266***
			(0,282)	(0,281)	(0,309)
Brands (Base = Other Brand)					
D_Schaer				-0,429*	-0,478*
				(0,252)	(0,245)
D_Digital					0,994***
					(0,291)
R-Squared	0,087349669	0,089464803	0,160733362	0,175056732	0,229295386
Adjusted R-Squared	0,082074234	0,078877185	0,130759553	0,140478272	0,192152995
No of observations	175				

For the breakdown of the Bread Substitutes category, it will be again considered Spec. 5, since it provides the most information, with the highest adjusted R-Squared (19,2%) among all specifications. Since it is a recurring pattern in these log-log transformed models, it will not be made explicit from now on.

Price elasticity of demand here is as not robust as the Pasta and Bread price elasticities, as its coefficient becomes statistically insignificant when other factors are added. The same trend was

found in the corresponding linear model. Similarly, the GDO effect is not providing any information on the demand of bread substitutes.

Considering the Italian partitions, it is curious to see the behaviour of the four dummy variables in the model. After their introduction, they all seem to influence the overall demand but, as soon as the $D_{Digital}$ variable is added, the only variable that remains significant is $D_{Insular}$. Its coefficient is interesting too, as it indicates that the demand increases by 254,7% if products falling under the Bread Substitutes category are sold in the two Italian isles. Further analysis of this result will be conducted after the outputs from the remaining categories have been presented.

Again, the $D_{Digital}$ variable shows a remarkable impact on the demand. Its effect is an increase of 170,2% in the demand. The p-value is well below 0.01 so the variable's significance cannot be rejected.

Lastly, the effect of the Schaer brand is significant only at a 90% confidence level; however, it validates the result obtained in the linear model, where the negative coefficient of the D_{Schaer} variable indicated a decrease in demand. This result reinforces the idea of a slight preference of the consumers towards other brands. Indeed, in this model, the data show a 40% decrease in the demand if the brand is Schaer.

Table 12: **Log-log regression results for the category Flours** (standard errors)

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	8,738*** (0,258)	8,795*** (0,376)	8,402*** (0,394)	8,1*** (0,405)	7,995*** (0,41)
ln(Price)	-0,425** (0,168)	-0,447** (0,2)	-0,48** (0,198)	-0,436** (0,196)	-0,498** (0,2)
Distribution Channel (Base = Pharmacy)					
D_GDO		-0,042 (0,204)	-0,035 (0,199)	0,109 (0,204)	0,069 (0,205)
Partitions (Base = South Italy)					
D_NorthEast			0,437* (0,241)	0,362 (0,239)	0,142 (0,283)
D_NorthWest			0,473* (0,242)	0,428* (0,239)	0,2 (0,286)
D_Central			0,842*** (0,241)	0,857*** (0,237)	0,632** (0,284)
D_Insular			0,752** (0,293)	0,661** (0,29)	0,901*** (0,334)
Brands (Base = Other Brand)					
D_Schaer				0,449** (0,175)	0,426** (0,175)
D_Digital					0,448 (0,311)
R-Squared	0,035628556	0,035867818	0,112111205	0,145771117	0,156309434
Adjusted R-Squared	0,030054154	0,024656979	0,080400891	0,109965116	0,115649647
No of observations	175				

From the Flours category output, it is possible to notice that the price is not as elastic as the first two analysed categories. As a matter of fact, for a 1% increase in the prices of flour the demand will decrease by 0,498%. Anyway, the $\ln(P)$ variable is robust and statistically significant at a 95% level of confidence.

Contrarily to the corresponding linear regression output, the D_{GDO} variable is never significant in the log-log transformed model. This result is discordant with the linear model so the effect on demand of the point of sale cannot be inferred precisely.

For what concerns the partitions Central and Insular Italy seem to be affecting the demand. This result clashes again with the corresponding linear model but, on the other hand, it is possible to see that a trend is developing in the log-log models concerning this variable set.

The brand appears to affect demand by increasing it by 53.1% (if the flour is branded Schaer). On the other hand, the same type of information cannot be inferred for the format of the voucher and its effect on the demand, due to the statistical insignificance of the $D_{Digital}$ variable.

Table 13: **Log-log regression results for the category Biscuits** (standard errors)

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Intercept	8,352***	5,742***	4,94***	4,941***	4,705***
	(0,58)	(0,784)	(0,777)	(0,78)	(0,771)
ln(Price)	-0,612**	0,24	0,344	0,35	0,299
	(0,238)	(0,289)	(0,28)	(0,287)	(0,283)
Distribution Channel (Base = Pharmacy)					
D_GDO		0,96***	1,034***	1,019***	1,002***
		(0,206)	(0,198)	(0,242)	(0,237)
Partitions (Base = South Italy)					
D_NorthEast			0,575**	0,578**	0,205
			(0,221)	(0,223)	(0,261)
D_NorthWest			0,737***	0,74***	0,367
			(0,221)	(0,224)	(0,262)
D_Central			0,774***	0,774***	0,4
			(0,222)	(0,223)	(0,261)
D_Insular			0,809***	0,813***	1,181***
			(0,266)	(0,269)	(0,299)
Brands (Base = Other Brand)					
D_Schaer				-0,025	-0,016
				(0,233)	(0,229)
D_Digital					0,738***
					(0,28)
R-Squared	0,036987855	0,145165045	0,231755275	0,231806419	0,262687614
Adjusted R-Squared	0,031421311	0,135225104	0,204317963	0,199606688	0,227154487
No of observations	175				

The last analysed food category, Biscuits, presents some peculiarities. Starting from the ln(P) variable, which is statistically significant only in the first specification; therefore, it will not be considered informative for the analysis. In addition, its coefficient becomes positive form the second specification onwards. It can only be inferred that Biscuits demand does not seem to be price elastic. It is necessary to evaluate the other factors that affect demand.

The coefficient of the D_{GDO} variable shows the highest coefficient compared to that of all other food categories. Considering again the fifth specification it can be inferred that the demand increases by 172,3% if the sales point is a store and not a pharmacy. This result agrees with the one found in the linear Biscuits model.

What differs from the linear model is, again, the significance level of the Partitions set of variables, that will be summarized shortly, and the $D_{Digital}$ variable. This last one, whose effect could not be considered significant in the linear model, now is significant at a 99% level of confidence. Its coefficient implies an increase of 109,2% in the demand if the voucher is in its digital format.

In conclusion, several valuable results have emerged from the log-transformed regression models. First, the impact of the format of the voucher on the demand. These analyses have shown how the format is impacting the elasticity of the demand, even if the linear models couldn't entirely grasp this effect, probably due to scale differences of the continuous variables, that the log-log model tends to adjust. The $D_{Digital}$ variable, in the linear models, was indeed statistically significant only in the Bread Substitutes model, at a 90% level of confidence. Quite the opposite for the log-transformed models, in which the $D_{Digital}$ variable was statistically significant in all models except for Flours. It can be inferred that the only product category that is not impacted by the format of the voucher is the Flours category; while for Pasta, Bread, Bread Substitutes and Biscuits the effect of the voucher format being digital is prominent, and it causes an increase in the demand. On average, the voucher format being digital makes the sales of every one of these product categories double.

The interesting pattern that can be found in the Partitions variable set will now be further examined. In the linear models the recurring trend is the statistical significance of the $D_{North\ West}$ variable, suggesting that in the north-western regions of Italy the overall demand for gluten-free products is higher. As soon as the logarithmic transformation is applied, that variable becomes

insignificant. The recurring trend in these newer models is the statistical significance of the $D_{Insular}$ variable in Specification 5, implying that the demand is more elastic (and overall higher) in the two regions that the variable represents. The coefficient of this variable is indeed larger than those of the other partition group variables, and their p-values do not indicate statistical significance. This is true for all five food categories, for which the $D_{Insular}$ variable at a 99% level. The Flours category also presents $D_{Central}$ as statistically significant, at a 95% level. It is important to highlight that this is true for the fifth specification of each food category, when the $D_{Digital}$ variable is added to the model. The behaviour of the partition variables is indeed more diverse in the previous specifications (Spec. 3 and 4). Notably, the only regions that had not yet adopted the digital voucher in 2021 were Abruzzo, Sardinia, Calabria, Molise and Sicily. Therefore, for Sardinia and Sicily, the only two regions contained in the Insular partition, the $D_{Digital}$ variable corresponds to a value of 0, while the $D_{Insular}$ variable equals 1. In all categories (except for Flours) both above-mentioned variables are statistically significant and with a positive coefficient. This interpretation of the results presents a peculiarity because the demand would increase if considering the two isles (when the $D_{Insular}$ variable is equal to 1), in which the voucher is in paper form. If we consider the case of the $D_{Digital}$ variable being equal to 1 (the $D_{Insular}$ variable consequently is equal to 0) the demand increases again, now in the instance of the voucher being digitalised. Hence, this contrast is caused by the correlation between these two variables.

For what concerns the primary hypothesis that this study aimed to analyse, that is the effect of price on gluten-free sales, a pattern has again emerged from the models. In both the linear and in the log-transformed models the price variable is statistically significant for the Pasta, Bread and Flours categories, while it is never significant for the other categories, neither in the linear nor in the log-log model. As predicted, the effect of price is detrimental for the demand of those three food categories.

The salespoint being a GDO retail store again produced similar results in both models. Its effect cannot be ignored for Pasta and Biscuits, while it is insignificant for the other food categories. The demand for those two food categories increases when the salespoint is not a pharmacy.

Chapter 4

Further insights

It is also possible to observe the gluten-free market in Italy from a general and broad view thanks to the data (provided by AIC) with which it is possible to portray the performances of the two main distribution channels (Pharmacy and GDO), considering sales volumes and prices, in the 2021-2024 timespan. Although data from 2019 were available, their inclusion would introduce a one-year discontinuity in the analysis; therefore, these data will be considered later for an additional comment. This supplementary evaluation of the available data can be useful to give a more up-to-date perspective into this market, since the statistical analysis have been performed on the 2021 dataset. More recent data can therefore help to possibly discover some insightful trends of the glute-free market over the years.

Pharmacy Distribution Channel

As already mentioned, the pharmacy distribution channel has been the precursor and the most important channel for all celiacs. However, as inferred in the previous analyses, the presence of the GDO channel is playing an important role in the market, increasing the overall demand of many gluten-free products. It is then interesting to examine how this distribution channel is facing its main competitor and the ever-growing gluten-free market. To do so, the aggregated data concerning all pharmacies in the gluten-free selling network have been considered, in the introduced timeframe.

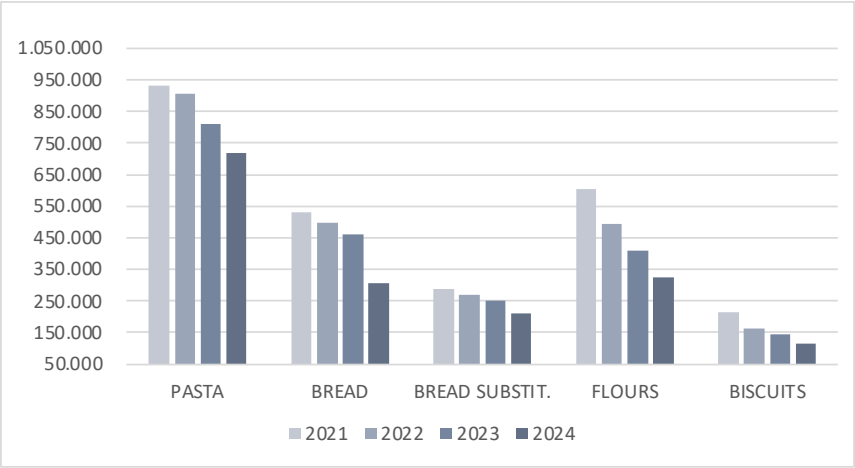

Figure 11: *Author's elaboration;* volumes trend in the pharmacy channel (from 2021 to 2024)

As shown in Figure 11, a clear reduction in the sales volumes has been uninterruptedly going on in the considered timeframe, for all the five food categories. This negative trend is the opposite of the prices trend. In Figure 12 below it is clear to see how prices (per kilogram) are constantly growing, except for Bread and Flours, for which the evolution of prices has seen a slight decrease from 2023 to 2024.

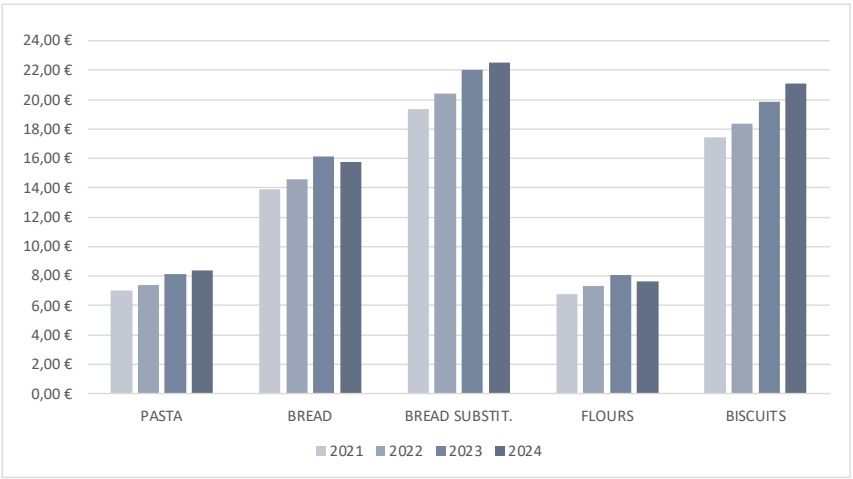

Figure 12: *Author's elaboration*; prices trend in the pharmacy channel (from 2021 to 2024)

	Pasta	Bread	Flours	Bread Subst.	Biscuits
2021-2019	-34625,00	-38598,00	74102,00	-4646,00	-25684,00
2022-2021	-25780,20	-32526,30	-110769,90	-16785,50	-51462,90
2023-2022	-94890,90	-80305,60	-108115,90	-33449,00	-19546,90
2024-2023	-93888,10	-112997,10	-61905,20	-26612,90	-30039,60

Table 14: *Author's elaboration*; GF items volumes variations in the Pharmacy distribution channel

The deltas in the sales volumes (considering the additional data concerning 2019) indicated in the previous table (Table 14), confirms that the volumes trend in pharmacies is negative. The only positive value of this six-years timeframe can be found for Flours in the 2019-2021 delta, as that timeframe coincides with the outbreak of the Covid-19 pandemic, in which people started to buy greater amounts of flours to cook and bake at home. Restaurants, coffee shops and pizzerias were indeed closed to the public due to the spread of the disease. Overall sales of flours have increased by 80% in this period, and they became the most purchased food item (Coldiretti, 2020).

Survey

A survey was conducted on a sample of pharmacies in the Piedmont region to understand how they are experiencing this phenomenon and how they are currently keeping up with the market of gluten-free products, considering the presence of a big competitor such as the large-scale distribution. The survey took place in the form of interviews in person or on the phone.

The first three pharmacies are in a metropolitan setting, namely in Turin (857.083 inhabitants), the fourth is in a small village (Garessio, 2.838 inhabitants), and the last two are in two medium-sized cities: Mondovì, with 22.165 inhabitants, and Cuneo, with 55.866 inhabitants (Istat, 2025).

In accordance with the numbers presented in the answers below, number 1 is Farmacia San Salvario (Turin), number 2 is Farmacia Comunale 42 (Turin), number 3 is Farmacia Porta Susa

(Turin), number 4 is Farmacia Manfredi (Garessio), number 5 is Farmacia Gasco (Mondovì), and number 6 is Farmacia Della Valle (Cuneo).

Questions

a. How many gluten-free products do you have in stock, on average?
    1. A few items, like 5 or 6 items just in case someone really needs them. We don't provide this service anymore. It has become unprofitable, and we stopped it in 2019
    2. More than 500 (estimate), we have a fully dedicated room in our pharmacy. We have all kinds of products, frozen foods too.
    3. More than 30 (frozen foods included)
    4. Around 30 items (no frozen foods)
    5. 200/300 items (frozen foods included)
    6. 20 brands, many product items for each brand (frozen foods too)

b. Did your stock quantities change in the last few years? Did the number of celiac customers increase/decrease/stall in these years?
    1. Every year we decreased our assortment because we saw a decline in the number of celiac customers shopping here. This resulted in too many costs for us, making it unprofitable to have someone managing this department.
    2. Both increased
    3. Stationary, both stock and customer numbers
    4. Stationary
    5. The stock has not changed much, we saw a little increase in the number of celiac customers
    6. Both increased

c. In the last few years, the GDO sector managed to increase its gluten-free foods production, making it possible to decrease a lot their prices, "stealing" part of the market that pharmacies had. Would you like to stop providing the service, leaving it to the GDO or not?
    1. Yes, that's why we stopped it
    2. No, we are very committed to this service, and we are constantly improving it
    3. No
    4. No
    5. No
    6. No, but only for niche products that the GDO does not sell

d. Why?
    1. Customers prefer the lower prices that only the GDO can provide, and it is also easier for them because they don't have to diversify their grocery shopping by going to both supermarkets and to the pharmacy.
    2. Because we are a reference point here in the city center. Other than us, there is only one big, specialized shop.
    3. Because our clientele is made of regular customers, they always come gluten-free shopping here and usually buy medicines too.
    4. Because we think it is an essential service in all small communities and villages that don't have access to a nearby well-stocked supermarket. So, it is a useful service that we are happy to provide, for small grocery shopping runs. We also provide the products that our customers ask us by making customer-specific orders.
    5. Because ours is a regular clientele, that usually spends the total amount of the monthly voucher here.
    6. Because we supply also peculiar foods that are rarely found in supermarkets and because of our regular clientele.

Results

These interviews show that celiacs still choose to shop at their local pharmacies due to convenience, but mostly in provincial areas. In a big city like Turin the number of pharmacies that sell gluten-free products is very limited: only a pharmacy (no. 2 in the interview) and a specialized shop provide this service in the three most central neighborhoods in Turin (which house circa 113.000 inhabitants) (Comune di Torino, 2023). Besides, that pharmacy's gluten-free stock is much bigger compared to the average stock that an average affiliated pharmacy can supply; it seemingly resembles a specialized shop. The concept of pharmacies as a proximity service has been reinforced by this interview, and its popularity can even be assessed in medium-sized cities that are also equipped with supermarkets. This can be due to the convenience of making more frequent smaller purchases in the pharmacy close-by rather than going to the supermarket, activity that is preferred when it comes to ampler food shopping. It is also important to remark that in some Regions GDO chains are not affiliated to the network and therefore celiacs necessarily must spend the voucher in pharmacies and/or specialized shops.

Pharmacies are also important in smaller town and villages, as they provide a "tailored" service to the customer. Since the available stock is limited to fewer units compared to stores and supermarkets, they offer an ordering service (that retailers, on the other hand, don't offer) to meet customers' demand. This service can be considered an advantage for a celiac patient, but, since the amount of the monthly voucher is the same for every celiac person (considering a single age group and sex), it may result in a lower purchasing power of the celiacs living in small towns or villages. Since the pharmacy represents the only (or the closest) selling point, the consumer has then to adapt to its proposed prices or he must bear the inconvenience of a longer trip to the closest store/supermarket. As emerged from the survey, pharmacies solve this setback by offering a proximity service, but that comes with higher prices.

Despite the threat of the GDO competitor, the gluten-free section appears still to be profitable for pharmacies, who are not willing to abandon this market, leaving it to large-scale distribution chains. Quite the opposite, since this competition does not seem to threaten pharmacies; it is not enough to induce pharmacies to lower down the prices they offer to the consumers.

GDO Distribution Channel

Aggregated data (provided by AIC) gathering hypermarkets, supermarkets and stores will be now used for what concerns this other relevant distribution channel. Since the whole previously conducted analysis was made to represent the perspective of gluten intolerant people and their choices when it comes to gluten-free food purchases, discount stores won't be included as they usually don't accept the monthly voucher. Again, aggregated volumes and average prices will be considered, to look at this "newer" distribution channel for gluten-free products.

In contrast to the pharmacy distribution channel, a trend cannot be fully identified for what concerns sales volumes in the GDO sector. As Figure 13 shows, overall sales of pasta, bread and biscuits have increased in the last four year, but bread and biscuits only saw a slight increase. On the other hand, bread substitutes and flours sales had a more fluctuating evolution in this timeframe, with sales growths and reductions.

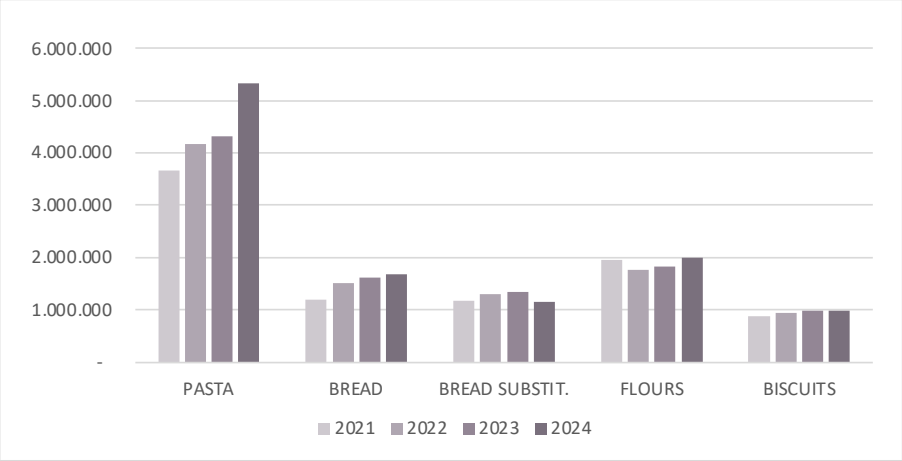

Figure 13: *Author's elaboration*; volumes trend in the GDO channel (from 2021 to 2024)

Observing prices now, it is possible to notice from Figure 14 below how a mild increase in average prices (per kilogram) is present in all five analysed food categories. The increase is however subtler than the growth observed in the pharmacy distribution channel.

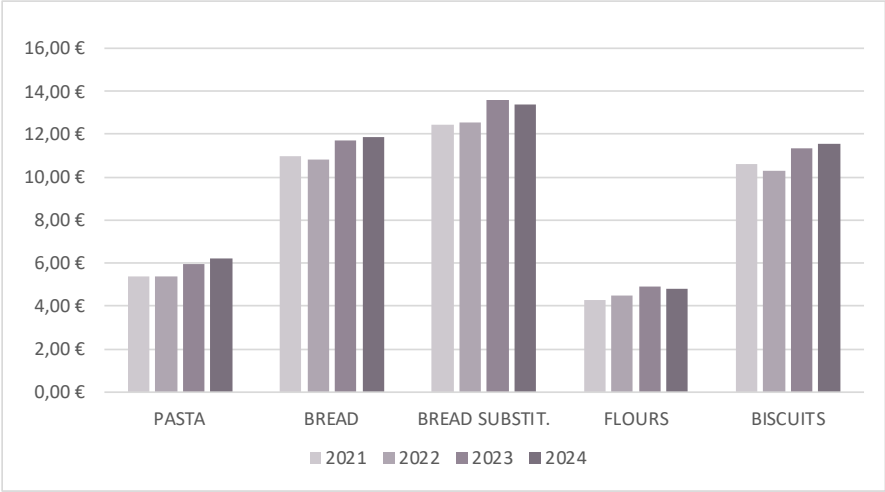

Figure 14: *Author's elaboration*; prices trend in the GDO channel (from 2021 to 2024)

A side-by-side comparison between the prices of the two distribution channels was already presented in Chapter 1.

In conclusion, the GDO distribution channel is somewhat a new actor in the gluten-free market in Italy, but its presence is already well established. As previously mentioned, not all GDO chains allow the use of the monthly voucher provided by the National Health Service, placing this sector at a disadvantage compared to the pharmacy distribution channel.

Conclusion

The objective of this dissertation was to gain a perspective, as feasibly comprehensive as possible, on the gluten-free market in Italy from the point of view of a celiac person; indeed, the focus was on the end consumers and on their demand of gluten-free foods, which are the factors that impact it and the overall equilibrium. This topic has not been widely studied or discussed so far in the literature, so the aim of this work was to help fill the gap in understanding this matter from an economic (but not only) point of view. The current number of Celiac Disease diagnoses and the estimate prevalence are increasing year by year, making this topic of growing scale and importance. The normative, social, and health-related backgrounds were necessary to gain a better understanding of the underlying mechanisms of this odd market, and they served the purpose of completeness. Because gluten-free products have always been more expensive than their gluten-containing counterparts (more than three times more, on average, as emerged from the analysis in Chapter 1) the economic weight of a lifelong gluten-free diet can impact the wellbeing of every celiac patient. But the burdens faced by celiacs also extend to the social and health-related spheres, especially for younger people who spend more time outside, and even more so in Italy, where eating out and sharing meals are highly valued occasions. Finding gluten-free foods when outside can be a challenge sometimes, due to the limited awareness and knowledge on this matter by restaurants and other establishments, which can also lead to accidental cross-contaminations. Partially or fully not adhering to the gluten-free diet has health repercussions in both the short and long term. All these factors may negatively impact the perceived quality of life of people with celiac disease and their loved ones. The price premium for gluten-free foods is not limited to purchasable products found on shelves but also to meals served in restaurants. The monthly financial aid was introduced in 1982, but it is only spendable on packaged gluten-free products. Explaining how the monthly voucher that the National Health Service provides to the Italian celiac population is regulated and how it works was useful to understand and depict the current economic situation. It is also worth knowing that, since the monthly voucher value has not changed since its 2018 revision, a loss of the "purchasing power" that the voucher provides is ongoing, due to constant increases in prices. Glute-free products that can be purchased with the voucher can be found in four different distribution channels: pharmacies, specialized shops, online (on dedicated websites), and large-scale distribution. The

conducted analyses have shown how the pharmacy channel is the most established distribution channel, as it was the first to ever provide gluten-free products, but also that its competitor (the GDO channel) is slowly acquiring power on this market, thanks to its cheaper prices. The online and specialized stores distribution channels have not been studied, due to the lack of data regarding them. Indeed, the econometrics analysis only focused on the GDO and the pharmacy channels. Made via a linear and a log-log transformed regression models, this analysis allowed to observe the consumer preferences towards gluten-free products, such as the impact of the brand image and of the monthly voucher, but, most importantly, the role of prices.

Overall, the results are consistent between the linear and the log-transformed models, reinforcing their reliability and soundness. The only exceptions regard the geographical variables and the variable representing the format of the voucher, for which the two analyses present substantial differences. In these two cases the considered results refer to the log-transformed models as, for dummy variables, this transformation can produce more accurate results than the linear model when the data present big scale differences. Indeed, a dummy variable may have little linear impact (not significant), but a large proportional effect, which becomes clear in the log model. For what concerns the partitioning of the Italian regions, it seems that (in the log-log model) the dummy variable representing insular Italy (Sicily and Sardinia), $D_{Insular}$, majorly impacts the demand. Anyhow, this result may be distorted, as the $D_{Insular}$ variable and the $D_{Digital}$ variable are intrinsically correlated. These poor results of the dummy variables concerning the partitions and the format of the voucher (due to the bias of the two Italian isles) highlight, however, the existence of a link between the voucher format and the demand.

On the other hand, the other variables followed approximately the same trend pattern in both models. The model was able to successfully grasp the effect of the prices on the gluten-free food demand, and to produce reliable results concerning this variable, that was statistically significant for three out of the five food categories (Pasta, Bread and Flours). The initial hypothesis of the negative impact of prices on demand is confirmed by the results; if prices increase, they can reduce the demand for these three categories of gluten-free foods, whereas both the demands of Bread Substitutes and Biscuits would not be affected.

The positive impact of the salespoint being a GDO retail store is significant for Pasta and Biscuits, while it is insignificant for the other food categories. Lastly, the brand name of gluten-free foods being Schaer also uncovered its impact on the demand, mostly for bread and flours, while trivial

for biscuits. Also the two most known pasta brands (Barilla and Rummo) did not prove to be relevant on the overall pasta demand.

The additional survey conducted on a sample of pharmacies can be representative of the situation that pharmacies and celiacs face when selling and shopping for gluten-free foods in the Piedmont region, but due to the limited samples of interviewed pharmacies (also due to time constraints) the results cannot be extended to all Italian territory.

In conclusion, since the effect of the voucher could not be properly estimated with the presented models, it would be of interest to focus the attention on this topic. Indeed, it can be debated that the presence of the voucher may lead the consumer to a pumped number of purchases or that the consumer won't pay a lot of attention to the price, rising its willingness to pay. This scenario is true for the bread food category, in which the effect of the brand (and what follows, like affinity with the brand or preferred taste) has the same magnitude of price, but in the opposite direction. Another issue can be found in the presence of the voucher in the current economic scenario, such as the inexistent need, for gluten-free food producers, to lower their prices to be more attractive on the market. For all intents and purposes, the National Health Service is paying for a big share of these products; the celiac population is the end consumer, but the government appears to be the customer.

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