Does a Deposit Have an Effect on Sales?

An Empirical Analysis of the Effect of the Increased Deposit on Beverage Containers in 2018 on Sales in Norway

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Abstract

A possible instrument to reduce plastic pollution is a Deposit Refund System. In 2018, the deposit in the Norwegian Deposit Refund System was increased to enhance the motivation of the consumers to recycle beverage containers, and thus reduce littering. This paper exploits the rollout of products with an increased deposit in Norway, which commenced in 2018, to study the effect on sales. We use a generalised differences-in-differences strategy to identify the causal effects.

Our results indicate that the increased deposit had a small negative effect on sales for products with an increased deposit. More specifically, we find that the increased deposit led to a [redacted] percent decrease in sales. We also conduct a separate analysis for the two different deposit levels of NOK 2 and NOK 3. The effect of the increase from NOK 1 to NOK 2 was stronger than our baseline result, and suggests a [redacted] percent decrease in sales. We find no evidence of an effect of the increase from NOK 2.5 to NOK 3 on sales. In addition, we find that the effect in different chain concepts varies.

There is wide acceptance of the positive effect of a deposit on recycling. However, there is little knowledge about the effect a deposit might have on sales. We add to this by presenting evidence that an increased deposit on beverage containers has a small negative effect on sales.

Abbreviations and Acronyms

BROD	The Norwegian Brewery and Beverage Association
DRS	Deposit Refund System
DiD	Differences-in-Differences
EAN	European Article Numbering
GDiD	Generalised Differences-in-Differences
MCE	The Ministry of Climate and Environment
NEA	Norwegian Environment Agency
NG	NorgesGruppen
OECD	The Organisation for Economic Co-operation and Development
OVB	Omitted Variable Bias
RVM	Reverse Vending Machine

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1 Introduction

1.1 Motivation and Purpose

In recent years, plastic pollution has been recognized as one of our greatest environmental challenges (Global Environment Facility, 2019). A study published by Marine Pollution Bulletin estimate the cost of plastic pollution in the world oceans to be 3.5 trillion US Dollars per year (Beaumont et al., 2019). Plastic bottles and plastic bottle caps are two of the most found items on clean-ups worldwide (Ocean Conservancy, 2019). The environmental impact of plastic has become a growing political issue and governments seek to fight the problem through policies and restrictions.

In the search for solutions, Deposit Refund Systems (DRS) have gained a lot of attention. These systems motivate the consumer to recycle a product by charging them a refundable deposit when they buy it. In Europe, ten countries have implemented a DRS for beverage containers in various forms, and an increasing number of countries is on the verge of doing so (Eunomia, 2019).

The Norwegian DRS for plastic bottles and metal cans has in recent years received increased international attention for its design and success. International news agencies such as The Guardian and Deutsche Welle have pointed out the system (The Guardian, 2018; Deutsche Welle, 2018). In addition, representatives from countries who are considering implementing a similar system have visited Infinitum, the operator of the Norwegian DRS (Infinitum, 2019). In 2018 cans and bottles achieved a return rate of respectively 87.3 and 88.6 percent (Infinitum, 2019). Still, around 170 million cans and bottles were not returned. To boost the return rate further the deposit was increased in 2018, it having been constant since the systems introduction in 1990 (Infinitum, 2018d). In the discussions prior to the increase, different stakeholders raised their concerns regarding the size of the increase in the deposit and its potential effect on sales (Infinitum and BROD, 2017).

Whether and at what level a deposit has an effect on sales is the core of the debate. In 2016, Petter Nome, the director of The Norwegian Brewery- and Beverage Association (BROD) at that time, warned that an increase in the deposit could be perceived as an increase in the price for the consumer (Dagbladet, 2014). The aim of the deposit is to motivate consumers to recycle, however there is little empirical evidence exploring the effect of a deposit on sales. This thesis aims to add to the literature by investigating how the increase in the deposit in 2018 affected beverage sales in Norway.

To our knowledge, this is the first paper of its sort investigating the effect of a refundable deposit on sales. The results can therefore contribute to the existing knowledge on a DRS and its effect on sales. From an economic view, it is also interesting to analyse whether the increase in the deposit has an effect on the behaviour of consumers, as it is refundable and thus does not equal an actual price increase.

We use a generalised difference-in-difference strategy (GDiD), exploiting the rollout of the increased deposit on beverages in 2018. We contrast the development of sales for products that received an increased deposit at any given time with products that had not yet received the raise in the deposit or that do not have a deposit. By controlling for product-shop specific effects and time specific effects, our estimates give the causal effects of the increase in the deposit on sales.

We use data from NorgesGruppen (NG), and measure sales as the number of units sold per week for each product in a specific shop. Sales is log transformed. Thus, the effect of the increased deposit can be interpreted as the percentage change in sales. In addition to our main analysis, we will conduct a separate analysis accounting for different chain concepts. See Section 4.1 for an explanation of chain concepts. Both analyses will be used on three samples. First we will use a total sample consisting of all products in our data set. Then, we will use a sample only consisting of small bottles, where all products in the treatment group receive an increase in the deposit from NOK 1 to NOK 2. Lastly, we will use a sample only consisting of big bottles, where all products in the treatment group receive an increase in the deposit from NOK 2.5 to NOK 3.

We find that the increased deposit in 2018 had a small negative effect on beverage sales for products with an increased deposit. More specifically, we find that the increased deposit led to a [redacted] percent decrease in sales. Our results further indicate that the increased deposit had a slightly negative effect on the sale of small bottles, while we find no evidence of an effect on the sale of big bottles. The effect on the sale of small bottles suggest that the increased deposit led to a [redacted] percent decrease in sales. When looking at the effect on different chain concepts, we find that the effect of the increase in the deposit varies.

1.2 Research Question

As the economic literature on the effect of an increased deposit on sales is limited, we were motivated to study possible impacts of such an environmental instrument. More specifically, we want to shed some light on how a raise in the deposit affects beverage sales. Thus, the aim of this thesis is to investigate the following research question:

How did the increase in the deposit in 2018 affect beverage sales in Norway?

The remainder of the paper is structured in the following way. First, in Chapter 2, we give a brief overview of a DRS, the Norwegian DRS, the increase in the deposit, and the development of beverage sales in Norway. Then, in Chapter 3, we present relevant theories and literature. In Chapter 4 we give an overview of our data, and in Chapter 5 we expand on our empirical strategy. Our results are presented in Chapter 6, and Chapter 7 discusses the findings and limitations of our paper. Lastly, our conclusions are presented in Chapter 8. Bibliography and Appendix can be found at the end of the paper.

2 Background

2.1 Deposit Refund System

The Organisation for Economic Co-operation and Development (OECD) defines a Deposit Refund System as "the surcharge on the price of potentially polluting products. When pollution is avoided by returning the products or their residuals, a refund on the surcharge is granted" (OECD, 2001). These systems are also known as deposit schemes or bottle bills, and are typically initiated through legislation by state or national governments (Tomra, 2018).

The main idea behind a DRS is to avoid pollution. Pollution is a negative externality. In other words, the effect of production or consumption of goods and services imposes costs on others that are not reflected in the prices of the goods and services being provided (OECD, 2003). A DRS attempts to minimize pollution by encouraging the consumers to recycle. The deposit is used as an economic incentive for consumers to return the potentially polluting products.

A DRS typically focuses on specific goods such as bottles and cans. Large quantities of well-sorted materials are collected which reduces contamination with other waste types. This further reduces sorting costs and enables high quality recycling (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2019). A DRS may thus potentially avoid pollution through 1) the reduction of littering, 2) conservation of energy through the recycling of used packaging, and 3) preventing the manufacturing of raw materials for new packaging.

Both the introduction and maintenance of a DRS impose costs. There are costs associated with running the system and with processing and disposing the used containers according to government regulation. These costs are to a varying degree covered by the revenues from selling the processed containers for further use and by the unredeemed deposits.

The principles and framework conditions of a DRS differ between states and countries. The most commonly covered items under a DRS are metal cans, plastic, and glass containers. In the different systems, details such as whether the deposit is paid by the producer or consumer, whether the deposit and refund is linked or differs, the visibility of the deposit, and the funding and role of the central system operator, varies.

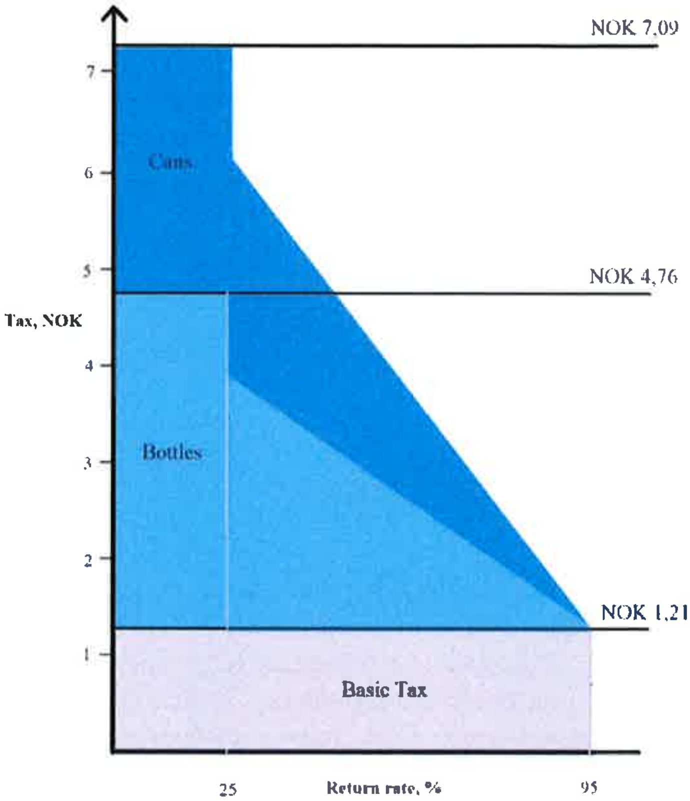
2.2 The Norwegian DRS

The Norwegian DRS for plastic bottles and metal cans is motivated by the design of the environmental tax on beverage containers (Ministry of Finance, 2007). The tax on beverage containers is composed of two elements. The first part is a basic tax of NOK 1.21, that covers all types of beverage containers[1]. The second part is an environmental tax[2] that decreases from a 25 percent return rate and is totally removed at a 95 percent return rate. Figure 2.1 illustrates how the size of the environmental tax on metal cans and plastic bottles decreases with the return rate. The higher the return rate, the lower the environmental tax on beverages. The environmental tax varies between different types of beverage containers. Glass and metal containers have the highest tax, at NOK 5.88 per container. Plastic bottles have an environmental tax at NOK 3.55, while cardboard beverage containers have an environmental tax at NOK 1.45 (Norwegian Tax Administration, 2018).

[1]The tax must be paid if the beverage container can not be reused in its original form. The exceptions are milk and dairy products, beverages produced of cocoa and chocolate and concentrates of this, goods in powder form, corn and soy based milk substitutes, and infant formula.

[2]Beverage containers that are used for beverages in powder form and infant formula are exempt from the environmental tax.

Figure 2.1: Relationship Between Tax and Return Rate



Notes: This figure shows how the level of environmental tax for both metal cans and plastic bottles decreases with an increasing return rate. The environmental tax starts decreasing from a 25 percent return rate, and is fully removed at a 95 percent return rate. The basic tax is not affected by the return rate.
Source: Adapted from Infinitum (2018c).

The link between the return rate of beverage containers and the amount of environmental tax which is imposed, gives the producers an economic incentive to achieve a high return rate and encourage consumers to recycle. In 1996 Norsk Resirk, now Infinitum, was established by the beverage producers and the Norwegian grocery industry to operate the Norwegian DRS for recyclable plastic bottles and metal cans (Infinitum, 2018b). In 2018, cans and bottles achieved a return rate of respectively 87.3 and 88.6 percent through reverse vending machines (RVM). Infinitum further reported that they control more than 95 percent of the cans and bottles (2019). The environmental tax is thus removed for the products that are included in the DRS, and gives producers of beverages an economic incentive to be part of the system.

In the Norwegian DRS, the consumer pays a deposit on top of the retail price when buying a product that is included in the DRS. The deposit is not part of the retail price. The deposit is labeled on the product itself and on the price tag. The label on the product is universal and should have a minimum size of 9 mm (Infinitum, 2018a). On the price tag, the deposit is less visible than the retail price. The entire deposit is refunded when the consumer delivers the beverage container at a RVM or other approved collection points. The retailers operate the RVMs, and receive a handling fee per beverage container collected. The deposits are collected by Infinitum, and they receive a net revenue if all containers are not returned by the consumers.

2.3 Increase in the Deposit

In 2018 the deposit in the Norwegian DRS increased from NOK 1 to NOK 2 for beverage containers containing up to 0.5 litres and from NOK 2.50 to NOK 3 for beverage containers above 0.5 litres (Infinitum, 2018d). According to the Ministry of Climate and Environment (MCE), there were two main reasons for the increased deposit. First, they wanted to increase the incentive to return empty bottles and cans, and thereby contribute to the reduction of plastic pollution. Second, the old rates of NOK 1 and NOK 2.5 had not been adjusted for inflation since the 1990s, and the real value was therefore halved (The Norwegian Government, 2017b). In addition, several stakeholders had pointed out that the levels of the old deposits were too low in order to avoid pollution and ensure the desired return rate (Infinitum and BROD, 2017).

The new rates were available to be implemented from the 1st of January 2018, and the final implementation date was due the 3rd of September 2018 (The Norwegian Government, 2017b). To separate beverages with the old and new deposit in the transition-period, the producers were asked to update the European Article Numbering (EAN) code parallel to updating the deposit. The EAN-code is a bar coding standard used to identify products. This enabled all actors in the value chain to separate products with the old deposit from products with the new deposit. The update in the EAN-code prevented retailers from charging and refunding customers a too high or low deposit. As it is most critical to avoid this for products with high sales, products with high sales were prioritised by Infinitum. Infinitum asked all beverage producers to create a list of products that account for minimum eighty percent of their sales. These products had to update the EAN-code. The EAN-code was not updated for the remaining products, those accounting for less than twenty percent of a producers sales. The remaining products were registered with the increased deposit on the 3rd of September 2018. Retailers were asked to introduce the products with the updated label on this date. Some customers may however have received a higher deposit, if they bought a product before the 3rd of September and refunded the product after the 3rd of September. Note that the producers had to update the EAN-code within the 3rd of September. As it takes some time for the inventory of a retailer to be updated, products with the old EAN-code could still be present in the market after the 3rd of September (Infinitum, 2018d).

In parallel to the increase in the deposit, a label requirement for products with a deposit was introduced. The requirement stated that deposit labels should have a minimum size of 9 mm (Lovdata, 2017). The introduced label requirement aims to ensure that consumers easier can separate beverage containers with and without a deposit. The new requirement of the labelling was also implemented by the 3rd of September 2018.

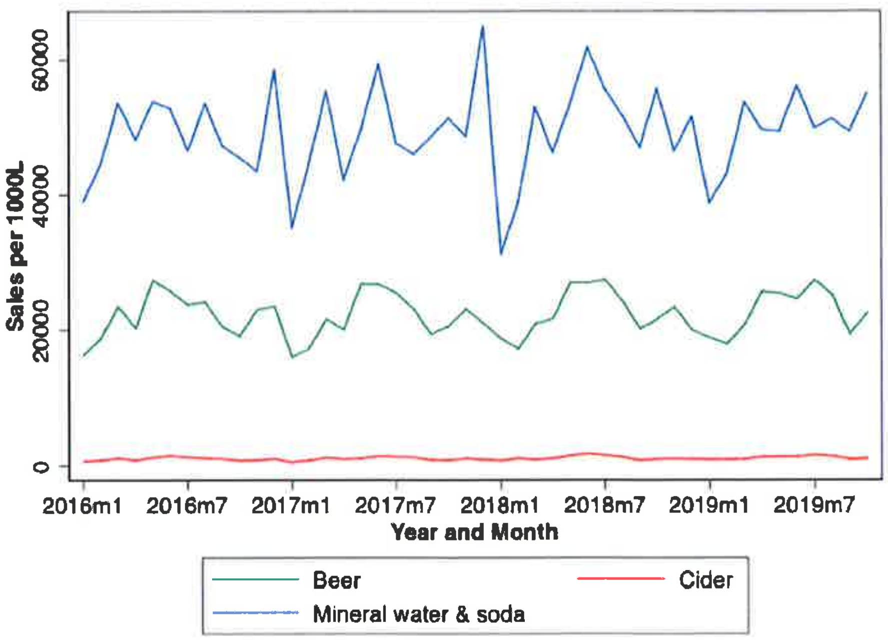
In 2014 the Norwegian Environment Agency (NEA) proposed the same increase in the deposit that was implemented in 2018 (2015). The change was not implemented in 2014. BROD opposed the increase in the deposit. Petter Nome, the director of BROD at that time, warned that the consumers may perceive the increase in the deposit as an increase in the price (Dagbladet, 2014).

Before the decision to raise the deposit in 2018 was made, stakeholders had the chance to raise their opinion in a hearing. The environmental organization The Norwegian Society for the Conservation of Nature proposed an increase in the deposit to respectively NOK 3 and NOK 5 (2017). Both Infinitum and BROD, on the other hand, warned that a high deposit could increase cross border trading and create distortion in the competition (2017). They further commented that the deposit may be perceived as a cost by some consumers which could cause them to prefer products without a deposit, and thereby affect sales.

2.4 Beverage Sales in Norway

In 2018 there was a turnover of around NOK 19 billion related to retail trade of beverages in non-specialised stores in Norway (Statistics Norway, 2019). Figure 2.2 shows the total sales of beverages in Norway[3] by different beverage categories, measured in 1000 litres, from 2016 to 2019. It can be observed that mineral water & soda has a substantial portion of the total sales compared to the other beverage categories. It is then followed by beer. Note that juice, coffee, and tea are not included in this figure.

Figure 2.2: Total Beverage Sales in Norway by Beverage Category



Notes: The figure shows the development of total beverage sales in Norway by different beverage categories, measured in 1000 litres. The category mineral water & soda contains the beverage groups soda, water and energy drinks. The time period is from January 2016 to October 2019.
Source: BROD (2019).

[3] Sales of beer comprises over 100 of Norways largest breweries and all imported beer. Sales of cider comprise all suppliers in Norway except small local producers. Sales of mineral water & soda comprise all soda producers in Norway, all water producers except the brand Isklar, and all energy drinks suppliers in Norway.

Total sale of soda was stable in 2016 and 2017 at around 480 million litres per year. However, in 2018 the sales dropped to 460 million litres (BROD, 2019). Numbers from BROD shows that the loss in sales is approximately 4.32 percent from 2017 to 2018, and that this is the weakest sales in 10 years (E24, 2019b).

In addition to the deposit, some beverages are covered by a tax on non-alcoholic beverages and an alcohol tax on alcoholic beverages. The sugar tax on non-alcoholic beverages[4] was raised by approximately 42 percent from the 1st of January 2018 (The Norwegian Government, 2017a). Petter Nome, director of BROD at the time, stated that the fall in sales in 2018 may be due to the raise in the sugar tax on sweetened beverages (Dagens Næringsliv, 2018). He further emphasized that this tax has led to increased cross-border trading with Sweden (E24, 2019b). Statistics from Norwegian beverage companies show an increase in soda sales along the Swedish border of about 40 percent from June 2017 to June 2018 (Dagens Næringsliv, 2018). In addition, numbers from Infinitum show an increasing trend in Swedish beverages deposited in Norway (E24, 2019a), which could indicate an increase in the border trade of beverages.

[4]The tax on non-alcholic beverages comprise beverages with added sugar or sweetener, commonly referred to as the sugar tax. Beverages containing natural sugar is not affected by the tax.

3 Literature Review

There is a growing attention to the economic implications of a Deposit Refund System, but there is to our knowledge no empirical papers exploring the effect of an increase in a deposit on beverage containers on sales.

In the following section we will present theories and literature on DRS and taxation that we found most relevant for our paper. We will first examine a paper that presents a framework for analyzing consumer costs in a DRS. Second, we will present a simple model on attention within behavioural economics. Third, we will present papers exploring the effect of a DRS and tax on sales. Lastly, we will discuss what implications the theories and literature has for our paper.

3.1 Theoretical Approach

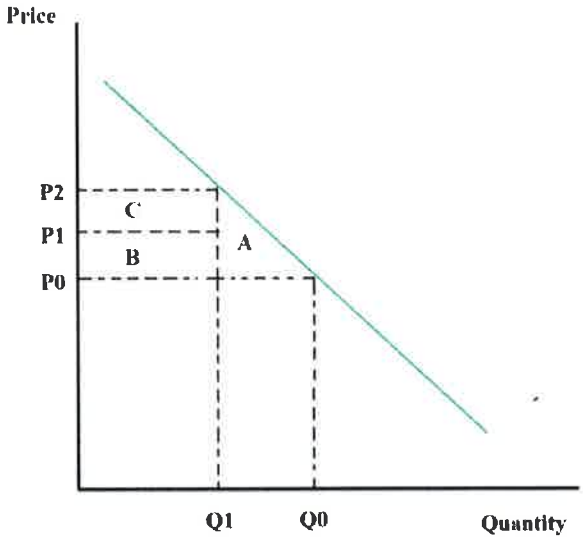
Naughton, Sebold, and Mayer (1990) present a framework for analyzing consumer costs in a DRS. The DRS that these authors are examining, The California Beverage Container Recycling and Litter Reduction Act, is different from the Norwegian DRS. However, the framework presented in this paper can give us an indication on how the price of the consumer will be affected by an increase in the deposit, and thus affect sales. Similar frameworks have been used by Porter (1983) and Pearce and Turner (1993).

In the paper by Naughton et al. (1990) they analyze the impacts of a beverage container recycling and litter reduction legislation act in California. More specifically, they examine both the consumer costs and benefits of the legislation. To examine the impact on the consumer surplus, they present a framework illustrated in Figure 3.1. As shown in Figure 3.1, the increase in the price of the consumer is twofold. The first part of the increase, $P_1 - P_0$, where (P_0, Q_0) represents the point prior to the legislation, is the increase in the higher money price. The new money price is given by equation (3.1).

$$P_1 = P_0 + (\text{retail price increase}) - (\text{return rate}) * (\text{increase in return value}) \\ - (\text{increase in return rate}) * (\text{prelegislation return value}) \tag{3.1}$$

As shown in equation (3.1), the new money price of the consumer depends on the increase in the retail price (the increase in the price paid in-store), the return rate and return value prior to and after the legislation. Thus, the new money price does not equal the retail price, but depends on the return rate of the consumers. A high return rate and high increase in the return rate will lower the new money price. If the increase in the retail price equals the increase in the return value, consumers will only experience an increase in their money price if they do not return the beverage containers. For instance, if there was a return rate of zero percent prior to the legislation and it increased to a 100 percent after the legislation, the consumer would not experience an increase in the money price.

Figure 3.1: Potential Loss in Consumer Surplus



Source: Reproduced from Naughton et al. (1990).

The second part, $P_2 - P_1$, is the increase in the price due to the inconvenience cost. There are two countervailing factors that influence a consumer's total inconvenience costs. First, it is the "mental" benefit of recycling for environmental reasons. If a consumer perceives this as large enough, the inconvenience costs will be negative, and the consumer will recycle even without a deposit. Second, the inconvenience costs are all the extra costs that appear for the consumer when returning the products to the collection point, such as transportation costs and storage costs. As a result of the increase in the price due to the inconvenience costs, the consumers lower their demand for the products to Q_1. Area A and C will then represent the dead weight loss and thus welfare loss. Area B represent the loss of consumer surplus due to the higher money price. This loss will however be transferred to the government or company that receives the net revenues from the deposits, and will thus not represent a dead weight loss.

To examine the net impact of the legislation, the authors further analyze the benefits that the consumers derive from the legislation through reduced littering. They argue that reduced litter provides two benefits for society. First, it is the aesthetic or "eyesore" costs. These are intangible and hard to measure. Second, it is the reduction in pickup costs, which are tangible and easier to measure. These benefits reduce the negative externalities outside of the framework presented above, and might increase the overall welfare surplus.

3.2 Behavioural Economics - Salience and Taxation

In the following section we will present a simple model on attention and studies exploring consumers attention to less visible components of a price. As the deposit in the Norwegian DRS is not fully visible on the price tag, this model and the following studies may give us an indication on how attentive consumers are to a change in the deposit.

DellaVigna (2009) outlines a model where attention is a scarce resource. He argues that a value of a good is determined as a sum of two components, expressed in equation (3.2).

$$V = v + o \tag{3.2}$$

V is the total value of a good, which consists of a visible component, v, and an opaque component, o. As consumers have limited attention, they perceive the value of the opaque component, o, dependent on the degree of inattention. The degree of inattention is expressed by θ. Thus, the perceived value, $\hat{V}$, of a good is expressed in equation (3.3).

$$\hat{V} = v + (1 - \theta)o \tag{3.3}$$

Here, $\theta = 0$ means full attention, while $\theta = 1$ means full inattention. Further, the degree of inattention is a function of the salience, s, of o and the number of competing stimuli, N. Thus, $\theta = \theta(s, N)$. The consumer will be more attentive, the more salient o is. Further, the consumer will be less attentive with more competing stimuli.

Two studies conducted by Chetty, Looney, and Kroft (2009) in the United States (US), find that consumer inattention to non-transparent taxes is substantial. In their first study, they compare the sales of products when manipulating the salience of a tax. They observe a decrease in sales after making the tax of a product visible on the price tag. In their second study, they examine whether the effect of a change in an excise tax is higher than a change in a sales tax on beer consumption. In the US, an excise tax is included in the price tag, thus visible, while a sales tax is added at the register, thus less visible. They observe that consumers are more sensitive to changes in an excise tax than in a sales tax. The results from these studies indicate that the effect of a change in a tax on sales depends on the visibility of the tax. More specifically, that salience is an important determinant of behavioural responses to taxation.

3.3 Effect of DRS on Sales

This section will present the effects of introducing a DRS on beverage sales. To our knowledge, there is no empirical papers exploring the effects of introducing a DRS on sales. There are however papers predicting and observing the effect of introducing a DRS on sales.

Denslow, Chavez, Romero, Holt, and Dewey (2011) use a cost-benefit analysis and economic theory to study the effect of introducing a DRS in Florida. In the paper, they argue that the effect on beverage sales is likely to be zero. This conclusion is based on the assumption that i) the deposit and handling costs are low relative to the beverage prices, ii) beverage consumption responds far less than proportionally to price increases, and iii) consumers cannot easily avoid the price increase by substituting one beverage for another if the deposit is charged on almost all easily substituted beverage containers.

Another study done by Berck and Goldman (2003) found no evidence of a decline in the sale of non-carbonated beverages after those drinks were added to California's Deposit Return Scheme in 2000.

3.4 Effect of a Sugar Tax on Beverage Sales

This section presents the effects of a sugar tax on beverage sales. Different from the deposit, the sugar tax is non-refundable. However, results from such an analysis can give us an indication on how sensitive consumers are to changes in the price. In addition, this tax is targeted directly at a product group that we are analyzing, soda, and it will therefore be interesting to examine.

The sugar tax consists of three different taxes aimed at different product groups. We are interested in the excise tax on alcohol-free beverages which in the media is referred to as the "sugar tax". As stated in the Norwegian State Budget of 2018, the excise tax on alcohol-free beverages consists of beverages with added sugar or sweeteners (The Norwegian Government, 2017c). Recent work by Steen and Ulsaker (2019) analyze the effect of an increase in the Norwegian sugar tax on soda. They find empirical evidence for a negative relationship between the raise in the sugar tax and sale of soda. Specifically, they found that the raise in the sugar tax led to an 11 percent reduction in the sales of soda. They argue that this indicates that soda meets an elastic demand.

Furthermore, there are several studies analyzing the effects of introducing an excise sugar tax on beverage sales. Colchero, Guerrero-López, Molina, and Rivera (2016) examines the changes in per capita sales of sugar sweetened beverages and plain water after the tax was implemented in Mexico in January 2014. They found that the implementation of the sugar-tax led to a 7.3 percent decrease in per capita sales of sugar sweetened beverages and an increase of 5.2 percent of per capita sales of plain water. The findings are consistent with a study done in the US (see Falbe et al., 2016).

3.5 Implication for our Study

The framework presented by Naughton et al. (1990) suggests that an increase in a deposit may have an effect on the price, and thus affect sales. The increase in the price however both depends on the increase in the money price and the increase in the inconvenience costs. In the Norwegian DRS, both the increase in the retail price and the increase in the return value equals the increase in the deposit. The deposit is not included in the retail price in the Norwegian DRS, however it is part of the price that the customers pay in-store. We thus interpret the increase in the retail price as the increase in the deposit. Thus, according to equation (3.1), the consumer will only experience an increase in the price if they do not return the beverage containers. This implies that if more consumers return the beverage containers after the increase in the deposit, their money price might be lower after the increase in the deposit as they now get the deposit refunded. As the return rate in the Norwegian DRS is high, and is expected to increase after introducing the new deposits, one could expect the price increase to be small. As an example, if we look at a product that increased the deposit from NOK 2.5 to NOK 3 with a retail price of NOK 25 and assume that the return rate was 85 percent before the increase in the deposit and 87 percent after the increase in the deposit, the increase in the price would equal:

$$\begin{aligned} P_1 &= \text{NOK } 25 + \text{NOK } 0.5 - 0.87 * \text{NOK } 0.5 - 0.02 * \text{NOK } 2.5 \\ &= \text{NOK } 25.015 \end{aligned} \tag{3.4}$$

Second, as we are looking at an increase in the deposit in an already existing DRS, we do not expect an increase in the inconvenience costs for the consumers who returned the beverage containers both prior to and after the increase in the deposit. There could however be an increase in the inconvenience costs for the consumers that begin returning the beverage containers after the increase in the deposit.

Using this framework, we would then expect the increase in the deposit to only have a small positive or no effect on the price of the consumer and thus to only have a small negative or no effect on sales. If the increase in the return rate is high, the price of the consumer could actually be lower than before the increase in the deposit, and thus have a positive effect on sales. The consumer might also experience benefits from the increase in the deposit, through less littering. These benefits are however difficult to measure, and in this paper we will focus on the effect an increase in the deposit will have on sales.

In the model of DellaVigna (2009), the deposit can be defined as an opaque component of the value of a good as it is less visible to the consumer. The findings of Chetty et al. (2009) indicate that the consumers are inattentive to changes in this opaque component when making a purchase. As these findings originate from the US and examine a tax, they are not directly transferable to our context as we look at a deposit in Norway. These findings could however indicate that the effect of an increase in the deposit on sales might be smaller than expected, due to the inattention of the consumers. In addition, we are examining a deposit which is refundable, not a tax, and this might further indicate that the consumers experience no change in the value of a good. If the customers do not experience a change in the value of the good, we would expect the increase in the deposit to have no effect on sales.

The literature examining the effect of the introduction of a DRS on sales find that the introduction will not affect beverage sales. If an introduction of a DRS does not affect beverage sales, one could also expect an increase in the deposit in an already existing DRS to not have an effect on sales. However, the picture is not clear since an introduction of a DRS is not the same as a raise in the deposit. Furthermore, the literature analyzing the effects of a DRS on sales originates from the US, and analyse the effect of introducing a DRS on sales in Florida and California. Since cultural, geographical, and other factors affecting beverage sales are likely to differ between the US and Norway, it is not certain that the results are directly transferable to Norway. In addition, Denslow et al. (2011) conclude that beverage sales will not be affected because the demand for beverages is relatively inelastic. On the other hand, Steen and Ulsaker (2019) find that the demand for soda is elastic. Their findings originates from analyzing Norwegian data. This further indicates that one should be careful when comparing results between the US and Norway.

The literature examining the effect of both the raise and implementation of the sugar tax on soda find that the excise sugar tax leads to a decline in beverage sales. Since soda is one of the product groups that we are examining, one might expect beverage sales to decline after an increase in the deposit, especially for soda. However, it is important to note that the deposit is not the same as an excise sugar tax. While a sugar tax might lead to a direct price increase for a consumer, the deposit is not a part of the retail price. Therefore, it is not certain that the effects of a sugar tax is directly comparable to an increase in the deposit.

The theories and literature presented above indicate that the increase in the deposit might have a slightly negative or no effect on sales. However, since there is no empirical study exploring the effect of an increase in a deposit on beverage sales, we can not compare the results from the literature directly to our study.

4 Data

In order to investigate the effect of an increase in the deposit on sales, we have constructed a panel data set that links the rollout of the increased deposit with beverage sales in Norway. Sales is measured by the number of units sold per week of a product in a specific shop. The analysis period is from week 26, 2016 to week 26, 2019. The data on sales is provided by NorgesGruppen.

In the following part, we present NG and the raw data on sales. We then present how we manipulated the data and the method we used to identify products with and without a deposit. Lastly, we present our final data set and descriptive statistics.

4.1 NorgesGruppen

NorgesGruppen is the biggest grocery group in Norway with a market share of 43.2 percent (2018). The grocery group consists of nine different chain concepts, ranging from discount, via district stores, and to supermarkets (Dagligvarehandelen, 2019). Furthermore, NG consists of 1 834 shops spread across Norway covering all regions.

In our analysis we are looking at four of the chain concepts; Kiwi, which is positioned in the discount segment, Meny and Spar, which are supermarkets that prioritise a wider product selection with local and perishable foods, and lastly Joker, a district store with a narrower product selection (NorgesGruppen, 2018).

4.2 The Raw Data

NG provided us with a representative selection of data on sales of beverages. The data is collected from 80 shops within the chain concepts Joker, Kiwi, Meny, Spar, and Eurospar. Eurospar is similar to the chain concept Spar. Thus, we define both shops as Spar. The shops are spread across Norway, covering all counties. The data contains transactional data aggregated on a weekly level in the time period mid-2016 to mid-2019. There are more than five million observations in the original data set. Each observation represents the weekly sale of a specific product in a shop. We define a specific product in a shop as product-shop. The original data set contains 4 768 products and 80 shops. Sales of beverages are measured in both quantity and gross sales. For each observation, we have information about the week of sale, year of sale, shop name, shop address, product group, and the EAN-code.

4.3 Data Manipulation

The data set is unbalanced, as we do not have an observation of each product-shop and each week. To reduce distortions in our results, we only include products that have been observed in half of the shops and in half of the time periods in our final data set.

Further, we remove observations that have negative or zero values of sales. As we are only interested in beverage sales, we remove the product group *coffee accessories and tea accessories.* Our sample then contains the product categories *mineral water & soda*, *beer*, *cider*, *juice*, and *other*. Note that the product group *other* contains the product groups *coffee*, *tea*, and other types of powdered drink mixes and extracts.

After cleaning our data set, we are left with nearly four million observations of 676 different products in 80 shops.

4.4 Identification of Products with a Deposit

There is no information about whether a product has a deposit or not in the data set. As we need this information in our further analysis, we identify the products with a deposit by looking at changes in the EAN-code that happened in 2018, and by examining product names.

First, we identify all products that changed the EAN-code in 2018 in our data set. NG stated that the majority of beverages that updated their EAN-code in 2018, updated the EAN-code due to the increased deposit (J. W. Slørstad, personal communication, October 29, 2019). Out of the 224 products that we identified, 20 products did not have a deposit. In our further analysis, we assume that the remaining 204 products that had a deposit and changed the EAN-code, changed the EAN-code due to the increase in the deposit. These products must then be part of the products that account for minimum 80 percent of the sales of a producer, as explained in Section 2.3. We define these products as Best Sellers. We use the timing of the change from the old to the new EAN-code as the timing of the increase in the deposit for each Best Seller in a specific shop. For each Best Seller in a shop, products with the old EAN-code, thus old deposit, and products with the new EAN-code, thus increased deposit, may be sold at the same time. The change from the old to the new deposit may therefore span over several weeks. We include a variable that identifies the first week a Best Seller was sold with the new deposit and a variable that identifies the last week this product was sold with the old deposit.

NG has stated that the EAN-code normally is not updated when a product changes design or image (J. W. Slørstad, personal communication, September 16, 2019). It is therefore reasonable to assume that a product only increased the deposit parallel to updating the EAN-code. One exception is [redacted] that changed to [redacted] at the same time as the EAN-code was updated. We therefore remove this product. We also remove the product [redacted], as this product had a sales campaign in the store Kiwi at the same time as it increased the deposit (Kiwi, 2018). As explained further in Section 5.4, this violates with the conditional exogeneity assumption of our analysis.

As explained in Section 2.3, some products with a deposit did not change the EAN-code parallel to the increase in the deposit. We define these products as Less Popular Products. We identified 196 products with a deposit that did not have an update in the EAN-code in our data set. Thus, a change in the EAN-code can not be used to identify the timing of the increase in the deposit for these products. As explained in Section 2.3, these products increased the deposit on the 3rd of September 2018. The timing of the increase in the deposit for Less Popular Products is therefore the 3rd of September 2018. The Less Popular Products were not sold with the old and increased deposit at the same time. Thus, the variable for the first week a Less Popular Product was sold with the increased deposit as well as the variable for the last week it was sold with the old deposit contains the week of the 3rd of September 2018. Further, the remaining 276 products in our sample do not have a deposit.

4.5 Final Data Set

There are 3 960 723 observations in our final data set. Our sample now consists of 676 products that we follow in the time period mid-2016 to mid-2019 for 80 shops in Norway. Each observation is the sum of transactions for a product-shop within a week. For each observation, we now have additional information on chain concept, whether a product has a deposit, and when a product increased the deposit.

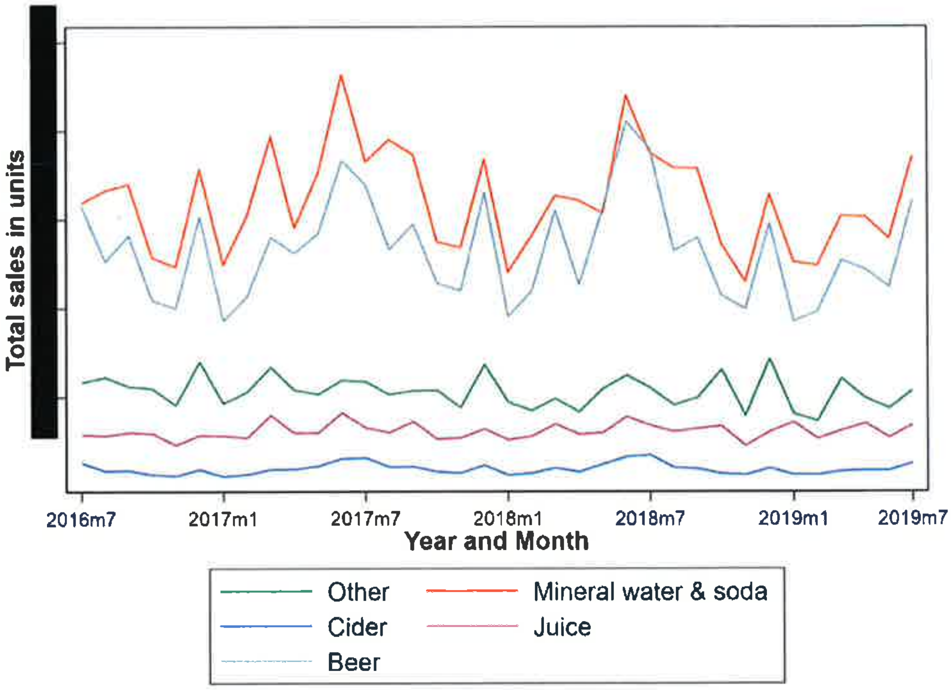
The original variable for weekly sales measured in units does not differ between single products and products sold in batches, such as a six pack of soda or beer. These different product types both count as one unit. As an example, a single Pepsi would have the same number of unit as a six pack of the same Pepsi. The variable for sales that we use in our analysis accounts for this difference. Furthermore, this variable is log transformed. Thus, the effect of the increased deposit can be interpreted as the percentage change in sales.

Further, we have added a variable indicating whether a product is a small bottle or a big bottle. A Small bottle is defined as a product containing up to 0.5 litres, while a Big bottle is defined as a product containing more than 0.5 litres. As explained in Section 2.3, Small bottles increased the deposit from NOK 1 to NOK 2 and Big bottles increased the deposit from NOK 2.5 to NOK 3.

4.6 Descriptive Statistics

In the time period of analysis, we observe no obvious negative or positive overall trend in total sales, see Figure 4.1. We observe that beverage sales is cyclical, with a spike in sales around Christmas and during the summer months. *Mineral water & soda* is the category with the highest sales, followed by *beer*.

Figure 4.1: Total Sales by Beverage Category



Notes: Our outcome variable is weekly sales measured in units. The figure shows the development of total sales by different beverage categories, aggregated to a monthly frequency. The period of analysis is mid-2016 to mid-2019.

Figure A.1 in the Appendix presents the product categories in our sample, and the number of products with and without a deposit within each product category. We observe that the product categories *mineral water & soda* and *beer* contains the majority of products with a deposit, while *other* contains the majority of products without a deposit.

Table A.1 in the Appendix presents some key numbers on weekly units sold by chain concept, product category, and by product type. We observe that the chain concept Meny has the highest mean weekly sales, with [redacted] units, while Joker has the lowest mean weekly sales, with [redacted] units. The mean weekly sale of a product in a shop is [redacted] units. The standard deviation is high, implying that there is a high variation in the level of weekly sales of a product in a shop, both between the different weeks and products in a shop. Further, we observe that the product categories *mineral water & soda* and *beer* have the highest mean weekly sales and also the most observations. By product type, we observe that Small bottles have a higher mean weekly sales compared to Big bottles. Further, the mean weekly sales for products without a deposit is [redacted] units.

Figure A.2 in the Appendix shows the share of products sold with the increased deposit in each week of 2018, only looking at products with a deposit. Products with the increased deposit entered the market from the first week of 2018, and picked up speed from the beginning of the summer, week 22. A big share of products increased the deposit in week 36. This jump is due to the change in deposit that occurred on the 3rd of September, for all Less Popular Products. The graph shows that even if these products account for a smaller total share of sales for the producers, it is a significant portion of all the products in our sample. We observe that products increase the deposit after the implementation date on the 3rd of September. This is due to gradual update of inventories of the products that changed the EAN-code.

Figure A.3 in the Appendix shows the development in mean weekly sales by products without a deposit, products with the old deposit, and products with the new deposit in every given week for our period of analysis. Products were sold with the new deposit from 2018, illustrated by the vertical black line. Less Popular Products received the increased deposit in week 36, illustrated by the vertical dashed line. We observe that products with a deposit share a similar trend with the products that have no deposit, before the increase. However, products with a deposit have a higher mean weekly sales compared to products that do not have a deposit. Further, we observe that the first products with the increased deposit had relatively low mean weekly sales. In the beginning of the summer of 2018, at the same time as the introduction of products with the new deposit picked up speed, we see a jump in mean weekly sales for products with the new deposit. Mean weekly sales falls dramatically for products with the old deposit, after week 33. As observed in Figure A.2, the majority of the products have then increased the deposit. The products that increased the deposit after week 33 have relatively low mean weekly sales. Further as observed in Figure A.2, the trend of products with a new deposit consists of a low share of our products until week 23. The trend in this time period is thus very sensitive to extreme observations of a single product in a shop. The same is true for the trend of products with the old deposit after week 40, as this group also consists of few products. We thus only have a time span of some weeks during the summer where both the trend of products with the old deposit and new deposit consist of a relative large share of products.

5 Empirical Strategy

The main purpose of this thesis is to measure the causal effect of the increase in the deposit on beverage sales. In order to do this, we have identified the timing of the increase in the deposit for the data on weekly beverage sales. Further, we identify the causal effect by using a generalised difference-in-difference (GDiD) strategy, which utilizes the full variation in our data set.

5.1 Generalised Differences-in-Differences

An ideal set-up would have been to compare the levels of weekly beverage sales in Norway after the deposit increase with a counterfactual situation where the increase did not happen. Since this is impossible, we contrast the development of beverage sales for products that have received an increased deposit with beverages that have not yet received an increase and with beverages that do not have a deposit.

We use GDiD to find the causal effect of the increase in the deposit on weekly beverage sales. This method takes into account that the increase in deposit occurred at different times for each product in each shop. The key to our identification is that each product in each shop increased their deposit in a random fashion. This implies that the increase in deposit is independent of other variables affecting beverage sales. More specifically, that the increase in the deposit influences beverage sales like an exogenous shock. The treatment group is any product in a shop that has an increased deposit, and the control group is any product in a shop that at a given time does not have an increased deposit, or a product with no deposit. This implies that a product in a shop could be in the control group one week and in the treatment group the next week.

Papers such as Bütikofer, Løken, and Salvanes (2015), Akerman, Gaarder, and Mogstad (2015), and Kose, Kuka, and Naama Shenhav (2018) have utilized the GDiD-method. Furthermore, the strategy is thoroughly explained by Goodman-Bacon (2018).

5.2 Defining our Treatment and Control Group

Our empirical strategy builds upon the differences-in-differences (DiD) framework. The main difference between a DiD and a GDiD strategy, is the variation in treatment timing (Goodman-Bacon, 2018). A condition for the DiD approach is to have a comparable treatment and control group, where treatment is the only factor dividing the two groups (Angrist and Pischke, 2015). Our treatment group consists of all beverages that have a deposit and that receives an increased deposit during our period of analysis. Our control group are all beverages that do not have a deposit or that have not increased the deposit yet.

Since we know that a product-shop might be sold with the old deposit and the new increased deposit at the same time, we need to make a simplifying definition of treatment in order to utilize our empirical strategy. We assume that a product-shop is treated after the first observation of the increased deposit. After a product-shop has been treated, it remains in the treatment group.

In Figure A.4 in the Appendix we look at the length of the transition period, measured in weeks for each product-shop, only looking at products with a deposit. The transition period starts when the first product with a new deposit is sold and ends when the last product with the old deposit is sold. We observe that 70 percent of products in a specific shop have a transition period below two weeks. Most of the long transition periods are due to observations of single products with the old deposit long after the majority of products with the old deposit are sold out. Since the transition from the old to the new deposit happened relatively fast for the majority of products in our data set, we find it reasonable to use our simplifying definition of treatment, discussed above. Furthermore, the impact of a different definition will be examined in Chapter 6.

5.3 Regression Model for the Effect of the Increased Deposit on Sales

In order to estimate the effect of the increased deposit on sales, we estimate the following equation:

$$lnY_{it} = \alpha + \delta_{GDiD} D_{it} + \lambda_i + \gamma_t + \omega_t + e_{it} \tag{5.1}$$

Our outcome variable sales, Y_{it} denotes the number of units sold per week for a product-shop at time, t. Product-shop is a specific product in a shop. The variables *product* and *shop* combined denotes our panel variable, i. Furthermore, the outcome variable is log transformed. Thus, the effect of the increased deposit can be interpreted as the percentage change in sales. α is a constant. D_{it} is a dummy variable equal to 0 for a product-shop at time t before it gets an increased deposit, and equal to 1 after it has gotten an increased deposit. Thus, δ_{GDiD} is our key coefficient of interest, expressing the percentage change in weekly sales for beverages in the treatment group.

λ_i represents product-shop fixed effects, allowing for time invariant differences between products in a specific shops. Differences in flavor or design are examples of characteristics that are relatively stable over time, but might differ between product types. Furthermore, differences in shop size, population density, location, and demography are examples of characteristics that are relatively stable over time, but might differ between shops. Our analysis will suffer from omitted variable bias (OVB) if these time invariant characteristics correlate with our variable of interest as well as having an impact on our outcome variable (Angrist and Pischke, 2015). We would then underestimate or overestimate the effect of the increased deposit on sales. However, by including λ_i we eliminate this potential bias by capturing the effect of the product-shop specific characteristics.

γ_t represents year specific effects and ω_t represents week specific (seasonal) effects. Both γ_t and ω_t will allow for time varying effects that differ between year or weeks, but are common to all product-shops. ω_t controls for seasonal variation or other common time shocks. An example of seasonal variation might be that beverage sales increases during the warm summer months or in the holidays, like Christmas. This implies that the summer-weeks and the last weeks in a year have a generally higher level of sales compared to the other weeks. Seasonal variation is visualized in Figure 4.1 in Section 4.6.

5.3.1 Accounting for Different Chain Concepts

Our sample consists of shops from four different chain concepts, Meny, Kiwi, Joker, and Spar. They differ in both pricing and product selection, and we suspect that the effect of the increase in the deposit could vary between the different chain concepts. To account for the effect of different chain concepts we introduce a second regression model to be estimated:

$$\begin{aligned} lnY_{it} &= \alpha + \delta_{GDiD} D_{it} + \rho(D_{it} \times Meny_i) + \eta(D_{it} \times Kiwi_i) \\ &+ \phi(D_{it} \times Joker_i) + \lambda_i + \gamma_t + \omega_t + e_{it} \end{aligned} \tag{5.2}$$

The only difference between equation (5.1) and (5.2) is that we have added three interaction terms for the shops Meny, Kiwi, and Joker. For instance, the interaction term for Meny is $(D_{it} \times Meny_i)$. Here, $Meny_i$ is a dummy variable equal 1 if the chain concept is Meny, and 0 otherwise. Note that Spar is the reference chain concept. Thus, ρ estimates the effect of the increase happening in Meny compared to Spar. The effect of the increase in the deposit on sales in Spar is the estimate of the increased deposit, δ_{GDiD}, while the effect on sales in the other chain concepts is the added effect of the increase, δ_{GDiD} and the interaction term of the respective chain concept. This added effect can however only be interpreted as the effect in the respective chain concepts if the added effect is significantly different from zero. This is done by testing for *Linear combination of estimators* (LINCOM).

5.3.2 Adjusting for Serial Correlation

Since we have repeated values for each product-shop, the panel structure of our data set could give rise to the problem of serial correlation. Serial correlation means that the outcome in one period is correlated with previous outcomes (Angrist and Pischke, 2008) Serial correlation could lead our statistical conclusion to be misleading, and we could be exaggerating the precision of our estimates (Angrist and Pischke, 2015). If this is the case, usual standard errors cannot be used for inference in our analysis.

Intra-product-shop correlation would in our case mean that there exists dependencies in sales within the same product-shop. One could argue that such dependencies exists as people buying the same product in the same shop share the same neighbourhood, background characteristics, and preferences. If such dependencies exists in our data and they are not adjusted for, our standard errors would likely be underestimated. To account for this problem, we cluster the standard errors on product-shop-level.

5.4 Validity for Empirical Approach

Our empirical strategy relies upon the assumption that the increase in the deposit is uncorrelated with time-varying unobserved characteristics of product-shop that are predictive of sales. This implies that there should not be any pre-trends in sales of a product-shop that influenced the increase in the deposit. We test for pre-trends in the event study specification presented below in Section 5.5. Further, there should be no confounding events with the increase in the deposit. In the following, we will discuss potential factors that could threaten our identification.

Since the deposit increase required a physical change in the EAN-code for the Best Sellers, there could also have been additional design changes for each product happening at the same time. NG stated that this was not likely, and thus will not affect our results (J. W. Slørstad, personal communication, October 29, 2019). In addition, changes in sales campaigns and advertisement could potentially affect beverage sales if it happened at the same time as the increase in deposit, which in turn could make it more difficult to isolate the effect of the increased deposit. If sales campaigns correlate with the increase in the deposit, it will affect our results. These potential violations of our key assumption will be discussed in further detail in Chapter 7.

There are more aspects to consider when examining the conditional exogeneity assumption. Policy changes that affect beverage sales could pose a potential threat to identification if they are correlated with an increase in the deposit. These policy changes could be relevant if they differ between products and shops, thus affecting them differently. As explained in Section 2.4, the sugar tax on non-alcoholic beverages was raised in 2018. This was a national reform that affected all shops in our analysis. However, this was a policy change that affected the products in our analysis differently. The policy mainly affects one of our main beverage categories, *mineral water and soda*. Since this policy change happened in 2018, the same year the deposit was increased, it could affect our results. We will discuss this in further detail in Chapter 7.

5.5 Event Study

The key assumption for identifying a causal effect of an increased deposit on sales is that each product in each shop increased the deposit in a random fashion. This implies that the increase in the deposit is independent of other variables affecting beverage sales. In order to test the assumption of independence in timing and location of an increased deposit, we can examine whether there was any preexisting trends that influenced the increase in the deposit. One example could be that shops with an upward sloping trend in sales implement the increased deposit earlier than shops with a downward sloping trend in sales. In addition, shops that have an upward sloping trend could be located in populous areas whilst shops with a downward sloping trend could be located in relatively more remote areas. If this is true, it might hurt our analysis. More specifically, our estimated effect of the rollout would then yield a positive effect even though the difference in sales outcome is not affected by the increase in deposit.

We use an event study specification in order to test whether the products in shops have any specific trends in the outcome before getting an increased deposit. This method has among others been used by Bailey and Goodman-Bacon (2015). We estimate the following equation:

$$lnY_{it} = \alpha + \sum_{\varphi=-5}^{-2} \delta_{\varphi} D_{it} 1(t - T_i^* = \varphi) + \sum_{\varphi=0}^{5} \sigma_{\varphi} D_{it} 1(t - T_i^* = \varphi) + \lambda_i + \gamma_t + \omega_t + e_{it} \tag{5.3}$$

Y_{it} has the same interpretation as in equation (5.1) and (5.2). D_{it} is a dummy variable equal to 1 if the product-shop has an increased deposit, and 0 otherwise. $1(t - T_i^* = \varphi)$ is the event week dummy, which is equal to 1 when the week of observation is φ = -5, -4, -3, -2, 0, 1, 2, 3, 4, 5 weeks from T_i^*, which is the week the deposit increased. Note that week $t-1$ will be omitted and serve as a control week. Further, δ_{φ} measures the anticipatory effect of an increased deposit. σ_{φ} measures the effect of our outcome variable after the increase in deposit. We include observations more than five weeks before and five weeks after the increase in the deposit through dummies, so that $1(t - T_i^* =< -5)$ and $1(t - T_i^* => 5)$. In addition, we include the same independent variables as in equation (5.1).

When executing the event study, we want δ_{φ}, the anticipatory effects, to be insignificant. If the anticipatory effects are significantly different from zero, or show clear signs of a trend, it means that the pre-trends could predict the outcome variable that we measure. It also implies that there could be different trends between the treatment and control groups. This will hurt our assumption that the rollout of the increased deposit is random.

6 Empirical Analysis

Overall, we find that the increase in the deposit had a small negative effect on beverage sales of products with an increased deposit. Our results also indicate that the increased deposit had a slightly negative effect on Small bottles, while we find no evidence of an effect on Big bottles. In the following part we first present our main results, results accounting for different chain concepts and the findings from the event study before we present a sensitivity analysis. At the end we conclude this chapter by summarizing the results.

6.1 Main Results

In Table 6.1 we present the results of estimating equation (5.1). Column (1) presents the overall estimated effect of the increase in the deposit on the total sample of beverages in our data set. Column (2) and (3) shows the estimated effect of the increase in the deposit on the Small bottles and the Big bottles sample, respectively. The outcome variable is weekly sales measured in units, log transformed. This implies that the estimate of the increase in the deposit can be interpreted as the percentage change in sales.

Our baseline result is presented in column (1) and suggests that the increase in the deposit led to a decrease in weekly sales of [redacted]. The estimated effect is significant at the five percent-level. Our baseline result show the combined effect of the increase in the deposit on Small, (2), and Big bottles, (3).

We look at the outcome variable separately for Small and Big bottles in the main analysis. The sample of Small bottles consists of products that have a deposit and contain up to 0.5 litres. The sample of Big bottles consists of products that have a deposit and contain more than 0.5 litres. All products without a deposit are included in both samples. As discussed earlier, the deposit was raised to NOK 2 for Small bottles and to NOK 3 for Big bottles. The raise from NOK 1 to NOK 2 for Small bottles represents a 100 percent increase in the deposit, while the raise from NOK 2.5 to NOK 3 for Big bottles represents a 20 percent increase in the deposit. This indicates that the effect of the increase in the deposit might differ between Small and Big bottles. Lastly, whether the different levels in the increase yield different effects could be valuable information in a discussion around setting the deposit in a DRS.

When looking at Small and Big bottles separately, we find that Small bottles experience a negative effect of the increase in the deposit, while Big bottles have an effect close to zero. The estimated effect on Big bottles is however insignificant, thus, we find no evidence of an effect on Big bottles. The estimated effect on Small bottles is significant at a one percent level, and suggests that the increased deposit led to a decrease in weekly sales of [redacted] percent. We observe that the negative effect on Small bottles has increased in size compared to the baseline results in column (1). It seems like our slightly negative effect in the total sample is driven by the Small bottles.

Table 6.1: GDiD-estimates - Main Analysis

	(1) Baseline Results Total	(2) Results Small Sample	(3) Results Big Sample
Increased Deposit	[negative]**	[negative]***	[positive]
	([positive])	([positive])	([positive])
Observations	3960723	3183865	2288195
No. of clusters	45067	37811	24992
Adjusted R^2	0.022	0.021	0.015
FixedEffects	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The outcome variable is weekly sales measured in units, log transformed. Thus, the effect of the increased deposit can be interpreted as the percentage change in sales. The results in column (1), (2), and (3) are estimated using equation 5.1 but on different samples. Column (1) shows the baseline results of the total sample. Column (2) shows the estimates of the Small bottle sample. Column (3) shows the estimates of the Big bottle sample. Standard errors are clustered at the product-shop level. The analysis period is from mid-2016 to mid-2019.

6.2 Results Accounting for Different Chain Concepts

As explained in Section 4.1, our sample consists of shops from four different chain concepts. They differ in both pricing and product selection, and we suspect that the effect of the increase in the deposit could vary between the different chain concepts. As observed in Table A.1 in the Appendix, the different chain concepts also differ in weekly sales. Thus, we are investigating whether the different chain concepts experience a different effect of the increase in the deposit.

Table 6.2 presents the results of estimating equation (5.2), accounting for different chain concepts. We conduct a separate analysis on the total, Small bottles, and Big bottles sample. Note that Spar is the reference chain concept. Thus, the effect of the increase in the deposit on sales for Spar is the estimate of the *Increased Deposit*, which on the total sample is [redacted] percent. Further, the estimate for the interaction term, *Increased at Joker*, on the total sample is [redacted] percent. This implies that the increase in the deposit was [redacted] percentage points larger for Joker than for Spar. Thus, the estimates from Table 6.2 captures the additional effects of the percentage change in sales for Meny, Kiwi, and Joker, compared to Spar.

We are interested in the total effects for Meny, Kiwi, and Joker. In order to find the total effect on sales in these chain concepts, we have to add the estimates for both the *Increased Deposit* and the interaction term of the respective chain concept. Furthermore, we conduct a Linear combination of estimators (LINCOM) test to examine whether these added effects are significantly different from zero. The results from the LINCOM test can also be found in Table 6.2. In the following, we are referring to both the estimates and significance from the LINCOM test when describing the effect for Meny, Kiwi and Joker. As an example, this estimate is [redacted] percent for Joker on the total sample.

Our baseline estimate is presented in column (1) and suggests that the effect of the increase in the deposit is significant at the 1 percent-level for Spar, Kiwi, and Joker. Both Spar and Joker experience a negative effect, while the effect for Kiwi is slightly positive. The effect for Meny is significant at a 10 percent-level, and slightly negative.

Further, in column (2) and (3) we present the results on the Small and the

Big bottles sample, respectively. For Small bottles, the estimated effect for Spar and Joker increases in size compared to the total sample, but it is still negative. The effect for Kiwi is close to zero and not significant. The estimate on Meny is significant at a ten percent-level and slightly negative. The effect on Big bottles is insignificant for Spar and Meny. However, we see a relatively substantial effect for Kiwi, suggesting that the increased deposit led to a [redacted] percent increase in weekly sales, significant at the 1 percent-level. On the other hand, the estimates for Joker suggests that the increase in deposit led to a [redacted] percent decrease in weekly sales, significant at the 1 percent-level.

Overall, our findings suggests that the increased deposit led to a decline in sales on the total sample, regardless of chain concept. The exception is Kiwi which experiences a slight significant increase. Further, our findings from the Small bottles sample suggests that the increase in the deposit led to a decline in sales regardless of the chain concept. The exception is again Kiwi, where we find no evidence of an effect. When examining the Big bottles sample, we get a positive effect for Kiwi and a negative effect for Joker. The effect for Spar and Meny is insignificant.

Table 6.2: GDiD-estimates - Chain Concept

	(1) Baseline Results Total	(2) Results Small Sample	(3) Results Big Sample
Increased Deposit	[negative]***	[negative]***	[negative]
	([positive])	([positive])	([positive])
Increased at Meny	[positive]	[positive]*	[negative]
	([positive])	([positive])	([positive])
Increased at Kiwi	[positive]***	[positive]**	[positive]***
	([positive])	([positive])	([positive])
Increased at Joker	[negative]***	[negative]**	[negative]***
	([positive])	([positive])	([positive])
LINCOM Test:			
Increased Deposit + Increased at Meny	[negative]*	[negative]*	[negative]
	([positive])	([positive])	([positive])
Increased Deposit + Increased at Kiwi	[positive]***	[negative]	[positive]***
	([positive])	([positive])	([positive])
Increased Deposit + Increased at Joker	[negative]***	[negative]***	[negative]***
	([positive])	([positive])	([positive])
Observations	3960723	3183865	2288195
No. of clusters	45067	37811	24992
Adjusted R^2	0.022	0.021	0.015
FixedEffects	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The outcome variable is weekly sales measured in units, log transformed. Thus, the effect of the increased deposit can be interpreted as the percentage change in sales. The results in column (1), (2), and (3) are estimated using equation 5.2 but on different samples. Column (1) shows the baseline results of the total sample. Column (2) shows the estimates of the Small bottle sample. Column (3) shows the estimates of the Big bottle sample. Standard errors are clustered at the product-shop level. The analysis period is from mid-2016 to mid-2019.

6.3 Findings Event Study

As mentioned in Chapter 5, our analysis depends on the assumption that there are no changes to the underlying trends of beverage sales that determines the implementation of an increased deposit. To test the validity of our results, we test whether the timing of the increased deposit is uncorrelated with trends for weekly beverage sales. We utilize the event study specification in equation (5.3) in order to test this. Furthermore, the event study will allow us to observe whether there is a lagged effect from receiving an increased deposit, and whether it has a positive or negative effect on weekly beverage sales over time.

Figure 6.1 plots the event study estimates for weekly beverage sales, as well as the 95 percent confidence interval when including five anticipatory effects and five post effects. More specifically, we are looking at a time span from five weeks prior to and five weeks after the increase in the deposit. Note that observations more than five weeks before and five weeks after the increased deposit are also included in this time window, as explained in Section 5.5. Figure (a) shows the estimates for the total sample, (b) for the Small bottles sample, and (c) for the Big bottles sample. The three regressions that form the basis for these plots include the same fixed effects as in the GDiD specification, see equation (5.1).

For both the total and Small bottles sample, we find no evidence of particluar pre-trends. This suggests that there were no underlying pre-trends that determines the implementation of the increased deposit. Furthermore, the anticipatory effects of the increased deposit on sales are close to zero for both the total and Small bottles sample. However, five weeks prior to the increase in deposit seems to have a significant negative effect on sales, for all samples.

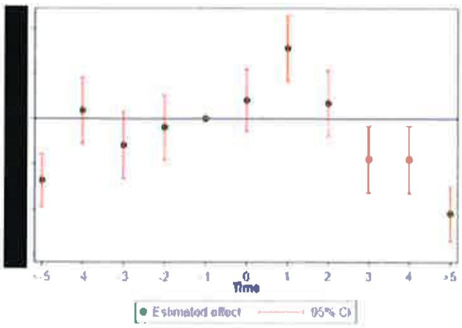
When looking at the development of the estimates after the increase in deposit, we observe that there is no significant effect in the implementation week for both the total sample and Small bottles sample. However, the Big bottles sample has a positive significant estimate, suggesting that the increased deposit led to an increase in sales. Further, the 1 week post effect is now positive and significant for the total sample and Big bottles sample, but not significant for the Small bottles sample. After the first week, the positive effect of the increased deposit starts to decrease and turn significantly negative in week 3 for both the total sample and Small bottles sample. For both theses samples, the negative effects persists and strengthens. For the

Big bottles sample, it takes until week 5 before we see a negative significant result.

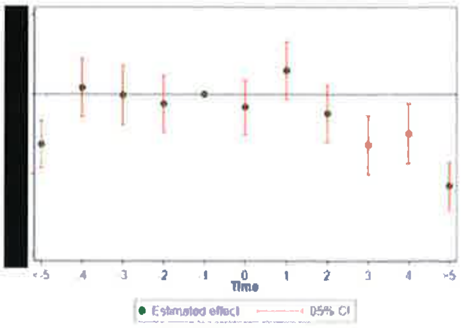
The event study results suggest that there are no underlying pre-trends that determines the implementation of the increased deposit for both the total and Small bottles sample. Furthermore, the event study results suggest that there is a lagged effect from the increased deposit that strengthens over time. For both the total and Small bottles sample, the effect is larger five weeks after the increase, than in the implementation week. This could imply that it takes time for consumers to adapt to the increased deposit. Lastly, the event study results for the Big bottles sample is ambiguous. The significant negative anticipatory effects in both week 3 and 5 could be an indication that we have a significant pre-trend prior to the increase. The pre-treatment trend and ambiguous post-effects weakens the validity of our results for the Big bottles sample.

Figure 6.1: Event Study Estimates

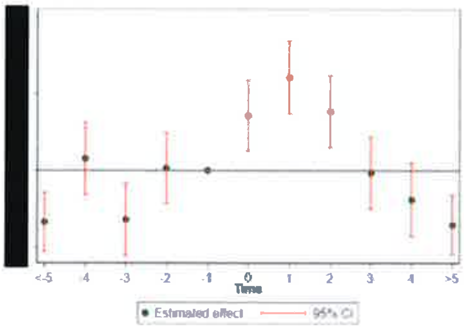
(a) Total Sample



(b) Small Bottle Sample



(c) Big Bottle Sample



Notes: The figure plots the post-treatment, σ_{φ}, and the anticipatory effects, δ_{φ}, from the event study specification (equation (5.3)) as well as the 95 percent confidence intervals. Figure (a) shows the effect on the total sample, Figure (b) shows the effect on the Small bottles sample, and Figure (c) shows the effect on the Big bottles sample. The analysis period is from mid-2016 to mid-2019. Robust standard errors are adjusted for clustering at the product-shop-level.

6.4 Sensitivity Analysis

We perform two sensitivity analysis in order to test the robustness of our results. A sensitivity analysis might expose weaknesses in our models. In the following part, we first conduct an analysis by removing products without a deposit. Then, we perform an analysis using a different definition of when a product is treated.

6.4.1 Results Only Products with a Deposit

In this part of the sensitivity analysis, we only look at products with a deposit. This implies that our control group now only consists of the beverages prior to the increase in the deposit. Our main analysis compared beverages with an increased deposit with all beverage types, regardless of whether they had a deposit or not. Even though the trend for products with and without deposit seems parallel, see Figure A.3 in the Appendix, the mean weekly units sold was higher for beverages with a deposit compared to beverages without a deposit. This could indicate that there are differences between beverages with and without a deposit. Further, a good control group should reveal the state of the treatment group in a counterfactual world where it was not treated (Angrist and Pischke, 2015). With this in mind, one could argue that the treatment and control group might become more equal when only looking at products with a deposit, and the results can be driven by the randomness in the timing of the increase in the deposit.

Thus, as a robustness test we limit the sample to only include products with a deposit. The treatment group are the beverages that received an increased deposit, while the control group consists of the beverages prior to the increase in deposit. Table A.2 in the Appendix presents the results from estimating equation (5.1), but with a restricted sample. Our baseline estimates are presented in column (1) and suggests that the increased deposit led to a [redacted] percent increase in weekly sales, significant at the 1 percent-level. Compared to our main results in Table 6.1, we observe that the estimated effect has changed from negative to positive for the baseline results. Further, the estimates for Small bottles is not significant. However, Big bottles is now significant at the 1 percent-level and suggests that the increased deposit led to a [redacted] percent increase in weekly sales.

The results given in Table A.2 show a sizeable change compared to all our estimates in Table 6.1. The findings for both the total and Big bottles sample suggest that an increased deposit led to increased sales. These results are opposite to what we found when analysing the full sample in Section 6.1.

The new estimates reduce our confidence in the main results. There are however weaknesses in the control group of this analysis. The treatment of the majority of our products happened during a relative short time period, see Figure A.3 in the Appendix. This implies that the treatment and control group might only be comparable in a very short time period in this analysis. As explained in Section 4.6, the control group only consists of a few products with relatively low sales at the end of our period of interest. In this time period, these products might not be a representative control group, as it seems like they are not popular or seasonal products. The estimates of this analysis might thus be overestimated. As the results in this analysis is driven more by the randomness in timing, we are also more exposed to the fact that the increase in the deposit is connected to sales. We will discuss this limitation in Section 7.3. Our main analysis including beverages with and without a deposit is less exposed to these issues. As the trend for beverages with and without a deposit seem parallel, we continue with our main results.

6.4.2 Different Definition of when the Deposit Increased

As mentioned in Section 5.2, we had to make a simplifying assumption in order to utilize our empirical strategy when defining our treatment and control group. In our main analysis, a product is treated in all weeks after the first time it has been observed with the increased deposit. In this subsection we conduct an analysis where we change the definition of when a product is treated. We do this in order to test the robustness of our result. In the following analysis, a product is treated after the *last* week it has been observed with the old deposit. As explained in Section 5.2, some products have a very long transition period. The transition period of a specific product is the time from the first product with an increased deposit is observed until the last product with the old deposit is observed. The long transition periods are due to sales of single products with the old deposit long after the majority of products with the old deposit were sold out. As the majority of products are sold with the new deposit within this time, we set the maximum transition period to be ten weeks. The difference in the two definitions of when a product has increased the deposit can thus maximum be ten weeks.

The results from this analysis is presented in Table A.3 in the Appendix. We estimate equation (5.1) as done in Section 6.1. The results are similar to our main results in Table 6.1. The estimated effect on the total and Small bottles sample are still slightly negative, however they are now significant on a 1 percent-level. We find no evidence of an effect on the Big bottles sample. Our simplifying definition of when a product is treated, as explained in Section 5.2, does not seem to have a big effect on our estimates. These estimates increase our confidence in the main results.

6.5 Summary of the Results

Our results suggest that the increased deposit had a small negative effect on beverage sales. More specifically, our baseline results suggest that the increased deposit led to a [redacted] percent decrease in sales. The effect on the Small bottles suggest that the increase in the deposit led to a [redacted] percent decrease in sales. We find no evidence of an effect on Big bottles.

When looking at the effect on different chain concepts, we find that the effect of the increase in the deposit varies. Our findings suggests that the increased deposit led to a decline in sales for the total sample, regardless of chain concept. The exception is Kiwi which experiences a slight increase. Further, our findings from the Small bottles sample suggests that the increase in the deposit led to a decline in sales regardless of the chain concept. The exception is again Kiwi, where we find no evidence of an effect. When examining the Big bottles sample, we get a positive effect for Kiwi and a negative effect for Joker. However, the results from the Big bottle sample have to be interpreted with caution, as the pre-treatment trend and ambiguous post-effects from the event study weakens the validity of these results.

7 Discussion

Our findings suggest that the increase in the deposit led to a small negative effect on sales of beverages with an increased deposit. In the following part, we will present a discussion of the results and potential limitations to our study.

7.1 Discussion of the Results

As presented in Chapter 3, there are to our knowledge no empirical papers exploring the effect of an increase in a deposit on beverage containers on sales. Using the theoretical framework presented by Naugthon et al. (1990) we would expect a small negative effect on sales, as the price of the consumers might increase slightly due to the increase in the deposit. Papers exploring the effect of a tax increase and the introduction of a deposit on sales suggest that the increase in the deposit could either slightly decline or have no effect on sales. Our findings suggest that the overall effect of the increase in the deposit on beverage sales is small, but significant.

Our results suggest that the increase in the deposit had little effect on whether a consumer bought a beverage with a deposit. This could indicate that the consumers did not perceive the increase in the deposit as an increase in the price. This seems reasonable considering that the deposit is refundable. Second, it could indicate that the consumers were not aware of the increase in the deposit. As described in Section 2.2, the deposit is not fully visible on the price tag. According to the findings of Chetty et al. (2009), the consumers might only pay partial attention to the deposit, and may thus not be aware of the increase in the deposit. Third, our results could indicate that the overall increase in the deposit was not large enough to have an effect on sales. Fourth, it might indicate that the consumers experience a "mental benefit" of recycling, as described in the framework of Naughton et al. (1990). Infinitum states that Norwegians are positive to the DRS (R. H. Varberg, personal communication, December 3, 2019). If the customers trust the liability of the Norwegian DRS, the "mental benefit" of recycling might outweigh the increase in the deposit.

When looking at Small and Big bottles separately, we find that the effect on Small bottles is slightly negative, while we find no evidence of an effect on Big bottles. This could be explained by the relative higher increase in the deposit on Small bottles than in the deposit on Big bottles. Customers might also be more sensitive to an increase in the deposit when buying Small bottles, as one often buys Small bottles "on the go" and as a part of a smaller purchase. In this situation, a consumer might also have less opportunity to refund the product. Big bottles, on the other hand, are often sold in batches and might be part of a bigger purchase. If the purchase is for a household, the customer might also be more likely to refund the product. One could argue that the customer might be more aware of both prices and deposits when making a smaller purchase, and thus also more sensitive to the increase in the deposit on the Small bottles.

When looking at different chain concepts, the effect of the increase in the deposit is close to zero or slightly negative for all chain concepts in the total sample. The only exception is Kiwi. However, this estimate seems to be driven by the Big bottles. The estimate on Big bottles in Kiwi is positive, and suggests that an increase in the deposit led to a [redacted] percent increase in the sales of Big bottles. We further find no evidence of an effect on Small bottles in Kiwi. The positive effect that Kiwi experiences on Big bottles is surprising. We suspect that there is a weakness in our identification strategy, that the Big bottles in the chain concept Kiwi is especially exposed to. We will discuss this issue in further detail below. Thus, we are careful to conclude whether the increase in the deposit had a positive effect on sales in Kiwi stores. We observe the largest negative effects on sales in the chain concept Joker. As this is a district store, customers might make smaller purchases than at the supermarkets and discount stores. These customers might thus be more aware of the increase in the deposit, as the deposit is a larger part of the total price. For the total sample, Meny and Spar experience an effect close to zero. Note that the 10 percent significance level for Meny indicates greater uncertainty about this estimate. These are supermarkets with slightly higher prices. The customers might thus be less sensitive to prices and be indifferent to the increase in the deposit.

As mentioned above, we suspect that the positive effect of an increase in the deposit on Big bottles in Kiwi stores might be overestimated. Out of the four chain concepts in our data set, Kiwi is the only one positioned in the discount segment. Together with the grocery stores Rema 1000 and Coop Extra, Kiwi competes in being the cheapest grocery store in Norway (Verdens Gang, 2019). The competition is based on pricing, and Kiwi cuts the prices of different products every year. We might thus be more exposed to changes in sales campaigns and other unobservable determinants of sale in this chain concept. Further, Big bottles are often sold in batches, and might, more often than Small bottles, be used in sales campaigns. If sales campaigns happen at the same time as Big bottles in Kiwi increase the deposit, we have an endogeneity problem. We will discuss this issue further in Section 7.3.

The negative pre-treatment trend and ambiguous results from the event study, weaken our results on the Big bottles sample. We do not expect anticipatory effects from the increase in the deposit, as consumers were not aware of when a product in a shop would increase the deposit. We thus suspect the pre-trend to be caused by other unobservable determinants of weekly sales that might correlate with the increase of the deposit. Our results could be driven by these determinants, rather than by the increase in the deposit. The results on the Big bottles sample can thus not be given a causal interpretation.

7.2 Limitations to the Data Set

Our data set contains information on 80 shops within NorgesGruppen. Data from more shops or several grocery groups, could have given us a more correct representation of reality. Further, we are bound to the fact that the deposit was increased quite recently. We thus have many observations in the pre-treatment period. Ideally there should have been more observations in the post-treatment period.

As explained in Section 4.4, we assume that a product increases the deposit when updating the EAN-code. The EAN-code could however have been updated due to other reasons. If this was the case, these products would wrongly be identified as Best Sellers and the true timing of their increase in the deposit would have been on the 3rd of September 2018. We would then capture the effect of the true reason for the update in the EAN-code, instead of the effect of the increase in the deposit. This would however be an exception, as NG stated that the majority of updates in the EAN-code of products in 2018 was due to the increase in the deposit (J. W. Slørstad, personal communication, October 29, 2019).

7.3 Limitations to the Estimation Strategy

At least three problems with the estimation strategy can be identified. First, the increase in the deposit could be correlated with other unobserved determinants of sales, which might cause endogeneity problems. For example, if the marketing of a product changed at the same time as the increase in the deposit, this could make the estimated effect of the increase in the deposit inaccurate, as we would expect marketing to have an effect on sales. We are especially exposed to this issue as there were a lot of reactions in the market for the product category *mineral water & soda*, following the increase in the the sugar tax in January 2018. As an example, Kiwi permanently cut the prices on sugar free soda in April 2018 (Kiwi, 2018). We have removed a product that increased the deposit at the same time as this campaign was launched, however other products might also be exposed to this issue. As mentioned in Section 7.1, we worry that this might be an issue for Big bottles in Kiwi. If the marketing of a product increased at the same time as the deposit increased, this could overestimate the effect of the increase in the deposit on sales. We are not able to account for this since we do not have data on the marketing of each product.

Second, the timing of the increase in the deposit is connected to sales. As mentioned in Section 2.3, the majority of the Best Sellers increased the deposit in 2018, while Less Popular Products increased the deposit on the 3rd of September 2018. Whether a product is defined as a Best Seller or Less Popular Product depends on the producers earlier sales of this product. For the Best Sellers, the exact timing of the increase in the deposit of a product in a shop is dependent on when the producer updated the EAN-code and how quick the inventory of this specific product is updated. How long it takes for an inventory to be updated is directly linked to our outcome variable, the sales of a product. If a product has high sales, the inventory will be updated quicker, and thus a product might increase the deposit early. If a product has lower sales, the inventory will be updated slowly, and thus a product might increase the deposit late. Thus, the timing of the increase in the deposit for both Best Sellers and Less Popular Products is linked to our outcome variable. Our assumption of random timing of the increase in the deposit could thus be violated, which threatens the validity of our results. As other factors, such as when a producer increased the deposit of a product, the transportation of a product from a producer to a store and the inventory policy of a store, also influences the timing of the increase in the deposit, we however assume that the variation in the rollout of the increase in the deposit is plausibly exogenous.

Third, our analysis is based on the notion that a consumer is aware of the deposit of a product, and thus also whether a product has the old or new deposit. As explained in Section 2.2, the deposit of a product is less visible to the consumer than the retail price. Thus, consumers might not become aware of the increase in the deposit at the same time as the increase happened. The results from the event study indicate that it might take some time for consumers to react to the increase in the deposit, as we first observe a negative effect of the increase after five weeks. If the consumers were not instantly aware of the increase in the deposit, we could underestimate the effect of an increase in the deposit on sales.

8 Conclusion

In this thesis we analyse the research question:

How did the increase in the deposit in 2018 affect beverage sales in Norway?

We have answered the question at hand, by exploiting the differences in timing of the increase in the deposit across products in shops in Norway. NorgesGruppen, the biggest grocery group in Norway, has provided us with sales data from 80 shops across Norway. We are able to identify the exact timing of the increase in the deposit for each product in a shop. Products with the increased deposit entered the market from the beginning of 2018, and the majority of the products had increased the deposit by the end of 2018. The difference in the timing of the increase in the deposit for each product enables us to identify the causal effect of the increase in the deposit on sales by using a generalized differences-in-differences approach and event study specification.

Our findings suggest a small but significant negative overall effect of the increase in the deposit on sales. Specifically, we find that the increase led to a [redacted] percent decrease in sales. The increase in the deposit was larger for Small bottles, from NOK 1 to NOK 2, than for Big bottles, from NOK 2.5 to NOK 3. When exploring the effect of the increase in the deposit on the respective bottles, the negative effect on the Small bottles is slightly larger than the overall effect, while we find no evidence of an effect on Big bottles. These findings suggest that the effect of an increase in the deposit on sales might depend on the size of the increase. The results from the total and Small bottle sample are robust when testing for a different definition of treatment and event-study specification.

When looking at different chain concepts the overall effect of the increase in the deposit on sales varies from a decrease of [redacted] percent to an increase of [redacted] percent. The effect of an increase in the deposit might thus also be dependent on a chain's concept and their customers purchase situation. A positive effect of an increase in the deposit on sales is however only observed in the chain concept Kiwi, and might be driven by the Big bottles. The results from the Big bottle sample however have to be interpreted with caution, as the pre-treatment trend and ambiguous post-effects from the event study weakens the validity of these results.

As more and more countries are considering to implement a Deposit Refund System, it is of interest to gain more knowledge about the system and the effect of a deposit. Our findings indicate that an increased deposit might have a small negative effect on sales, and thus impose a cost on producers and consumers through lower sales. However, the size of the effect is small and must be compared to the added benefits of increasing the deposit.

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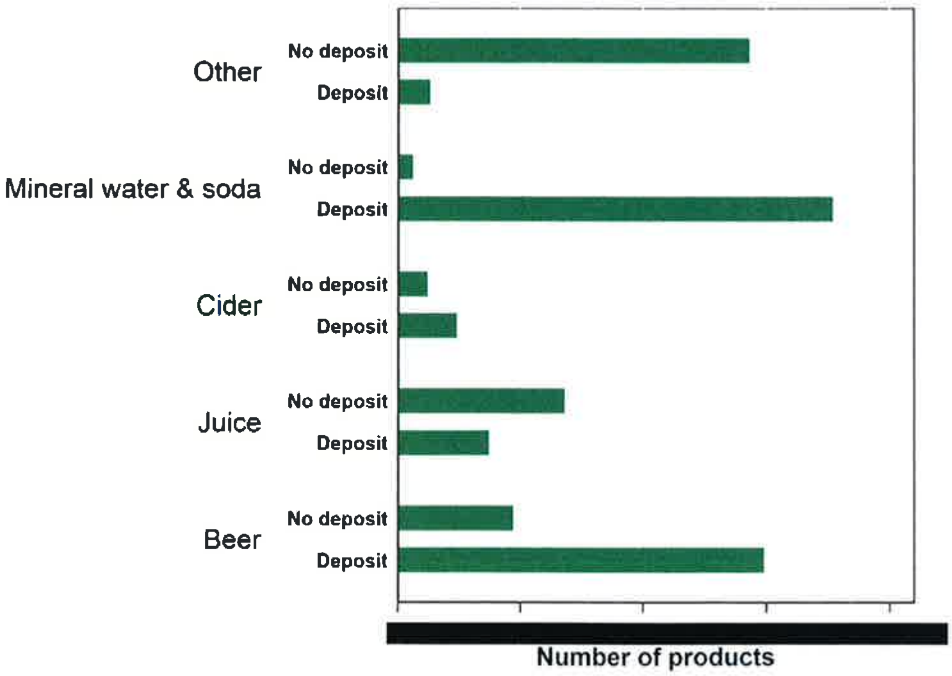
A Appendix

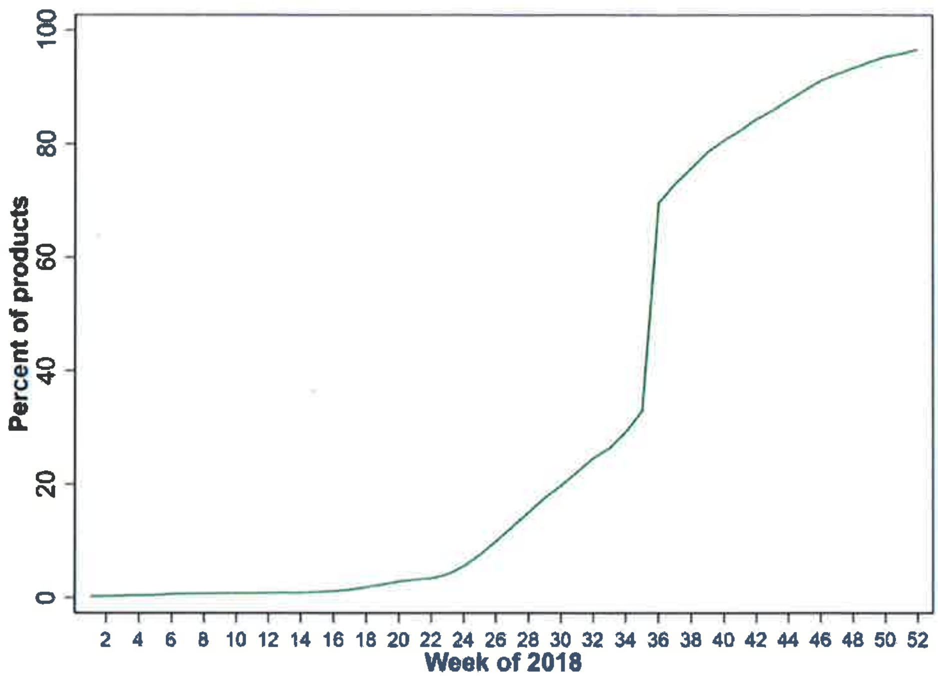
A.1 Descriptive Statistics

Figure A.1: Overview of Product Categories



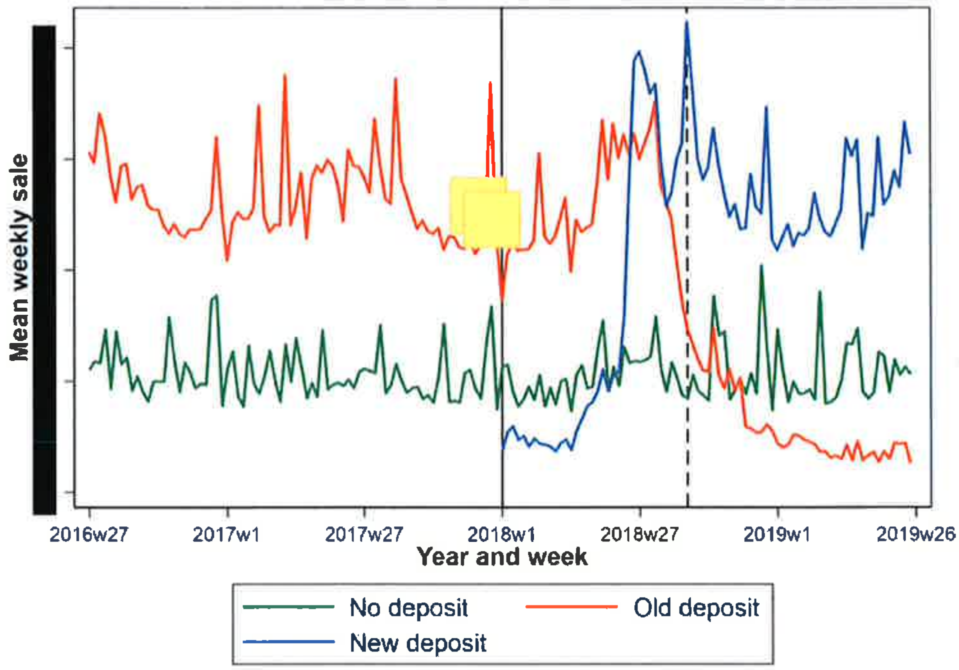
Notes: This figure shows the number of products with and without a deposit within each product group.

Figure A.2: Percentage of Product-Shops with Increased Deposit



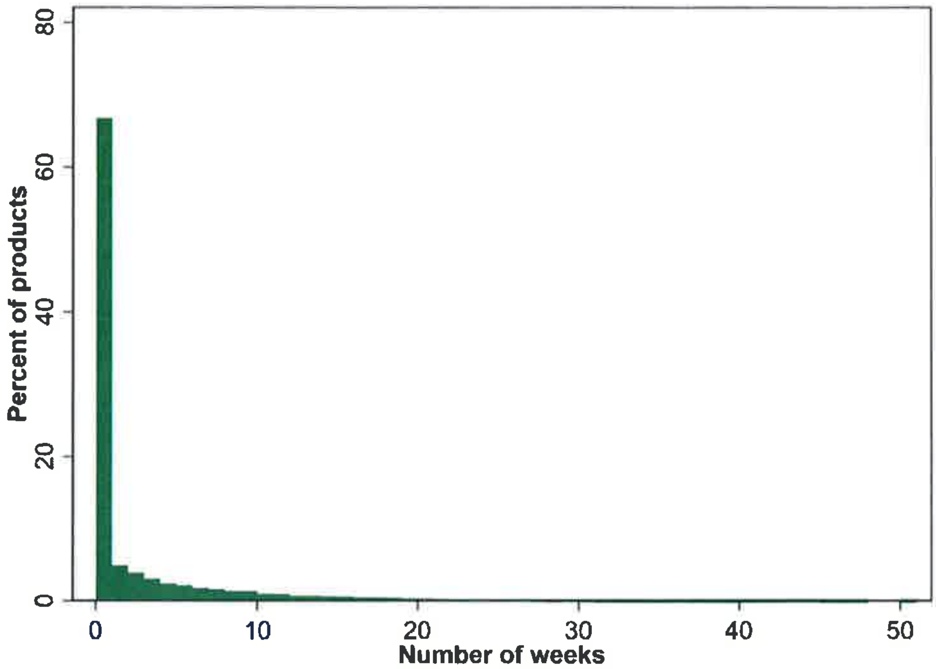
Notes: This figure shows the percentage of product-shop with an increased deposit in each week of 2018, only looking at product-shops with a deposit.

Figure A.3: Development of Mean Weekly Sales



Notes: This figure shows development of mean weekly beverage sales for products without a deposit, products with the old deposit and products with the new deposit. Beverage sales is measured in units sold. The vertical black line indicates when the first product with an increased deposit may be observed. The vertical dashed line indicates when the Less Popular Products increased the deposit.

Figure A.4: Length of Transition Period for Product-Shops



Notes: This figure shows the length of the transition period for each product-shop in weeks. The transition period for a product-shop starts when the first product with a new deposit is sold and ends when the last product with an old deposit is sold. Zero weeks include the product-shops that sold out the products with the old deposit one or more weeks before the product was sold with the new deposit. This figure only includes products with a deposit.

Table A.1: Summary Statistics

	(1) Observations	(2) Mean	(3) Std.Dev.	(4) Min	(5) Max
CHAIN CONCEPT					
Joker	533547	[redacted]	[redacted]	[redacted]	[redacted]
Kiwi	1066133	[redacted]	[redacted]	[redacted]	[redacted]
Meny	1331857	[redacted]	[redacted]	[redacted]	[redacted]
Spar	1029186	[redacted]	[redacted]	[redacted]	[redacted]
PRODUCT CATEGORY					
Beer	925032	[redacted]	[redacted]	[redacted]	[redacted]
Cider	203520	[redacted]	[redacted]	[redacted]	[redacted]
Juice	650803	[redacted]	[redacted]	[redacted]	[redacted]
Mineral water & soda	1258727	[redacted]	[redacted]	[redacted]	[redacted]
Other	922641	[redacted]	[redacted]	[redacted]	[redacted]
PRODUCT TYPE					
Small Bottle	1672528	[redacted]	[redacted]	[redacted]	[redacted]
Big Bottle	776858	[redacted]	[redacted]	[redacted]	[redacted]
No Deposit	1511337	[redacted]	[redacted]	[redacted]	[redacted]
Total	3960723	[redacted]	[redacted]	[redacted]	[redacted]

Notes: The table shows summary statistics of our outcome variable, the number of units sold per week. We look at our outcome variable with regards to chain concept, product category, and product type. Column (1) shows the number of observations, (2) the mean value, (3) the standard deviation from the mean value, (4) the minimum value, and (5) the maximum value for the number of beverage units sold per week.

A.2 Sensitivity Analysis

A.2.1 Results Only Products with a Deposit

Table A.2: GDiD-estimates - Only Products With a Deposit

	(1) Baseline Results Total	(2) Results Small Sample	(3) Results Big Sample
Increased Deposit	[positive]***	[positive]	[positive]***
	([positive])	([positive])	([positive])
Observations	2450368	1672528	777840
No. of clusters	27331	20075	7256
Adjusted R^2	0.034	0.037	0.030
FixedEffects	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The outcome variable is weekly sales measured in units, log transformed. Thus, the effect of the increased deposit can be interpreted as the percentage change in sales. The results in column (1), (2), and (3) are estimated using equation 5.1 but on different samples. Column (1) shows the baseline results of the total sample. Column (2) shows the estimates of the Small bottle sample. Column (3) shows the estimates of the Big bottle sample. Standard errors are clustered at the product-shop level. The analysis period is from mid-2016 to mid-2019.

A.2.2 Different Definition of when the Deposit Increased

Table A.3: GDiD-estimates - Different Definition of When the Deposit Increased

	(1) Baseline Results Total	(2) Results Small Sample	(3) Results Big Sample
Increased Deposit	[negative]***	[negative]***	[positive]
	([positive])	([positive])	([positive])
Observations	3960723	3183865	2288195
No. of clusters	45067	37811	24992
Adjusted R^2	0.022	0.021	0.015
FixedEffects	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The outcome variable is weekly sales measured in units, log transformed. Thus, the effect of the increased deposit can be interpreted as the percentage change in sales. The results in column (1), (2), and (3) are estimated using equation 5.1 but on different samples. Column (1) shows the baseline results of the total sample. Column (2) shows the estimates of the Small bottle sample. Column (3) shows the estimates of the Big bottle sample. Standard errors are clustered at the product-shop level. The analysis period is from mid-2016 to mid-2019.