Effects of the COVID-19 Pandemic on Sales of Products with Excise Taxes in Norway

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Thesis submitted as part of the Master of Philosophy Degree in Health Economics, Policy and Management 60 Credits

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June 2021

Preface

I would like to thank NHO Drikk og Mat especially Gerhard Scalith for the access to the Nielson Group data. I would like to thank my supervisor Geir Godager for helping me run the statistical regressions and guiding me through the process.

I would also like to thank friends and family for their proofreading and support.

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1.0 Introduction

Cross border trade and revenue loss for producers is one of the leading arguments against consumption and excise taxation in Norway. The simplicity of traveling to Sweden to purchase goods that are heavily taxed in Norway at a lower price in Sweden creates large incentives for Norwegians to engage in cross border trade. Tax supporters argue that these taxes were implemented to help control overconsumption of products with potential future negative health effects by regulating them. Unregulated markets create overconsumption and lead to market failure from externalities. The Norwegian government regulates products that create negative health consequences through taxation. The increase in price is used to control the amount of consumption of each product. But what happens when these taxes incentivize individuals to engage in cross border trade? The purchasing of these products in different countries at lower cost is rational for individuals. Is this excise tax protecting the market from failure caused by future negative health consequences related to consumption or is it a failed public health policy driving cross border trade?

Understanding cross border trade is pivotal to understanding the effectiveness of excise taxes. Consumption is generally hard to measure, so using sales data from stores is a way to measure consumption. Consumption measurements are accurate at measuring sales of products within the countries border. Norway has the longest shared border with another country within the European Union. This allows 48% of Norwegians to live within a two-hour drive to Sweden, a country that does not have excise taxes on sugar products and has a much lower taxation on alcohol and tobacco products comparatively. This incentivizes Norwegians to travel across the border and purchase sugar, alcohol, and tobacco products at a much lower price. Norwegians also engage in a high rate of duty-free shopping, which affects the measurement of consumption. This leads to an unmeasured amount of consumption, making it difficult to assess the effectiveness of these excise tax policies on public health.

The use of these excise taxations to lower consumption of products with future health consequences has generated vigorous debate in Norway. Most recently when the COVID-19 Pandemic closed the border to Sweden in March of 2020 there was an opportunity to describe

the influence of cross border trade in Norway. The border closure has also allowed for a greater understanding of how location and proximity to Sweden effects the amount of cross border trade for individual Norwegians. More recently many political parties have come out against these excise taxations, believing they are the driving factor behind the large amounts of cross border trade. The research about the effectiveness of taxation on individual's consumption is varied. Some countries, typically countries that do not share a border with another have seen success with this type of public health policy. Other countries and cities where there are low opportunity costs of time to travel outside the border to locate the products at a lower price have seen these policies to be less useful. There are many arguments about how these taxes can affect the welfare of a society in a positive way and will be explained in more detail further in this thesis. The goal of this thesis will be to understand the theories behind excise taxation and the welfare effects of these taxes. It will also attempt to explain some of the empirical effects the closure of the border to Sweden due to COVID-19 had on sales in Norway. Ultimately helping to understand if the volume of sales for taxed products changed when cross border trade had a higher opportunity cost to the individual due to COVID-19 restrictions.

Why tax these products?

Norway was one of the first countries to implement excise taxation on sugar products, alcohol, and tobacco. It also has one of the highest rates of excise taxation and the second highest value added tax in the European Union. This increases the cost of products in Norway to a rate that is 50-200% greater than neighboring countries. Taxation as a public health policy was implemented to combat the future negative effects of consuming the good or offsetting the consequences from consumption of the product. These future negative effects are different depending on the product type. Overconsumption of sugar products may lead to higher BMI levels, overweight and obesity, cardiovascular diseases as well as reducing the quality-of-life years for many people. Overweight is defined as having a BMI between 25-30kg/m^2. In 2017 one in four young people was overweight or obese in Norway. "A high BMI contributes to approximately 2400 annual deaths in Norway and probably many cases of cardiovascular disease, diabetes and other chronic diseases" (fhi 2017). Norway has universal health care for all Norwegians. These future health costs will be absorbed by the government who must pay for the

care of these individuals in the future. Alcohol and tobacco have similar future health concerns including liver disease, lung cancer and other heart, lung, and kidney diseases. These products also have other consequences when consumed, cigarettes produce secondhand smoke that creates future health concerns for the third-party individuals inhaling the secondhand smoke. Alcohol when overconsumed can create an increase in criminal activity as well as the potential for hospitalization or death if greatly over consumed. If the government is not regulating the market in some way all these products can be overconsumed and create a burden on the governments health systems in the future.

In 2017 the World Health Organization released strategies to decrease the incidence of noncommunicable diseases, which they define as any chronic illness shortening life that cannot be transmitted to another person. One of the strategies they set forth was a 20% tax on all sugar sweetened beverages. "Estimates suggest that, over 10 years, a tax on sugary drinks of 1 cent per ounce in the United States of America would result in more than US$ 17 billion in healthcare cost savings" (WHO 2017). Taxation on these products can save governments money in the future but also raises revenue immediately, in 2020 the Norwegian government generated 17.66 billion kroner in revenue from the alcohol tax. They generated 8.96 billion kroner in tobacco taxation and 4.82 billion kroner in sugar, confectionary and nonalcoholic drinks combined in 2020. Government revenue and decreasing demand and consumption do not automatically justify these excise taxations. In more recent years, the effects of cross border trade and smuggling have created a distorted understanding of the impact of these excise taxations. In this thesis I start with examining theories and showing how the price elasticities of demand, time inconsistent preferences of individuals, utility maximization and asymmetric information change the effects of these taxes. Arguing that the unregulated and open border to Sweden has increased the incidence of cross border trade lowering the revenue for producers and sellers in Norway. I also show how the SARS-COVID 19 pandemic has impacted the demand of taxed and non-taxed products. Using a random coefficient model with fixed effects for the dummy variables to show the effects of COVID-19 and region of Norway and their effects on the sales of taxed products. Showing a positive effect on the volume of sales for taxed products compared to non-taxed products under the same circumstances.

2.0 Theoretical Framework

2.1 Theory of Taxation

Excise taxes are taxes that are imposed on certain products or categories of products by the government to lessen consumption and raise revenue for the government. More recently governments have been using these taxes as a public health policy designed to decrease the consumption of products that have negative externalities. Negative externalities of consumption are when the consumption of a good produces a harmful effect to a third party. This third party is typically the payer of healthcare, in Norway that is the government. Secondhand smoke from cigarettes, health costs from smoking, lung cancers, and any diseases related to overweight and obesity including diabetes are negative externalities from consumption. To combat the effects of negative externalities governments, impose a taxation for certain products. These taxations are typically in addition to the value added tax (VAT) already imposed on most products.

Excise taxes are used in OECD countries to influence consumer behavior, redistribute wealth, and raise revenue for the governments. "When taxes are designed to pursue public health goals, they aim at raising prices above some consumers' willingness to pay, in order to put off those consumers and lead others to cut their consumption" (Sassi, F., A. Belloni and C. Capobianco 2013). Currently there are three principal product categories defined by the OECD that have excise taxes levied on them, mineral oils, alcoholic beverages, and tobacco products. These taxes are generally calculated in terms of the weight of the product being sold or more recently the amount of alcohol or sugar that is in the finished product. These taxes are paid once the good enters circulation. Depending on the amount of tax that is passed through to consumers the price of the product may reflect the full taxation amount or just part. This pass-through rate is determined by the producer who can choose how much of the tax they will absorb. In some cases, the producer or supplier will take on a portion of the tax and then pass the other portion of the tax through to the consumer. Most producers in Norway pass the full rate of the tax through to the consumer. Increasing the price by the total amount of excise taxation.

Arthur Pigou was the first economist to show how under certain assumptions tax schemes can lead to pareto optimal resource allocation. Under Pareto efficiency these tax schemes are

implemented on specific products and will always cause someone to gain from the tax and someone to lose from the tax. Consumption taxes assume that individuals are unable to consider the costs of their behaviors on other people or systems and on their future welfare creating negative externalities. Governments can then use this tax to have the individual pay close to the full cost of these negative externalities for certain products. In the case of alcohol, tobacco, or sugar products, this is an excise tax at the rate that would cover the future negative effects of consuming the product. This is also seen as a mechanism to decrease overconsumption which contributes to the negative externality from these products.

Using excise tax and pareto efficiency to understand how consumers respond to a price increase, shows us that consumers who are willing to pay more for the product than the market price before tax are those that will lose some gains when the tax is implemented. These consumers in the case of tobacco or alcohol are typically addicted to the product and so have limited choices but to consume the product at a higher cost. Consumers who are not willing to pay the price will typically find a substitute, this is where the gains for the health systems in terms of future health costs are seen. This lowering of consumption for the product for certain individuals aligns with the idea of implementing the tax for public health reasons. Products that have an elastic demand will have a greater welfare loss than products with an inelastic price elasticity of demand. This is one of the reasons that products with a more inelastic demand are targeted for taxation. The tax revenue is generally seen to offset the effects from those individuals choosing to purchase the product at a higher price.

2.2 Externalities
In the early 1920's Arthur Pigou introduced the idea of externalities in relation to welfare economics and how a Pigouvian tax can help to eliminate these externalities. A consumption externality is seen when the consumption of a product causes a cost to a third party. Alcohol, tobacco, and sugar products create consumed externalities. This is the future health consequences to the healthcare system from diseases related to sugar, tobacco, and alcohol consumption. There is a welfare loss in these situations because the social marginal benefit of consumption for these goods is less than the private marginal benefit. Pigouvian taxes are those that are placed on any good creating a negative externality, thus increasing the price for the

product. Pigouvian taxes were implemented because the producers of the product were not the ones bearing the cost from the negative externalities their products created.

To offset the effects from the negative externality a tax is applied to the product in an attempt to bring the social marginal cost equal to the private marginal benefit. Using Figure 1 in a free market the equilibrium, seen at quantity Q0 and price P0, the private marginal cost is equal to the private marginal benefit. This is not the socially efficient point which creates social inefficiency. To account for these negative externalities the efficiency point must move to where the social marginal cost is equal to the social marginal benefit. The distance between the private marginal cost line and the social marginal cost line is the negative externality. A tax seen as t on the diagram or the distance between p0 and p* is then applied to reach P* where the social marginal cost is equal to the private marginal benefit. The consumer is then responsible for paying the private marginal cost + externalities. This decreases the quantity to Q* creating a decrease in consumption. The externalities distance is also the amount of revenue that the government will receive from taxing that specific product.

In the case of alcohol or sugar sweetened beverages, the producer does not pay the cost for externalities from their products, instead a third-party typically bears this cost. Using Pigouvian theory the government who is the third party bearing the cost of negative externalities would then create a tax that the consumer bears in the end price of the product. Producers have the choice on how much of the assigned tax will be passed through to the consumer price and how much is absorbed by them. In the case of 100% passthrough the consumer takes the full cost of the tax. The government is gaining revenue in this tax structure that is equal to (P*- P0) Q*, or the change in price multiplied by the quantity demanded.

Figure 1 (Pigouvian Model)

p

SMC

p*   S + Tax

t

PMC   DWL

p₀   S

PMB

Q*   Q₀   Q
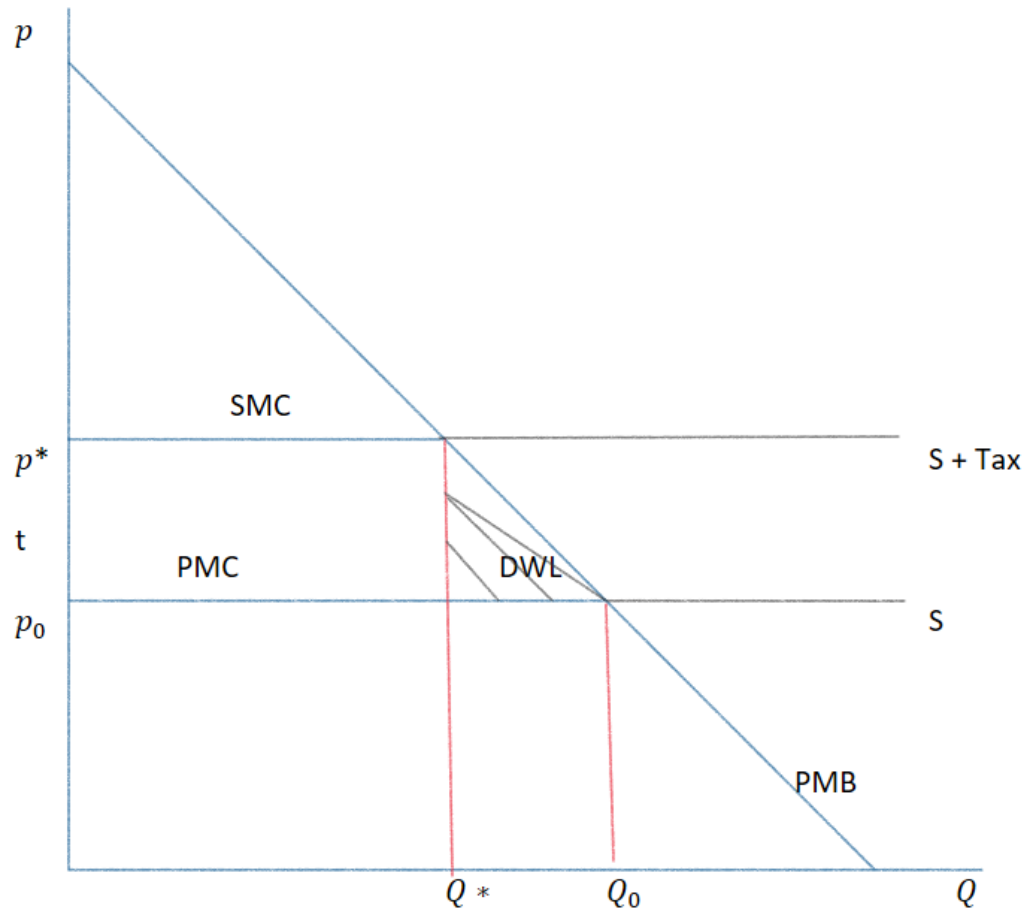
2.3 Price Elasticity

The price elasticity of demand is an important feature to excise or consumption taxes and what revenue or public health effect the government can generate from each product. The price elasticity of demand is calculate using equation 1 below, percentage change in quantity over the percentage change in price. Another important elasticity is the cross-price elasticity shown in equation 2.

Equation 1 (Price Elasticity of Demand)

$$\frac{\%\Delta Quantity}{\%\Delta Price}$$

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Equation 2 (Cross Price Elasticity of Demand)

$$\frac{\%\Delta QuantityX}{\%\Delta PriceY}$$

If a product has an elastic demand when the price of the product goes up the demand for that product will decrease, this is typically seen with products that have close substitutions or high cross price elasticities of demand. Imposing an excise tax on these products will typically lower consumption and not raise as much revenue for the government. Instead, taxing products with inelastic demand has the opposite effect. Consumers are likely to pay more for the product which does not decrease consumption but will be a revenue generator for the government. These products are generally hard to find substitutes for, are addicting or are necessities. In more recent years it has been shown that products like tobacco, alcohol and food have inelastic price elasticities of demand. Increasing the amount of excise taxes being levied on them will create a constant revenue source for governments, incentivize cross border trade but not lower actual consumption. Many food products also have a high cross price elasticity. When the price of one brand or product increases then consumers will switch to a similar product at a cheaper price.

Figure 2 Domestic Supply With open and closed Border

P

Open border with Sweden
Norwegian domestic supply

Domestic Supply
Closed border

Norwegian Price

Demand During COVID-19

Demand pre COVID-19

Q1   Q2   Q
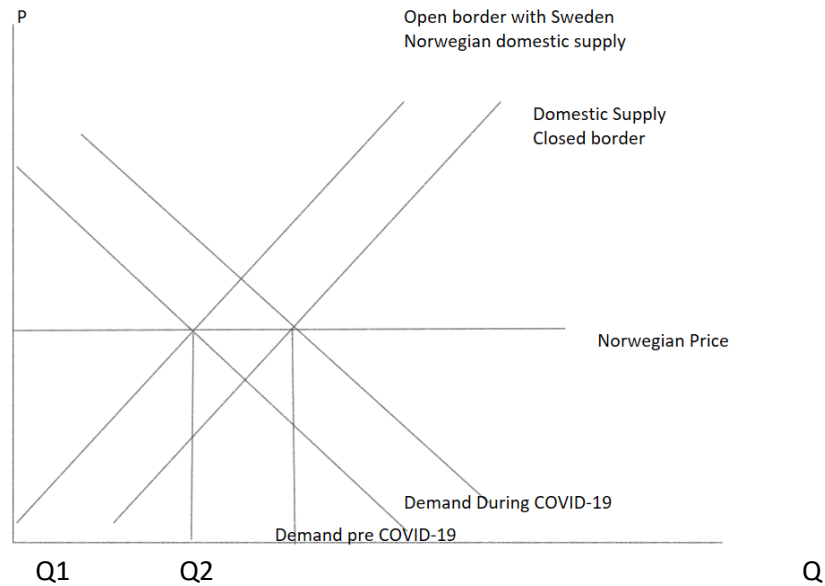
COVID-19 created a supply and demand shift within Norway for products that are typically imported from Sweden. This quantity of these products being sold within Norway was higher than when the border was open. The price of the products remained stable during this time. The above graph shows how when the border with Sweden is open the quantity sold of the product is lower than when the border to Sweden is closed. This shows that products that are being taxed in Norway have an inelastic price elasticity of demand. The price remains stable but the opportunity to import is taken away the domestic quantity sold will increase. This shift aligns with previous research on the elasticity of demand for alcohol, sugar and tobacco products.

The OECD estimates alcohol price elasticity at -.50 with differences between the types of alcohol. Beer is estimated between -.29 to -.46, wine -.46 to -.70 and spirits -.54 to -.80 (OECD 2015). These estimates show the inelasticity of demand for alcohol products. OECD also found that the dominating beverage in each country was less responsive to price changes making it more inelastic than other beverage types and that countries where wine is produced the demand is more inelastic than countries that do not produce wine. The same was found for countries where beer is the dominantly produced alcohol.

There are also elasticity differences found depending on the level of alcohol an individual consumes, the demand elasticity for those who are considered heavy drinkers was -.21 compared to moderate drinkers whose price elasticity was -.47 (OECD 2015). Heavier drinkers are less price

inelastic which aligns with consumption theory and the idea that addictive products tend to be more inelastic. Increasing the price does not have as large of a consumption effect as for those products that are elastic. When taxing inelastic products, the government is sure to get a revenue from the taxation. Taxing elastic products, the government would be likely to see a larger decrease in consumption but their overall revenue from the taxation would be much lower.

Most estimates for cigarette price elasticity of demand are between -.3 to -0.5 increasing price by 10% would decrease consumption 3-5%. Like alcohol there are factors that affect what the price elasticity of demand for tobacco products including, smuggling, age of consumer and level of consumption. The own price elasticity of tobacco is dependent on the mode of consumption. Norwegian price elasticity of demand for cigarettes is estimated at -.46 when border trade is accounted for (Melberg 2007).

Nonalcoholic beverages and food have an inelastic demand but what the price elasticity is for these certain products differs across countries and types of product. Studies have shown that the price elasticity of food consumed outside the home is more elastic than food consumed at home. Finding that food consumed at home may have a price elasticity of demand around -0.59 (Andreyeva et al., 2010). Nonalcoholic beverage price elasticity of demands is still relatively new and so the estimations are not as accurate or precise. Every country estimates their own price elasticity of demand for nonalcoholic beverages at different levels. OECD 2015 estimates soda to have a price elasticity of -0.86 and sugar sweetened beverages at -1.21. Chile estimates at -1.37, with a 10% increase in price the demand would decrease by 13.7% (Guerrero-López, C.M., Unar-Munguía, M. & Colchero, M.A 2017). The United States estimates soda price elasticity of demand between -.79 to -.86. With the elasticity of sports drinks being -2.44.

Cross price elasticity effects the consumption of products, when the price of a certain product increases the rate of consumption for another substitute product with a lower price typically increases. These cross-price elasticities depend on the price elasticity of demand for both products. Ready rolled cigarettes have a cross price elasticity with roll your own cigarettes, snuff and chewing tobacco of .4. Showing that if the price of ready to use cigarettes are increased then individuals will consume tobacco in a different form if these other products are priced lower.

Alcohol has been found to be a complement for cigarettes, but cigarettes are not a compliment for alcohol (Koksal & Wohlgenan, 2011). Within sugar sweetened beverages the cross-price elasticities of high sugar high taxed products and low-calorie sodas was between -0.46 to -0.86 showing that these products were not substitutes but instead complimentary of each other. There was weak substitution effect found between non healthy foods (sugar, salt, and fat) and healthier foods (fruits and vegetables) with a cross price elasticity of 0.01 (Guerrero-López, C.M., Unar-Munguía, M. & Colchero, M.A 2017). Supporting the arguments that increasing the cost of non-healthy foods does not incentivize individuals to consume healthier foods.

The change in the price for the consumer will depend on the pass-through rate that the manufacturer and seller decide. In the case of foods and nonalcoholic beverages it is almost always fully passed through to the consumer. The price reflects the full increase in the taxation. Cigarettes pass through rates depending on country have been estimated between 39-64 percent. More recently it has been found that food and beverage suppliers pass the taxes on to consumers at a rate higher than the tax rate, Coca Cola Norway is one of the suppliers that pass the full cost of the taxation to consumers, this is expected because Coco Cola sells homogenous goods that are available in the world market with a world market price. Norway is a small country so the amount of pass through is going to equal the amount of the global economy When the tax is increased some countries experience a doubling in pass through rate for nonalcoholic beverage compared to when the products taxation is lowered which bring the pass-through rate back down to around the full value of the tax. Pass through rates for alcoholic beverages depend on the type of alcohol as well as the brand of the product. Beer products typically have the highest pass-through rate close to 100%.

According to Pigouvian and consumption tax theories, governments should tax products with elastic demands if they are interested in the public health benefits of taxation. If the government is interested in revenue generation than taxing products with inelastic demand creates the largest revenue source. Norway currently taxes products that are generally inelastic in demand or seen as luxury or addicting goods. A consequence of this type of taxation is an increase in cross border trade and smuggling. Norway has seen a steady increase in the amount of cross border trade with Sweden after the large tax increase in 2018. Norway and Sweden have

different tax structures and levels which makes almost all products cheaper in Sweden. Currently Sweden does not have any excise tax on sugar products which include nonalcoholic beverages, chocolate, and confectionary products. This makes the price for these products much lower than Norway and creates incentives for Norwegians to purchase these products in Sweden. In 2020 the exchange rate was 1.025 Swedish Krone for 1 NOK. With value added taxes in Sweden for food and nonalcoholic beverages at 12% compared to 15% for foodstuff in Norway and 25% for other products. Figure 4 shows what the tax rate comparisons for certain food, tobacco, and alcohol products where for the year 2020.

Figure 3 (Tax rate comparisons)

Product	Sweden		Norway
Alcohol 4.5 – 6,9% ABV	13.92 NOK per liter	Alcohol 2.7-2,7%ABV	13.18 NOK per Liter
Alcohol 7-8.4% ABV	19.16 NOK per liter	3.7-4.7% ABV	22.83 NOK per liter
Alcohol 8.5-15% ABV	26.83 NOK per liter		
Alcohol 15.1-18%	56.16 NOK per liter	4.7-22% ABV	5.11kr per percentage volume per liter
Cigarettes	1.64 NOK per item + 1% retail price		2.77 NOK per Item
Snus	0.47 NOK per gram		0.85 NOK per Gram in Package
Chocolate and Confectionary	No Tax		21.22 NOK per Kg
Soda	No Tax		4.91 NOK per liter

Norway has one of the highest levels of taxation within the EEAU and the EU and has the highest tax rates in all Scandinavian. Eurostat which finds the price index levels for a basket of goods in the 27 EU countries, reported in figure (5). Shows that Norway had the highest cost for alcohol products for all EU and EEA countries in 2019. While also having a significantly higher cost for food and nonalcoholic beverages than Sweden.

(Figure 4 Price indexes EU27=100 in 2019)

Product	Norway	Sweden
Alcohol/ Tobacco	235.6	131.1
Food and non alcoholic beverages	157.3	114.1

Using these price indexes alcohol and tobacco products in 2019 were on average 79% more expensive in Norway than in Sweden, and food and nonalcoholic beverages were 38% more expensive on average. This gives many Norwegians the opportunity to increase their utility by purchasing products in Sweden.

2.4 History of Norwegian Taxation

Norway has a long history of taxation, they were one of the first countries to implement a taxation on sugar and have some of the largest tax rates on alcohol, cigarettes, non-alcoholic beverages, and sugar products. These taxes are all levied as excise taxes. Starting in the early 1920's Norwegian parliament was given the sole responsibility of creating annual tax policies and levels. Taxes fall under the finance sector which parliament has control over. Norway has used different types of taxes to create revenue and decrease consumption of certain products. In 1922 when the sugar taxation went into effect it was levied on what the government called luxury goods. This meant that the tax was only affecting those who could afford the luxury product. When this tax was introduced it was used as a source of revenue for the government. "Excise duties are levied on specific goods and services and is mainly fiscally justified. In addition, excise duties can help to price society's costs of using, for example, health and environmentally harmful products (Finansdepartementet, 2017, p.133). In 1922 when the excise sugar taxation went into effect, the government also created Vinmonopolet stores, which are state owned liquor stores. Vinmonopolet is the only store in Norway that you can buy alcohol over 4.7% except in duty free parts of airports. The tax levels have changed many times since 1922, there have also been additional products added to the taxed groups. In the past twenty years the focus on these taxes has shifted from being just a revenue source for the government to being used as a public health policy. Targeting products that are associated with

unhealthy lifestyles that have the potential to lead to loss of quality life years while also potentially creating future health problems. Norway also imposes a packaging tax on these same products. In 1994 Norway introduced the beverage packaging tax, which taxes single use packaging. These single use packages can be made of metal, glass, plastic, or cartons. Lastly Norway has a value added tax or VAT, that is imposed on all products at the point of sale, including food and beverages. Norwegian VAT was 20% in 1970, it then increased to 24% in 2004, currently in 2021 it is 25% for non-food products and 15% for food products. The average VAT in OECD countries in 2019 was 19.3% for non-food products, only Hungary currently has a higher VAT than Norway out of all OECD countries (OECD).

In 2017 the largest increase in taxes was proposed in Norway. This increase went into effect in 2018 where the tax on chocolate and sugar increased from 20.19 kr/kg to 36.92 kr/kg. The tax was then reduced in 2019 and 2020. In 2020 chocolate and sugar products were taxed at 21.22kr/kg. The excise tax on sugar and chocolate was abolished in 2021, as of January 1st Rema 1000 reports that this tax decrease brings chocolate prices from 199.5 kroner for a kilogram of milk chocolate made by Freia down to 174.5 kroner per kilogram. Many products saw a decrease in taxation after parliaments 2020/2021 proposal, which stated that the reasons for the sharp decreases in taxation in 2021 were partially affected by the large amount of cross border trade. "The tax shall provide the state with revenue and contribute to reduce alcohol consumption. High fees on alcohol can, however, lead to increased cross-border trade, domestic production, and smuggling. Such unregistered turnover weakens control of consumption and entails a loss of tax revenue" (p.199 2020/2021 finansdepartment). In 2014 there was a change in the amount of alcohol you could buy bring into Norway tax free, the government allowed individuals to exchange the tobacco quota for 1.5 liters of wine. "The number of liters of wine per arriving traveler increased from 0.49 liters in the years before the quota change to 0.56 liters in 2015 (Finance 2020 p.201). Parliament adopted in 2021 a proposition to reduce alcohol tax by 10%. This proposal also reduced the tax on tobacco products by 25% and cut the sugar sweetened beverage tax by 50%. One of the main goals of this proposition was to decrease the amount of cross border trade by bringing the cost of products that are highly susceptible to cross border trade down. This proportion took affect

January 1st of 2021. Table 3 below shows the levels of taxation compared to 2020. The taxation level decreased for all products but the automatic price adjustment level of 3.5% still created an increase in the cost of tobacco products.

Table 1 (Taxation Levels 2020-2021 Alcohol)

Alcohol Content	2020 (NOK)	2021 (NOK)	Percentage Change
0.0=0.7 pct. Alcohol by volume	0	0	0
.7-2.7 pct. Alcohol by volume	3.51	3.27	-6.8
2.7-3.7 pct. Alcohol by volume	13.18	12.28	-7.3
3.7-4.7 pct. Alcohol by volume	22.83	21.27	-7.3
Spirits over .7 pct. Alcohol by volume	7.84	8.11	-3.4
Other Alcohol 4.7-22 pct. By volume	5.11	4.76	-7.4

Table 2 (Taxation Levels 2020-2021 Tobacco)

Type of Tobacco Product	2020 (NOK)	2021 (NOK)	Percentage Change
Cigars NOK/100 grams	268	277	3.4
Cigarettes NOK/100 units	268	277	3.4
Smoking Tobacco NOK/100gr	268	277	3.4
Snuff NOK/100grams	109	85	-22
Chewing Tobacco NOK/100grams	109	113	3.7

3.0 Cross Border Trade

3.1 Factors influencing Cross Border Trade

There are many factors that influence the amount of cross border trade. The first is the distance an individual will have to travel to get the products they want. Most cross-border trade literature defines travel times as driving distances, for most individuals to engage in cross border

trade they must have access to a vehicle. Frieburg et al 2019, found that travel distance to Sweden and the utility gained from the travel was hump shaped. Using 30-minute increments to measure the amount of utility gained from cross border trade they found that the relative price coefficient is different for each 30 min interval creating the hump shaped curve. Soda was found to be the most elastic product group, finding that it is easier to import compared to cheese or meats which have restrictions on the amount that can be brought over the border. Soda also has a long shelf life so individuals can purchase a large volume during one trip leading to infrequent trips with large volumes bought in Sweden. It has also been shown that the Strongest effect of demand is not seen closest to the border. For individuals to breakeven using a cost of 30 US dollars per hour in average travel cost for individuals they must spend 1390 per trip on average so at 50 minutes of travel time you are breaking even. Time cost based on driving, median time cost based on income gas a 12NOK per liter avg fuel consumption at .08 liters per kilo, fuel cost .96NOK per kilo median income 473,000 NOK 27% tax rate, 1,695 hrs work. Travel cost per minute of 4.56NOK. Breakeven point at 42 minutes with average exchange rate and 30 percent price difference (Frieburg et al. 2019). This study showed that a depreciation in the Norwegian currency would move the travel distance closer to the border. Those who live further from the border would then have a larger opportunity cost of traveling.

Canada a country that shares an 8,891-kilometer border with the United States also sees a large amount of cross border trade. Baggs et al 2018 found that the most marked effect for cross border trade is seen at 50 kilometers from the border. An appreciation of the Canadian dollar substantially decreases the sales of Canadian retailers and that this effect decreases with distance from the closest US store. These same concepts were found in Chandra et al. 2014 where border crossings responded strongly to exchange rate changes and that distance exerts a major influence on the propensity to cross the border.

The two major factors effecting cross border trade are the travel time to the nearest foreign store as well as the exchange rate between the two countries. There is also an effect from the within country price differentiation. In regions that are closer to the border many grocery stores will adjust their prices to be more competitive with stores in the bordering country. Where regions of the country that are not high cross border trade areas will have a higher price for

products because they are not likely to lose revenue from the individuals in the area because the opportunity cost of time outweighs the higher price tag.

3.2 Norwegian Cross Border Trade

Norway and Sweden share the longest common border in Europe, this creates the opportunity for Norwegians to buy certain products in Sweden. Creating a market in Sweden for large shopping malls to be built in common Norwegian shopping areas. Nordby, the largest shopping mall in Scandinavia was specifically built to attract Norwegian consumers by selling products at cheaper prices. This mall built in 2004 in Strømstad Sweden a city located 10 minutes from the Norwegian border originally had 42 stores but in the last 15 years the number of consumers shopping at the mall has increased the demand for more stores. Today it has 110 stores and over 75% of its sales are to Norwegians. The COVID-19 Pandemic has shown how much revenue these malls are gaining from Norwegian consumers, Nordby reports that in 2020 they lost 95% of their sales due to the loss of Norwegian consumers and strict border regulations due to the pandemic. While Swedish stores have seen a drastic decrease in sales due to the pandemic, stores in Norway that typically loose consumers to Sweden have seen a massive increase in sales. Vinmonopolet the state-owned liquor store in Halden Norway which is a 15 minute drive to the Swedish border has seen a 200% increase in sales in 2020 compared to the previous year. This trend has been seen in many regions known for cross border trade. Showing that previous consumption data for products may not be accurately showing the effects of excise taxations in Norway.

For an individual utility to maximized by traveling to Sweden for products they must live within a certain driving distance, these areas are typically referred to as border regions. Different studies have defined what distance from Sweden should be qualified as a border region. Friberg et al 2019 a study focused on understand the utility maximization of purchasing products in Sweden found that this utility is shown with a hump shape curve. Those who live over 90 driving minutes see a diminished marginal return on their utility from cross border shopping. The reasons for this vary, they set the limit for defining a border area at 90 minutes or under. Nielsen Group instead sets their limit at a two-hour drive from the border. Finding that in 2019 46.7% of Norwegian households lived within a two-hour drive to the border. Seven of the eleven regions

in Norway are included in the Nielson border area; Viking, Oslo, Innlandet, Vestfold og Telemark, Trondelag, Norland and Troms og Finnmark. For the purpose of this thesis regions and individuals will be included in the border category if they are within a two-hour drive to Sweden. These individuals have a low opportunity cost of time and transactional costs related to shopping in Sweden. Increasing the likelihood of shopping in Sweden.

The amount of cross border trade and the amount of day trips is also positively correlated with the exchange rate. A 10% depreciation in the Norwegian Kroner was associated with a 2.8% decrease in the amount of cross border trade. Showing that Norwegian consumers are highly responsive to changes in price and will increase cross border trading when prices in Sweden are at a rate low enough to compensate for the opportunity cost of time. "Results indicate that the closer a location is to the border, the more sensitive is local demand to foreign prices, but also that effects of cross-border shopping can stretch far inland" (Friberg et al., 2019).

There has been specific attention paid on the effects of cross border trade of alcohol beverages between Norway and Sweden. Nordic countries have relied on a common understanding that they will have higher prices on alcoholic beverages compared to other EU countries. But when Finland and Sweden joined the EU they were forced to converge into the single market and have the prices of their products reflect that of other EU countries. There is also a harmonized excise tax rate within the EU, which dropped the price of alcohol in Sweden and Finland. When Sweden dropped their tax rates by 39% on strong beer in 1997 it forced Norway to decrease their tax for the first time since post war in 1999 by 2 percent. The single market EU is a driving factor behind the differences in prices of not only alcohol but most products in Sweden and Norway. To decrease their losses in revenue due to cross border trade to Denmark and Finland, Sweden has kept the cost of their products low. This has increased the amount of cross border trade that Norwegians engage in.

In 2019 53% of Norwegians reported going to Sweden for a day trip, of the 53% only 4% said they did not shop for daily goods. The top daily goods that are bought in Sweden by Norwegians are meat, cheese, soda, chocolate, candy, and alcohol. A study done by Nielson Group in 2020 found that soda, sweets and ready to eat meat products were the top three items

that Norwegians shopped when in Sweden. 44% of Norwegians who bought products in Sweden said they purchased soda everytime, with 42% saying they always purchased chocolate and other candies. There are no import restrictions on the amount of soda or candy that can be brought back to Norway. There are import limits on agricultural products including meat and cheese, with a 10kg limit on the combined total you can import into Norway. After the tax increases in 2018 the amount of cross border trade has steadily increased. The lower price of goods in Sweden is the driving factor behind cross border trade.

When COVID-19 forced the border to Sweden to close in March of 2020 towards the end of quarter one, the amount of cross border trade saw a sharp decrease. By quarter three there was a 72.1% decrease compared to 2019. Cross border trade in the last quarter of 2020 was down 87.7% compared to the fourth quarter in 2019. Figure 6 Shows the trends in cross border trade over the last five years and how COVID-19 has affected the levels of day trips and spending.

Figure 5 (Cross border trade amounts – Nielsen Group 2020)
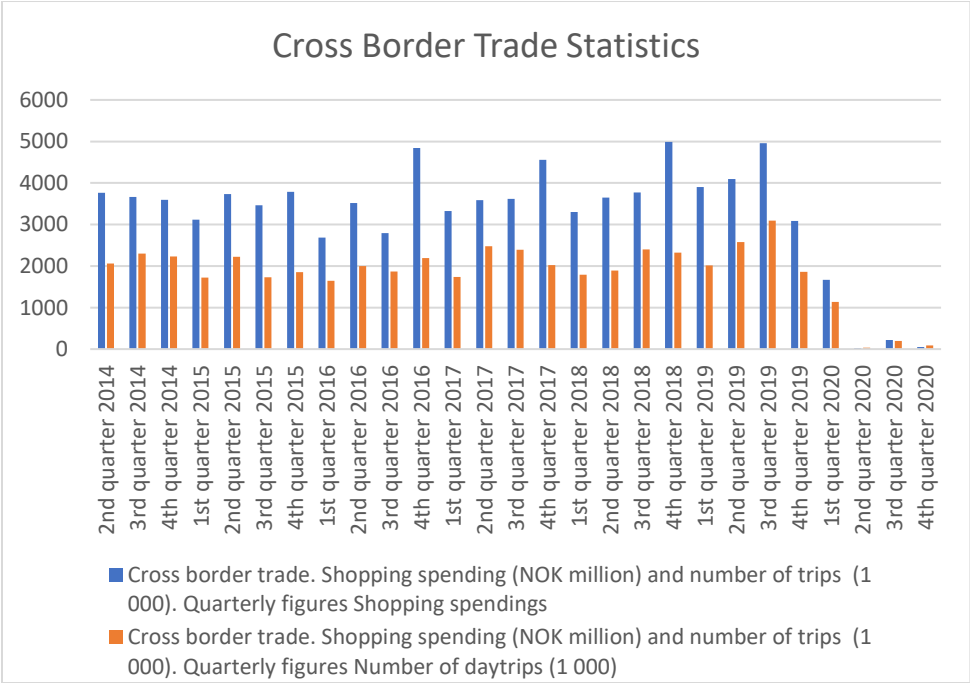
There is a large discrepancy in the number of sales that Norwegian grocery stores who are in border regions sell compared to their non-border counterparts. Table 1 shows the percentage of sales in a select group of grocery stores in border areas. Before restrictions is

measured as week's 1-11 in 2020 and after restrictions is the weeks of 12-16. The data shows the volume differences in sales of each product for those time periods. There was growth in volume of sales in most product categories especially in the top three cross border trade products, soda, alcohol, and candy. The largest decrease was seen in weighted candy, this is related to the closure of many of these dispensers within grocery stores during the first part of the COVID-19 pandemic. In the border areas during the first four weeks of the closure Norwegian grocery stores did 900 million in sales in the categories listed in the figure below. This shows how much money stores loose over the course of the year due to cross border trade.

Table 3 (Cross Border Trade during COVID-19 – Nielsen Group 2020)

Product	Before Restrictions	After Restrictions
Carbonated Drinks	-.1%	21.5%
Beer	3,7%	28.3%

Sports and Energy Drink	29.0%	30.6%
Chocolate	-1.4%	29.7%
Weighted Candy	8.5%	-38.5%
Confectionary	-2.6%	79.3%
Cigarettes	-2.1%	38.4%
Chewing Tobacco	5.7%	51.9%
Fresh Bacon	0.5%	30.8%
Dough	2.7%	17.2%
Fresh Poultry	11.4%	19.3%
Meat	-.5%	24.6%
Milk	0.5%	20.0%
Cheese	6.2%	21.4%
Animal Food	5.2%	1.3%
Cold cuts	2.0%	0.5%
Clothes Washing products	8.2%	-1.2%
Frozen Pizza	3.3%	-10.5%
Baby food	-1.0%	-17.7%

Nielsen group gathered data on a group of surveyed Norwegians who shop regularly in Sweden. 62% of them spent 0- 3000 NOK per trip. With 23% spending between 3000-6000 per trip. This generates a large revenue loss for Norwegian grocery stores within the border areas. Nielson estimates that in 2019 per capita Norwegians spent on average 37,600 NOK on grocery store items. This number was much lower in border regions including Ostfold which per capita spend 29,900 on grocery items for 2019. The opposite was found for regions that are much further from the border including Sogn and Fjordane which per capita was spending 44,000 per year on grocery items. Lower spending on products was seen in almost every category but was more pronounced for the products that are taxed at a higher rate in Norway than in Sweden.

Table 4 (Regional sales for products)

Product	Østfold Region	Sogn and Fjordlande Region	Percent Difference
Beer	1640	2640	160%
Carbonated Drinks	1180	1990	169%
Cold Cuts Fresh	430	510	118%
Chocolate	740	1200	162%
Confectionary	180	270	150%
Cigarettes	790	1650	209%
Chewing Tobacco	330	1110	336%
Meat	630	930	148%

3.3 Consumption Patterns

Consumer behavior is the driving factor for consumption and demand. Consumption patterns of individuals are functions of the individual's personal preferences, self-control, information asymmetry, and the level of daily consumption. Depending on the level of self-control an individual has as well as the level of addiction with a product drives the consumption of that product for many individuals. Information asymmetry is when manufacturers and suppliers label products in certain ways leaving out pieces of information, not allowing the individuals to make fully informed decisions because they do not have the full information regarding the product. It may lead to individuals believing they are making healthier choices, instead the manufacturing company omitted marketing the unhealthy aspect of the product. This is typically seen when a manufacturer puts "fat free" on a package, it may be fat free but is high in sugar offsetting the health benefits of the fat free aspect. The addiction level of a product and the individuals consumption levels before taxation will impact the consumption of the product post taxation, typically highly addictive products are inelastic, and consumers will continue to demand the product no matter price. Tobacco and alcohol are both addicting products, creating an inelastic price elasticity of demand. The increase in price may have a short-term effect but the addictive nature of the product will create demand after the initial price shock. In welfare

economics there are three main theories that explain why addicting products are inelastic, including the theory of imperfectly rational addiction. Where the individual wants to make good choices and has foresight about future health consequences but that part of their personality that is addicting wins in the end and they fall back into consuming the product. When a taxation increases the cost of the product there will be an initial dip in the demand for the product, but it will rebound after a short period of time when the individual is no longer able to control their addiction. Anther common theory is the rational addiction model. Where individuals are seen to have foresight and understand the future health cost of their consumption but weigh that against that instant pleasure of the action of consumption and choose the short-term pleasure and continue to consume. Lastly the myopic theory, where individuals are seen as short sighted and that the price increase will decrease the number of new smokers but those who are already addicted will not see the price increase as a reason to consume less, instead a decrease in price would increase the number of new smokers and consumption of those already addicted. These theories help explain why there is always a demand for addicting products no matter the price of the product.

Many governments report consumption based on the per capita sales of certain products, using companies' and stores point of sales data to understand trends. Consumption of sugar products peaked in European countries in the early 2000's. This created pressure on governments to find solutions to lower the incidents of obesity and diabetes related to sugar consumption. In the 2019 Developments in the Norwegian Diet report published by The Norwegian Directorate of Health reported consumption rates for sugar had met the goal the government set for energy percentage of sugar products in the diet in 2018. This percentage is based on the recommended caloric intake for certain individuals. In Norway, the rate was lowered from 17% in 2000 to 11% by 2018. The recommended percentage of a person's diet that is sugar should be 10% or below. These estimates are based on sales data from Norwegian stores and do not account for sugar that is imported by individuals. During this same time, the amount of cross border trade was steadily increasing, from 3.665 million NOK being spent in cross border trade in quarter three of 2014 to 4.958 million NOK in the third quarter of 2019. Some have argued that the consumption

data the government publishes is not an accurate depiction of what consumption rates are especially for products with high taxation and cross border trade rates.

Alcohol consumption in Norway has seen a slight decrease per capita in the past ten years. Statsita reports that consumption in 2009 was 90.96 liters per capita and in 2019 it had decreased to 82.46 liters per capita. According to the Norwegian Helsedirektoret 13 percent of adults between the age of 16 and 72 use smokeless tobacco snus daily. Smokeless tobacco use has seen an increase in usage in the past ten years as smoking tobacco has decreased in usage. In the past ten years in Norway the percentage of young adults smoking tobacco daily has dropped from 12 percent down to 1 percent. Chewing tobacco is a strong substitute for smoking tobacco especially in younger groups of individuals. Approximately 6300 people die annually in Norway from tobacco related diseases (Helsedirektoratet 2018). Tobacco is one of the most regulated products in Norway, the excise tax on the product may have some effect on the decrease in usage but the stringent regulations are also a strong contributor to lessening tobacco use in Norway.

The impact of these taxes is seen across the market. Consumers who are in lower income groups bear the effects of the taxes more than those in higher income groups, this is known as regressivity. When these taxes increase the price to the consumer those in lower income classes must use a higher percentage of their income to purchase the product. "A tax on soda and juice drinks would disproportionately increase taxes on low-income families in Philadelphia" (Bernie Sanders, U.S Senate April 2016). Sugary drinks and cigarettes are disproportionately consumed by poor individuals, in the United States products that are cheapest in grocery stores are typically products that contain high sugar or fat contents and are typically unhealthy. When the tax is implemented without a subsidy or a lowering in price of healthy products individuals of low income will feel the burden of the tax at a much higher rate than other individuals. To offset this regressivity some governments have earmarked the revenue of these taxations to help low-income individuals. The revenue from excise taxation in Norway is not earmarked and goes into a general fund.

The taxes also have an impact on Norwegian suppliers and producers. When the border to Sweden closed NHO Mat og Drikke was able to understand how many Norwegian jobs they

could add with the new consumption and demand levels. Finding that if taxes on sugar products and sugar sweetened beverages were removed and alcohol taxes halved it would add 7,800 jobs to the Norwegian market (NHO Mat og Drikke 2020).

Taxes also impact the government's budget and revenue for each year. Parliament creates an estimate on how much revenue they will gain yearly from each excise tax. In 2020 they predicted a revenue from alcohol taxation at 17.4 million NOK with the border closer they made 17.659 million NOK from the taxation. For chocolate and confectionary products, they predicted a revenue of 1.475 million NOK, they brought in 1.519 million NOK in 2020. Nonalcoholic drinks predicted to raise 3.1 million NOK but only generated 3.090 million NOK in 2020. Tobacco products were estimated to bring the government 8.8 million NOK and generate 8.957 million NOK. All products except for nonalcoholic beverages generated more revenue to the government in 2020. This can be attributed to the lower rate of cross border trade in the last three quarters of 2020. Arguments against taxation say that the uptick in consumer spending within Norway would generate a similar revenue to governments with the Value Added Tax, the increase in products sold will increase the total amount of VAT revenue offsetting the decrease in revenue from eliminating other taxations.

An interview with members of the tax department at Coca Cola Nordics was conducted in February of 2021. Coca cola says that they use the same marketing for their zero sugar and full sugar products. This means that no special attention is given to products that are going to be taxed at different rates in 2021. The government proposes that the gradient taxation is a public health way to induce producers to lower the amount of sugar in their products. Producers have been reducing the amounts since the 1960's when there was no incentive to do so. The Norwegian government set forth standards for Coca Cola and other sugar sweetened beverage producers to meet for sugar content in 2019, lowering content by 19% this was done by Coca Cola in 2017. The concept of creating sugar free beverages also must be accepted by the consumer for the idea to work. Consumer behavior is the driving factor on consumption and demand. If consumers do not like the taste of a product that does not have sugar in it then they are likely to continue to buy the product with sugar. The producers are not able to create the exact replica of the sugar product without sugar. Fanta is a great example of this, it has different

formulas depending on the country that it is being sold in. When Coca Cola attempted to reduce the amount of sugar in the product in Sweden there was an outcry from the consumers wanting the original to come back.

This is a similar idea with cross border trade. Certain products are available in Sweden and are sold in different commodities. This is another driving factor for cross border trade. Norwegian producers are now trying to create the same commodities and types of products that are sold in Sweden to be sold in Norway. That could be selling soda by the case or having the Fanta that is produced for the Swedish consumer. This is also a part of consumer behavior where individuals want to maximize utility the easiest way to maximize utility in relation to saving money and time would be to buy the good, in a larger amount. There is an overconsumption because consumers are incentivized to buy so much in Sweden and then have it readily accessible to them in their homes in Norway. If the products were available in Norway this could help curb overconsumption lessening access to bulk amounts within their homes.

The Norwegian government put forth a differentiated tax structure for sugar sweetened beverages that will be implemented in July of 2021. Before the differentiation in taxation that will start the share of sugar free soda beverages on the market was already 60%. The trends were already leaning Toward providing more lower sugar products without government. In 2020 it was 4.91 NOK per liter of soda as of January 1st of 2021 the taxation rate was 1.82 with the taxation on sugar free 1.28 per liter. There is still no tax on this product in Sweden. For a liter and half, its over 2 extra NOK. This is a small increase in price but when product is bought in bulk then the increase of 2 NOK large enough to create an incentive for people to shop in Sweden.

4.0 Country Examples

Denmark was the first country in the world to put a tax on fatty foods. This tax was implemented in 2011 and quickly repealed in 2012 after economic concerns and revenue loss in Denmark. This tax failed for many reasons but the strongest arguments for failure was the amount of economic harm it did to the market. There was an increase in cross border trade in Sweden and Germany as well as encouraging producers to move their production outside of the country creating job loss in Denmark. The same year that the fat tax was implemented

Denmark also increased the taxation on sugar and alcohol products. This led to over 60% of danish individuals to shop in Germany at least once a year for products highly taxed in Denmark. The increased tax also caused some producers to make their products smaller to maintain the same price for the product, finding that if the price remained the same consumers were more likely to purchase it even if the volume of the product had lessened.

Chile is another high-income country that has implemented taxation on products deemed unhealthy. In 2014 the government increased the ad valorem tax on high sugar beverages by 5% and lowered the tax on low sugar containing beverages by 3%, the threshold for low sugar beverages is set at 6.25gr/100ml. Tax increased from 13% to 18% for high sugar over the set threshold. VAT is already reflected in posted prices in Chile. It is estimated that the own price elasticity of demand for sugar sweetened beverages is around -1.06 in Chile. Showing an elastic demand for the product. If the price of the products increases by 10% then consumption would decrease by 10.6%. Sweets and dessert were found to have an inelastic demand at -.802 showing a lower response to price increases than that of sugar sweetened beverages. The cross-price elasticity found between sweets and desserts and SSB was low at 0.07 showing these products are substitutes for each other but at a small rate. This was also found for SSB's and healthy drinks like water and fruit juices. When individuals in Chile are given the choice between a SSB with a high price compared to a mineral water of juice with a lower price they are not likely to substitute the SSB with one of those products (Caro JC, Smith-Taillie L, Ng SW, Popkin B 2017). After two years of this increased taxation, it was found that sugar consumption was down 3.2% and that the taxes had increased the prices of beverages and products by around 2%.

Chile was one of the first countries to implement a labelling regulation on sugar products in 2016. This regulation required products containing 22.5g/100g of sugar to have a label on the outside of the product warning of the health concerns from consumption, as well as banning the sale of sugar sweetened beverages and sugar products in school and banning the marketing of these products to children. This labelling regulation is like the warning labels on many tobacco products. This regulation was found to be more successful in lowering consumption than the taxation and increase in price. A comparison of sugar sweetened

beverage consumption in 2015 compared to rates a year after the regulation was implemented in 2017 found that it had decreased the consumption of sugar products by 23.7% (Taillie, Lindsey Smith, et al.). Comparing this public health policy with taxation it is seen to be much more effective at deterring consumption of unhealthy products. This labeling is also much less likely to incentivize cross border trade because the product is close to the price of neighboring countries.

Berkley a city within California implemented the first excise tax on sugar sweetened beverages in March of 2015 taxing all beverages at $0.01 per fluid once in the drink. This tax was applied at the manufacturer or merchant level depending on the pass-through rate. Using pre and post data in the city they found that four months after implementation there was a 21% decrease in consumption compared to increases in neighboring cities like Oakland and San Francisco. Water consumption in Berkley also increased after the taxation by 63% compared to 19% in neighboring cities. Data from the first year of the intervention found that it had decreased the sales of SBB's by 6.9% in Berkeley but in neighboring cities the sales had increased 6.9% (Silver LD, Ng SW, Ryan-Ibarra S, Taillie LS, Induni M, Miles DR, Poti JM, Popkin BM, 2017). This excise tax was only levied on a single city with the opportunity for many consumers to drive to neighboring cities to buy the drinks they like. There was also no significant decrease of sugar sweetened beverages per capita in Berkley. The availability and opportunity for residents of Berkley to consume and purchase sugar sweetened beverages was not greatly impacted by this taxation because of the simplicity of accessing the same product at a lower price in a neighboring city. This cross-border shopping has been seen in many of the cities within the United States that have implemented a sugar taxation.

Philadelphia also implemented an excise tax on sugar sweetened beverages in January of 2017 with a .015$ charge per ounce of sugar sweetened beverages. Using longitudinal data for Philadelphia and three non-Philadelphia neighboring large cities (Zhong et al.2020) found that the within person change in consumption of sugar sweetened beverages 12 months after the tax was implemented was not significantly different. This study contradicted many earlier modeling studies that oversimplified the effects of persistent consumers, cross border shopping and the marketing effects of the sugar sweetened beverage manufacturers.

Oakland California implemented an excise tax in 2017. Looking at 10 stores within Oakland and 15 stores in comparison cities it was found that there was no significant decrease in the consumption of these beverages, and that the amount of Oakland residents who were shopping in different cities has increased as well as the amount of sales on these products in cities outside of Oakland (Cawley, John, et al. 2020). Using a difference in differences model to compare the stores within the Oakland area to those outside of the Oakland area. The pass through rate found in Oakland was 60 percent, increasing the price of the product by 60 percent of the tax levied. Using a difference of differences estimate to understand the impacts of cross border trade where Oakland consumers who bought SSB outside of Oakland would be double counted in the impact by adding that purchase to the outside city function. Comparing the change in purchases within stores in Oakland vs stores outside of Oakland. Finding a 2.98 percentage point increase in the probability that Oakland residents would go outside of the city to buy these beverages at least once a week. 42% of Oakland residents report that their usual source of beverage purchases was outside of Oakland. There was no statistically significant finding on the decrease of consumption for adults or children in the city of Oakland in the first year this tax was implemented (Cawley, John, et al. 2020). Cities have found it difficult to implement these types of taxations because of the simplicity of acquiring these goods at cheaper prices without an opportunity cost of time. For these taxes to be successful when cross border trade is easily used the state and country must have a uniform tax rate as to decrease the opportunity for purchasing the same good at a lower cost.

5.0 Empirical Section

5.1 Data Description

To understand the effects of the COVID-19 pandemic and region on sales of certain products and consumption levels I would ideally want to measure consumption for each product. As stated earlier in this paper it is hard to measure consumption so I will be using sales

data provided by the Nielson group. The data collected represents point of sale statistics from grocery stores within Norway. Sales data is reported as the volume of sales for each product, measured by weight in liters or kilograms. Using panel data for sixteen different products labeled in figure (). Data is split into weeks covering the first 24 weeks of each year and split into four-week measurements for the years of 2018-2020. Nielson splits the data based on driving distance to Sweden, with a threshold of a two hour drive to be considered a border region. To construct an understanding of the effects of the COVID-19 pandemic a dummy variable was inserted. Three of the four-week segments in 2020 weeks ending in 16,20 and 24 are considered as `covid`. I also wanted to understand the effects of the border closure and COVID-19 combined on the sales of products. To do this a latent variable was introduced which is called `covidborder`. Equation 1 shows the regression used to understand these effects. The log of sales is taken to account for discrepancies in the sales volume measurements. Each product is given a corresponding ID used to identify during the regression, listed in table 6. A total of 576 observations is used to run a random coefficient model with fixed effects.

Table 5 (Summary statistics for variables)

Variable	Obs.	Mean	Std. Dev	Min	Max
Sales	576	3323.89	5210.30	30.44	24016.32
Week	576	14	6.837	4	24
Year	576	2019	.817	2018	2020
Border	576	.5	.5004346	0	1
Covid	576	.166667	.3730019	0	1
Covidborder	576	.083333	.2766256	0	1

Table 6 (Corresponding ID for each product)

ID	Product
1	Chocolate
2	Confectionary
3	Looseweight Candy
4	Carbonated Drinks
5	Beer
6	Cigarettes
7	Snuff/ Chewing Tobacco
8	Snacks
9	Sport/Energy Drink
10	Meat
11	Poultry
12	Fresh Dough
13	Fresh Bacon
14	Cheese
15	Milk
16	Laundry Detergent

5.2 Empirical Strategy

Equation 3 (Regression model)

$$Y'_{it} = \alpha_i + \beta_c C_t + \beta_B B_t + \beta_{CB_i} C_t B_i + \gamma_1 T_{1t} + \gamma_2 T_{2t} + \delta_2 S_{2t} + \delta_3 S_{3t} + \delta_4 S_{4t} + \delta_5 S_{5t} + \delta_6 S_{6t} + \varepsilon_{it}$$

The above random coefficient regression model with fixed effect dummy variables was used. Where Y'_{it} is the log of sales for i products over t time. α_i is the product specific constant term

for each of the i products. The term $\beta_c C_t$ is the effect of dummy variable `covid` over t time. $\beta_B B_t$ represents the dummy variable border of t time. $\beta_{CB_i} C_t B_i$ shows the interaction of `covid` and `border` for each of the i products of t time. The i intercept allows the interaction effect to vary across product types known as the random effect. This is used as the latent variable in this regression. $\gamma_1 T_{1t}$ and $\gamma_2 T_{2t}$ are the non-constant year terms, of 2019 and 2020, because year is the same for all products and individuals there is no need for the i term. The same is seen with the terms for seasonal variation seen in $\delta_2 S_{2t} + \delta_3 S_{3t} + \delta_4 S_{4t} + \delta_5 S_{5t} + \delta_6 S_{6t}$, showing the five non constant weekly terms. Lasty ε_{it} accounts for any error not picked up by the other terms in this regression, typically seen as stochastic noise.

Predicting the variations in the random coefficient and setting the mean effect to 0 for the `covidborder` variable interaction. The fixed intercepts for the dummy variables are then included again with the random latent variable with an expectation of 0 for the mean value. The fixed effects predict a mean value of .1190 so any mean value varying by more than 0 will lead to rejecting the null hypothesis and show that `covidborder` influences the sales of products. The model used maximum likelihood estimations for the parameters.

The random coefficient model allows the assumption of heteroscedasticity in the residual variances to be relaxed. Using the maximum likelihood function for unknown parameters allows us to maximize with respect to the parameters and those that maximize the likelihood of realizations of the sample are estimates for the parameters. When predicting the variation for the latent variable the random coefficient is set to 0 with the specification of fixed effects, this is then included again but with random coefficients for the latent variable with an expectation of 0.

5.3 Main Results

Two models were tested with fixed effects and random slope referred to as model 1, this model is represented in the regression equation and the final predicted results. The second model tested had fixed effects and slope which will be referred to as model 2. Model 2 omitted the 16th id and used it as the constant for the regression because of collinearity in the data. Model 1 then allows for random slope and is done without the use of a constant finding a

coefficient for all product ids. This allows for the coefficient found in the interaction of `covid` and `border` to be used to predict the mean effects on each product id. The goodness of fit for model 1 is shown in figure 7. There is homoscedasticity in the data and the predicted values fit a linear distribution. The model can account for almost all the error with little left up to the stochastic error term. Both models are reported below.

Figure 6 (Results) *(Random Coefficient with fixed effects model.)* *(Fixed effects and slope model.)*

Variable	Coef.	95% Conf. Int		Coef.	95% Conf. Int	
Week 2	0.080	0.033	0.126	0.080	0.033	0.126
Week 3	0.130	0.068	0.193	0.130	0.068	0.193
Week 4	0.098	0.017	0.180	0.098	0.017	0.180
Week 5	0.076	0.005	0.148	0.076	0.005	0.148
Week 6	0.092	0.006	0.178	0.092	0.006	0.178
Year 2019	0.002	-0.022	0.026	0.002	-0.022	0.026
Year 2020	0.041	-0.008	0.091	0.041	-0.008	0.091
covid	0.229	0.131	0.326	0.229	0.131	0.326
border1	0.378	0.320	0.436	0.378	0.320	0.436

covidborder	-0.119	-0.153	-0.085	-0.119	-0.153	-0.085
Chocolate	6.454	6.387	6.522	0.614	0.614	0.614
Confectionary	5.099	5.033	5.165	-0.730	-0.730	-0.730
Looseweight Candy	5.506	5.437	5.575	-0.348	-0.348	-0.348
Carbonated Drinks	9.421	9.354	9.489	3.582	3.582	3.582
Beer	8.613	8.547	8.680	2.777	2.777	2.777
Cigarettes	7.386	7.319	7.453	1.551	1.551	1.551
Snus	3.501	3.434	3.567	-2.333	-2.333	-2.333
Snacks	6.887	6.819	6.954	1.042	1.042	1.042
Sport/Energy Drinks	6.778	6.712	6.843	0.954	0.954	0.954
Meat	6.875	6.809	6.941	1.045	1.045	1.045
Poultry	6.663	6.595	6.731	0.816	0.816	0.816
Fresh Dough	6.788	6.720	6.856	0.943	0.943	0.943
Fresh Bacon	5.136	5.069	5.202	-0.697	-0.697	-0.697
Cheese	7.671	7.603	7.739	1.823	1.823	1.823
Milk	9.252	9.183	9.320	3.404	3.404	3.404
Laundry Detergent	5.865	5.794	5.935	n.a	n.a	n.a
Cons	n.a	n.a	n.a	5.841	5.769	5.912

Figure 7 (Fit of model 2 – Random Coefficient with fixed effects model.)
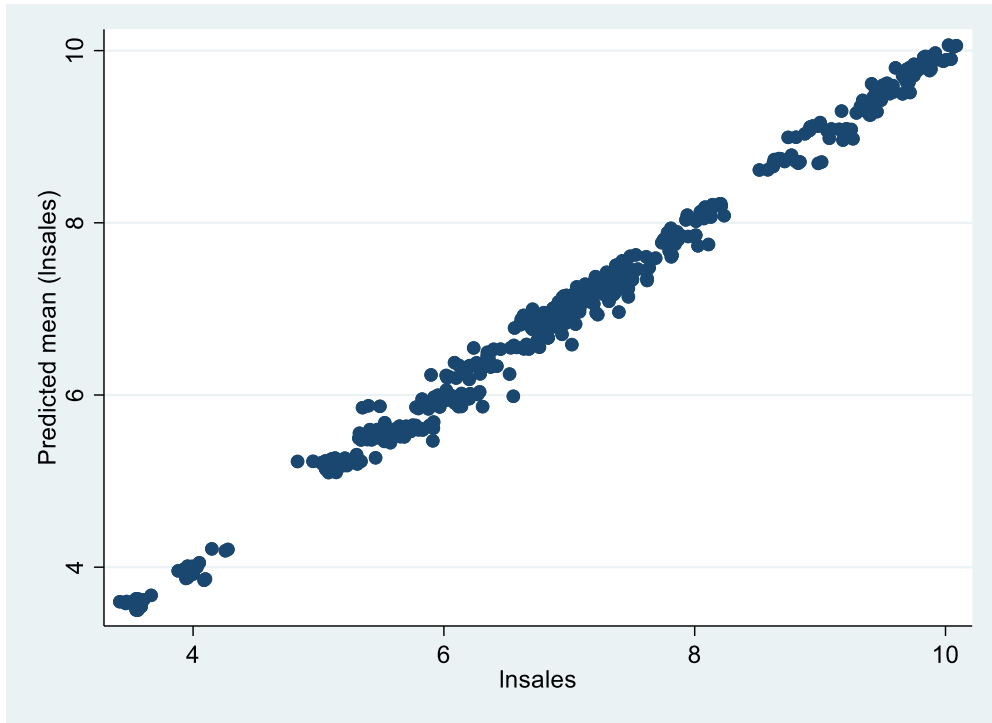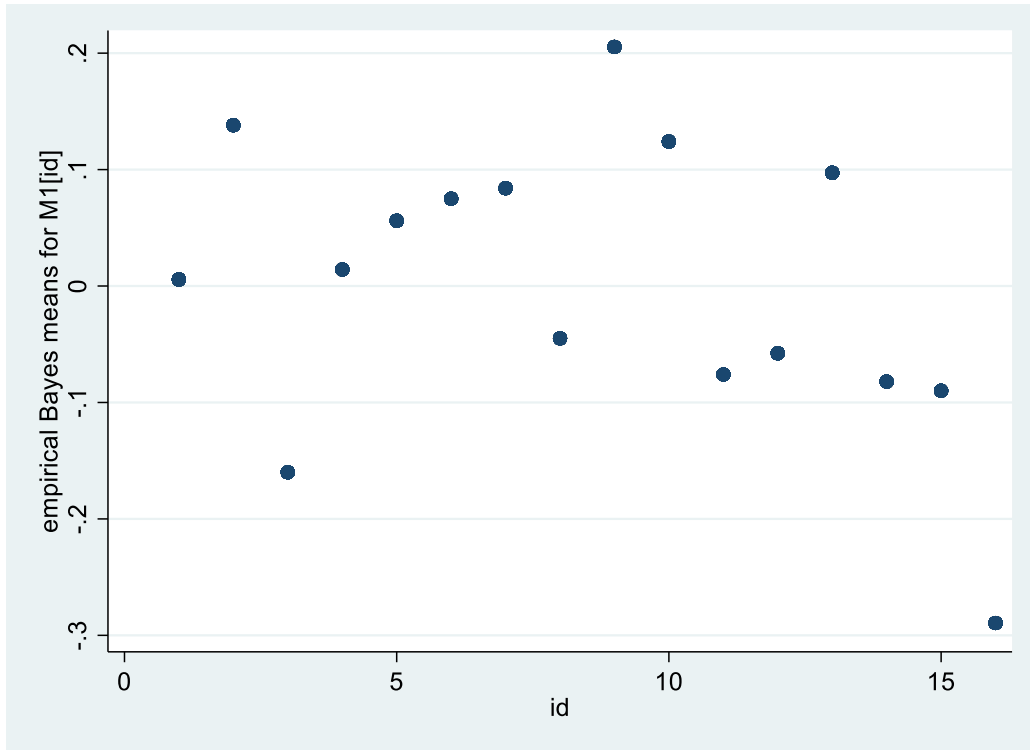

Figure 8 (Predicted effects on latent variable using model 2)

To predict the effects from the latent variable we took the estimated values from the regression and predicting the latent variable for each id group using Empirical Bayes mean predictions to understand the effect of `covidborder` on each product. Using the prior distribution found in the above regression and the likelihood function. Results are shown in figure 8. Any product with a mean over 0 will have a positive impact on the sales of that product during COVID-19 in the border regions. All taxed products have a positive effect except for loose weight candy which can be justified by the closure of lose weight candy dispensaries at the start of the COVID-19 pandemic. Having all taxed products above the mean it can be argued that in border regions the closure of the border to Sweden has created an increase in the sales of these products and helps strengthen the argument of lowering taxation to not loose revenue within the Norwegian market. It also helps show that current consumption numbers are not as accurate as the Norwegian government believes and shows that Norwegians are consuming more sugar, alcohol and tobacco than reported but that these products are being purchased in Sweden instead of Norway.

6.0 Discussion and Conclusion

6.1 Discussion

The purpose of this study was to look at how cross border trade effects the sales of taxed and non-taxed products in Norway. The closure of the Norwegian Swedish Border in March of 2020 allowed the opportunity to track sales of these products in a time when cross border trade had a larger opportunity cost to the individual. This allowed us to gain an understanding of the amounts of these products that Norwegians are demanding and how much revenue and sales are lost to Swedish grocers. This also gave the opportunity to split regions in Norway based on proximity to the Swedish border allowing for an understanding in the differences in sales in border versus non border regions. Using a random coefficient model with fixed effects we were able to show that taxed products are seeing the biggest positive effect on their sales within Norway. While products that do not have excise taxes levied on them saw mainly negative effects on their sales in border regions during COVID-19. By creating a latent variable that measured the effects of the interaction between `covid` and `border` allowed us to show that border regions during COVID-19 saw positive effects in their sales volume compared to those nontaxed products. This study supports the findings from Neilson group that border areas have seen the sharpest increase in the sales of their products especially in the products with large excise taxes. What this study adds is the prediction of the effect from the combined interaction of `covid` and `border` variables. This interaction separated the taxed products from non-taxed products by showing that the effect is positive for all taxed product but loose weight candy. This can be explained by the closure of loose weight candy dispensers at the beginning of the COVID-19 pandemic.

This study was limited by the amount of data points and the period of time that data was available for. There is much more data now available on the sales of these specific products during the COVID-19 pandemic. Using a time horizon of more than three months to understand the full effects of not only the COVID-19 pandemic but also the decrease in cross border trade would give better predictions of the demand of these products in Norway. There was also a change in the taxation structure on January 1st of 2020. Chocolate is no longer a taxed product in Norway from that date which has dropped the price significantly. This could give the

opportunity for future research on how this change in price is affecting the sales of chocolate within Norway as well as abroad. This would help the government understand if the taxations are decreasing demand or if the amount of chocolate being sold is the same as the amount sold before with taxation and the amount that is purchased in Sweden.

6.2 Conclusion

This study mimics results found by Nielson group on the effects of sales during COVID. They found a large increase in the percentages of sales for taxed products in border regions during the border closure. Every product except washing detergent listed in this study was found to have an increase in sales in the Nielson study, matches studies before about the effects of COVID-19, but what this study adds is the ability to predict the mean effect of the combination of `covidborder`. This showed that taxed products had a positive effective of the combined effect. While nontaxed products had a negative effect of the interaction between `covid` and `border`. It can then be argued that the products with taxation that have a positive effect would be sold at a higher rate in Norway and generate a greater volume of sales which leads to an increased revenue to the Norwegian market if the border to Sweden stayed closed. This is a scenario that is not likely to last. Instead using the theories of taxation, demand, and cross price elasticity we can say that if the price of these products is lowered to the same level as Sweden that the Norwegian market would benefit. The volume in sales of those products would increase, this in turn would increase the sales of the other products that Norwegians buy when in Sweden. This positive effect also shows that consumers are purchasing, and consuming higher quantities of these products than originally estimated. This creates a break down in the use of taxation as a public health policy. Not only is consumption greater than thought but the revenue from consumption is going to another country.

Although these statistics only show three months during the COVID-19 pandemic they give us a starting point in understanding the effect of `covid` and `border` on the volume of sales. This study would have benefitted from a longer time horizon using the entire year of 2020. This study was also limited to what type of products were studied. The opportunity to include a product category that is just sold in Norway would have allowed for a greater understanding of effects of COVID-19.

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