Cross-border shopping of alcohol – What is the effect on tax revenue and sales and which products are most affected?

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Cross-border shopping of alcohol – What is the effect on tax revenue and sales and which products are most affected?*

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Abstract

We use COVID-19 border closings and comprehensive store-level data on Norwegian alcohol sales to quantify the effect cross-border shopping of alcohol on sales volume and commodity tax revenue. Effects are large, for instance we estimate that commodity tax revenue for wine is about 20% lower because of cross-border shopping. Using product level data we establish that effects come from across all products rather than just a few, but effects are especially marked for bag-in-box wines. Neither availability of the exact same product in Sweden nor idiosyncratic product-level price difference with respect to Sweden has any marked effect on the impact of cross-border shopping on sales.

Keywords: Cross-border shopping, Commodity taxes, Excise taxes, Tax Competition
JEL: D62, F15, H20

1 Introduction

Consumption of alcohol can bring joy, but harmful use also has negative social and economic consequences. For instance, globally, 5.3 % of all deaths and 5.1 % of the burden of diseases and injuries are attributable to alcohol use (World Health Organization 2022). Excise taxes are commonly used to limit the consumption of alcohol and raise tax revenue, but cross-border shopping is likely to constrain the effectiveness of excise taxes in many cases. The existence of such cross-border shopping has been documented in several papers (see, e.g., Beard, Gant, and Saba (1997), Asplund, Friberg, and Wilander (2007), Leifman, Dramstad, and Juslin (2022)), but many questions regarding the overall impact of cross-border shopping on sales and tax revenue remain.

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In this paper, we rely on the universe of daily store and product-level sales of liquor and wine from Norway's monopoly retailer of alcohol (January 1, 2018, up to December 31, 2021), combined with the COVID-19-induced closing of the border, to contribute to the literature on cross-border shopping of alcohol in two ways. First, the closing of the border allows us to estimate the overall loss of sales and tax revenue (excise taxes and VAT) due to cross-border shopping. Second, while the previous literature on cross-border shopping of alcohol has almost exclusively relied on category-level data—e.g., studying the effect of cross-border shopping on the total amount of wine sold, but not examining differential effects across different price levels or packaging types—we pay particular attention to tracing out product-level effects, systematically investigating the impact across different price levels, packaging types, and whether the exact same product is available in neighboring Sweden.[1]

We observe large effects. For stores within one hour's drive of the closest foreign store, the loss in tax revenue (excise tax and VAT) is 66.1% for wine, 42.1% for spirits, and 56.1% in total. Effects are statistically significant even at distances of two to three hours from the closest stores across the border. Aggregated to the national level, the effects are also substantial: tax revenue is lowered by around 17.5% due to cross-border shopping. Turning to heterogeneity in the product dimension, we see the largest effects for low-priced products close to the border. The effects are particularly stark for wine sold as bag-in-box, where our estimates indicate that cross-border shopping lowers the volume of bag-in-box wine by 56%. At longer distances from the border, the effects are more similar across product types. For distances between one and two hours from the closest stores, the estimated decrease in volumes is around 20% for both low- and high-priced wines, for instance.

Understanding such differential effects is potentially important for designing appropriate policy responses to limit cross-border shopping of alcohol. A natural point of departure is that if there is significant cross-border shopping, excise taxes may need to come down. With an understanding of which types of products are most affected, other policy instruments come into play: for example, by affecting the assortment of products or by changing the structure of taxes, such as adjusting the mix of taxation by volume or by ad-valorem taxation, or by adjusting markups.[2] Examining the amount of cross-border shopping at the product level may also have repercussions for firm-level strategies with respect to what assortments to offer and what margins to set in different countries.[3]

A possible reason for the paucity of evidence on the impact of cross-border shopping at the

[1] Analysis at the level of categories (rather than individual products) is pervasive also for the study of cross-jurisdiction shopping of other goods, such as sugar-sweetened beverages (Seiler, Tuchman, and Yao (2021)), or groceries (Burstein, Lein, and Vogel (2022), Kluser (2023)).

[2] Our approach has some links to work that examines the effects of assortment, taxes, markups, and store access on alcohol consumption but with little explicit study of cross-border shopping. See, e.g., Nelson and Moran (2019), Voon and Fogarty (2022), and Kilian et al. (2023) for overviews. Miravete, Seim, and Thurk (2020) pays particularly careful attention to the product dimension (but without tying it to cross-border shopping). They use a structural model of the Pennsylvania state retail monopoly on alcohol to examine links between welfare and markup rules.

[3] In principle, cross-border shopping could be used as a mechanism for price discrimination; see Anderson and Ginsburgh (1999) for a theoretical analysis. On a related note, there is substantial literature on parallel imports, where wholesalers take deliveries of the same good from lower-priced countries. See Malueg and Schwartz (1994) for an early analysis. Much of the subsequent literature has focused on pharmaceutical markets, which is a prominent example of parallel imports; see, e.g., Ganslandt and Maskus (2004) or Dubois and Sæthre (2020).

level of individual products is that it is hard to identify in data with many confounding effects and relatively minor relative price movements that can be used to trace out substitution patterns. In contrast, we rely on the COVID-19-induced closing of the border to identify the effects of cross-border shopping and the non-availability of a substitute product. Conceptually, we thus make use of a similar source of variation as that used when out-of-stock observations or store closings are used to make inferences about diversion ratios in competition policy applications (see, e.g., Conlon and Mortimer (2021)). Raval, Rosenbaum, and Wilson (2022), in their evaluation of how hospital demand responds to the closing of a competing hospital as a result of natural disasters, use the term "choice-removal diversion ratios" and note that in their setting, models that are estimated using marginal changes in price systematically under-predict choice-removal diversion ratios.

Friberg, Halseth, et al. (2024) provide a similar analysis of the effect of cross-border shopping as the current article but instead examine products purchased in grocery stores. The current paper differs in three important ways. First, given the large external (e.g., drunk driving) and internal (e.g., self-control problems) costs associated with alcohol, it is arguably an inherently more interesting market for cross-border shopping than groceries. Second, for groceries, we had access to only a subset of stores, whereas here we have price and quantity data for the whole market, including on the Swedish side of the border (albeit less granular for Sweden). Finally, in the current paper, we delve into the product dimension, something left unexplored in Friberg, Halseth, et al. (2024). Related is also simultaneous and independent work by Bjørkås and Rickertsen (2024), who also examine data from Vinmonopolet with similar identification and results.[4] The main difference between the two papers is that they do not explore differences across products. Thus, while the findings on the overall effects are not unique to this paper, they provide an important reference point for the heterogeneous effects, which we consider to be the main contribution.

Apart from work discussed above we tie into a rapidly growing literature on how to set "sin taxes" with a particular focus on heterogeneity, where much interest has focused on taxes of sugar-sweetened beverages (see e.g. Allcott, Lockwood, and Taubinsky (2019)). For instance, combining UK household data with a structural model of demand, Griffith, O'Connell, and Smith (2019) evaluate different excise tax schemes, but do not examine the link to cross-border shopping.[5]

Finally we also relate to a large literature that examines reasons for price differences across countries, focusing on e.g. the role of retailer networks, differences in costs and preferences and exchange rate volatility (see e.g. Gopinath et al. (2011), Messner, Rumler, and Strasser (2023), Hoste and Verboven (2024)). Here the role of cross-border shopping is typically not explicitly quantified however. We contribute to this literature by gauging the overall effect of cross-border shopping on local sales.

The next section describes the institutional setting and data and then Section 3 presents the

[4]Similar results are also found in a master's thesis by Bergli and Zakariasse (2023).

[5]Somewhat related, Gehrsitz, Saffer, and Grossman (2021) examine the responses across different products to a sharp increase in excise taxes in Illinois and find tax-induced substitution to lower priced products. They find little evidence of systematic differences in patterns in areas close to state borders, and note that low across-state price differentials may contribute to this lack of important differences. See also Griffith, O'Connell, and Smith (2022) for an analysis of a price floor on alcohol imposed in Scotland.

results. Section 6 concludes.

2 Institutional setting and data

2.1 Alcohol consumption and retail sales in Norway

To set the stage for an analysis of alcohol taxation and cross-border shopping Table 1 presents some measures of alcohol consumption, alcohol-related health costs and an index of the price for alcohol (normalized so that EU average is 100). Excessive drinking leads to significant public health issues: 7% of the Norwegian population above 15 is estimated to have alcohol use disorders and 4% are estimated to be alcohol-dependent. 36% of traffic crash deaths in Norway and 4% of cancer deaths are attributed to alcohol, and of all deaths, 3% is attributed to alcohol.

[Table 1 about here]

Due to the significant social costs of alcohol use, the sale of alcoholic beverages is heavily regulated in Norway. Alcoholic beverage with more than 4.7% ABV is only available through a state-owned monopolist called Vinmonopolet.[6] Beverages with less that 4.7% ABV are available in supermarkets but not in convenience stores and gas stations. Alcohol is not available on Sundays or public holidays and only between 08.00 and 18.00. In addition, all alcoholic beverages are subject to significant taxes in Norway , and as a result alcohol is very expensive in Norway. As reported on the last row in Table 1, alcoholic beverage is more than twice as expensive in Norway than the average in the European Union, and 66 percentage points more expensive than in neighbouring Sweden.

Pricing in Vinmonopolet is determined by a number of simple rules, the purpose of which is to provide a level playing field so as to make a retail monopoly consistent with the rules of the common market (in contrast to Sweden, Norway is not a member of the EU but nevertheless a member of the common market). The suppliers to the retail monopoly are a set of independent profit maximizing wholesalers and producers and assortment is regulated by a number of set rules.[7] Retail prices are in effect determined by the wholesalers as the retail monopolists add deterministic markups that are common for all products (a fixed percentage markup and a smaller fixed markup per package). The identification of effects of closing of the border is facilitated by that many possibly confounding effects are shut down. Prices are the same nation-wide in all Vinmonopolet stores, there are no temporary sales and sales-enhancing activities such as in-store tastings and special end-of-aisle displays to increase sales are absent. The purpose of the monopoly is to promote responsible alcohol consumption and while instructed to operate in a cost-efficient way its purpose is not to maximize profit.

[6] https://www.vinmonopolet.no/content/english/about-vinmonopolet.

[7] Sweden also has a retail monopoly on sales of alcohol, Systembolaget, with very similar rules as Vinmonopolet. See e.g. Friberg and Sanctuary (2017) for an exposition of the Swedish rules for product assortment.

As seen from Table 1 a price index of alcohol was on average 66 percentage points higher in Norway than in Sweden. For concreteness let us consider the price difference for one product that is available in both countries. Sweden has a very similar institutional setting as Norway, with a state-owned retail monopoly, Systembolaget, governed by transparent rules. A 2020 Côte du Rhône red wine from Guigal that in August 2022 cost 139 Swedish kronor (SEK) and 199.9 Norwegian kroner (NOK). The exchange rate between the two countries is floating but has over the period been rather stable at around parity (very roughly 1 NOK equals 0.1 EUR). At this point in time the price in NOK is about 50% higher and the Swedish price of 139 SEK is equivalent to 130 NOK. Several factors contribute to the higher price in Norway: Vinmonopolet's margin is 6.7 NOK per bottle and 22% added on the input price whereas Systembolaget's margin is 5.06 NOK and 14.7% of the input price. VAT is added and is equal to 25% in both countries. Excise taxes are by volume in both countries (and both increase with alcohol content but in slightly different ways). For this bottle the excise tax is about 56 NOK in Norway and about 20 NOK in Sweden. The input price finally is about 80 NOK in Norway and about 5 NOK lower in Sweden.[8]

2.2 Data

Our main source of data is Vinmonopolet who delivered data on sales revenue and quantity at the level of each product × store × day and we use data covering the period January 1 2018 up to December 31, 2021. Since Vinmonopolet indeed has a retail monopoly (literal translation: "The wine monopoly") we observe the universe of retail sales of wine and spirits in Norway. Also from Vinmonopolet we received data on store and product characteristics.

The data contains the location of each of Vinmonopolet's 340 stores across Norway. From Sweden's retail monopoly Systembolaget we downloaded quantity at the product category × county × quarter level (Q1 2006 up to and including Q1 2022) as well as location of their stores. Using map data from OpenStreetMap we calculate driving duration in minutes from each Norwegian store to each Swedish store. Panel a) of 1 plots the location of Norwegian Vinmonopolet stores (in red) and Swedish Systembolaget stores (in blue) together with the names of Norwegian and Swedish border counties. We see that the Swedish counties are relatively large and in several cases stretch far from the Norwegian border (for reference Sweden is about the size and shape of California). Panel b) shows the driving duration in minutes from Norwegian locations (here reported by municipality) to the closest Swedish Systembolaget store. We see substantial variation in the east-west dimension across much of the north-south length of the border. Note that to the west and South Norway borders the Atlantic so that access to foreign stores on that side of the country is not an issue.[9]

[Figure 1 about here]

We combine these data with demographic data at the municipal level from Statistics Norway.

[8] Skatteetaten.no, Vinmonopolet.no, Skatteverket.se, Systembolaget.se, own calculations

[9] In very far North Norway borders Finland, these are very sparsely populated areas however well above the arctic circle.

For discussion of results and validation we also rely on a national drug use survey (Statistics Norway) and Eurostat and WHO for cross-country comparisons of alcohol use and prices.

Table 2 provides summary statistics on sales revenue, volumes and average prices for alcohol for stores located in different distance bins with respect to driving time to the closest Swedish store. We see that volume, in terms of liters per capita, is lowest in the areas closest to Sweden but clearly other effects than just distance to the border are also determining patterns. For instance, for wine, volumes sold are highest in the regions between one and two hours' drive from the border, something likely reflecting that this includes large urban centers like the capital city Oslo. In our later empirical estimation we rely on difference-in-difference estimation.

[Table 2 about here]

2.3 COVID-19 regulations

In March 2020 the COVID-19 pandemic triggered a large number of policy responses in Norway, in particular from March 17 travel to Sweden was severely restricted and the possibility of cross-border shopping effectively shut down. Later on in summer and early fall of 2020 border crossings to some Swedish counties with low infection rates were opened only to be closed again by November 2020. Summer 2021 then saw openings again and from February 2022 all border trade was open again. Figure 2 presents the opening/closing (source of data: Norwegian Institute of Public Health (2021)).

[Figure 2 about here]

The relevant restrictions on cross-border shopping were almost exclusively due to policy in Norway, rather than due to Swedish policy which only had light restrictions in comparison to other European countries. In Norway a number of other restrictions were in place and many people would be working from home. For households without COVID-19 symptoms however there were no shelter-at-home restrictions and with almost no exceptions Vinmonopolet stayed open.[10]

3 Effect of cross-border trade on alcohol sales - Category level results

We consider the effect of cross-border shopping on retail activity in Norwegian Vinmonopolet stores that are located within a 240-minute drive from the closest Swedish Systembolaget store. We assume that cross-border shopping is not a viable alternative for stores located 240 minutes or more from the closest Swedish Systembolaget store. This group of stores will therefore be assumed to be

[10] 14 Vinmonopolet stores stayed closed a total of 19 days because of sickness among staff during 2020 (Vinmonopolet (2021)). The Norwegian government ordered the closing of 45 stores in the Oslo region on January 23, 2021. Due to strong reactions from the public the closings only lasted one day however (NRK (2021)).

unaffected by the travel restrictions, effectively functioning as a control group in our analysis, by providing a reference point from which we can estimate the effect of the accessibility of cross-border shopping for stores closer to the border.

To estimate the effect of cross-border shopping on alcohol sales in Norway, estimating models of the following form.

$$Y_{st} = \gamma_s + \lambda_t + \sigma_{rm} + \sum_j \delta_j (B_t \times D_{j(s)}) + \epsilon_{st}, \tag{1}$$

where s denotes store and t denotes time periods (days in this case) and Y_{st} is the dependent variable of interest. B_t is a binary variable indicating whether cross-border shopping is feasible in time period t. This variable is zero in weeks when a visit to Sweden would trigger a quarantine stay upon re-entering Norway and one otherwise. γ_c and λ_t are store and time fixed effects, while $\sigma_{r,m}$ are region–month-of-the-year fixed effects and are included to capture different seasonal trends in different regions. This can be important since some regions are popular holiday destinations that may experience significant spikes in demand in particular months of the year. We use the municipality of the store as the regional measure. $D_{j(s)}$ is a categorical variable capturing the distance between store s and the closest Systembolaget store. The effect of cross-border shopping is estimated by the δ_j coefficients, where we estimate separate effects for each 60-minute duration bin $D_{j(s)}$ including the bin $(180 - 240]$. The duration bin > 240 is the reference value, as stores in this duration bin are assumed unaffected by the feasibility of cross-border shopping.

For the main analysis we restrict attention to the time period between January 1, 2018 and July 5, 2020. From January 1, 2018 to March 16, 2020 cross-border shopping in all Swedish border counties was feasible, while in the period from March 17, 2020 to July 5, 2020 cross-border shopping was not feasible in any of the Swedish border counties. Restricting the sample period to this window allows a clean comparison of the availability of cross-border shopping.

In Table 3, we report the results from the estimation of (3) with three different store-category level outcome variables: the natural logarithm of daily sales revenue, the natural logarithm of the daily sales volume in liters, and the natural logarithm of the daily sales volume measured in pure alcohol. The product categories we consider are liquor and wine.

[Table 3 about here]

We see that across the different specifications sales revenue and volumes sold are significantly lower in areas closer to Swedish stores when the border is open. Effects diminish with distance to the border but are statistically significant also for areas that are between two and three hours drive from the closest Swedish store. The estimated effects are economically large; for instance we estimate that the availability of cross-border shopping leads to a reduction of the volume of wine sold of 47.9% $((e^{(-.652)} - 1) \times 100)$ for stores within one hour of the closest Swedish store. The corresponding number for stores between one and two hours from Swedish stores is 19.2% and for

stores between two and three hours away a still non-trivial loss of 10.9%. Effects for liquor show similar patterns of statistical significance, are somewhat lower in magnitude, but still economically large. For stores within one hour of the closest Swedish stores an open border reduces volume sold by 34.0%, followed by 16.6% (1-2 hours away) and 7.1% (2-3 hours away).

The results reported so far are informative about the percentage change for the respective distance bin. To aggregate effects for all of the country we also need to take account of how much sales accrue to the different distance bins as we do in the following. Using the results reported in Table 3 we can also estimate the effect of cross-border shopping on sales in Norway, measured in revenue, volume in liters, pure alcohol in liters and tax revenue. We take the counterfactual level in 2018 as our benchmark and the full set of results is reported in the Online Appendix, in Table IA.1. The estimated effect is then calculated as the difference between the counterfactual value and the actual value. In Table 4 we report the percentage change in alcohol tax revenue but results are similar also for volumes.

[Table 4 about here]

We see that effects are large. For stores within one hours drive of the border the loss in tax revenue is 66.1% for wine, 42.1% for spirits and 56.1% in total. Effects are substantial, around 15%, also at a distance of one to two hours from the closest stores across the border and around 13% when aggregated to the national level. Clearly these numbers reflect the Norwegian situation with its high excise taxes but it is noteworthy that the effects are indeed large and spread far inland – in many European countries or US states a large fraction of the population live within two hours drive of a border.

Also noteworthy is that Norway has a restriction on how much alcohol that can be legally brought back after an across-the-border shopping trip. If no liquor is imported an adult may currently bring back 6 bottles (0.75 litres) of wine (alternatively a maximum of 1 liter of liquor and 3 liters of wine if not importing cigarettes in the data period Norwegian Customs (2024)).[11] While random checks are possible, border crossings are often unmanned and casual observation suggests that it is not uncommon for people to exceed their quota. On the other hand, while it may not be uncommon to exceed the quota, the kind of quantities of alcohol that can risklessly be taken across the border within EU or the US is substantially higher. Within EU for instance, alcohol that is determined for personal use can be brought across the border at no charge with 90 (sic!) liters of wine being used as the benchmark for what can reasonably be assumed to be for personal use in Sweden (Swedish Customs (2024)). Thus, the Norwegian quota is likely to contribute to limiting levels of cross-border shopping of alcohol and thereby lower the estimated effects.

[11] This was later changed from January 1 2022, when the quota on wine was reduced, see: https://kommunikasjon.ntb.no/pressemelding/17923333/endringer-i-alkohol–og-tobakkskvoten-fra-1-januar-2022?publisherId=17847994

3.1 Assessing the empirical strategy

The key identifying assumption that enables a causal interpretation of our results is that the underlying trend in alcohol sales is not dependent on the distance to Sweden. We examine this examination in various ways and relegate most of this examination to Appendix **??**.

Figure **??** plots the natural logarithm of average monthly sales of wine for stores in the different duration bins, where the sales amounts are normalized to the month before the Norwegian lockdown was imposed (*i.e.*, February 2020). The thick grey line represents the stores in the control group, that is, stores that were located further than 240 minutes from the closest Swedish store before the travel restrictions were implemented. We plot the average weekly sales in the period when all Swedish counties were open to border trade (from January 2018 until February 2020) and in the period when all Swedish counties were closed to cross-border trade (that is, March 2020 and June 2020). While there is some variation in the levels between the groups, they follow each other quite closely over time, and there is no indication that the trends are different. We also see a clear increase in sales after travels to Sweden became restricted for the duration bin closest to the border.

[Figure 3 about here]

For a more formal examination of our identifying assumption we also estimate an event study model, where $D_{j(s)}$ indicate the duration bin of store s and where k denotes the week of border closing.

$$\begin{aligned} Y_{st} = \gamma_s + \lambda_t + \sum_j 1(t \leq k-5) D_{j(s)} \delta_{-5,j} \\ + \sum_j \sum_{\tau=-4}^{-2} 1(t = k+\tau) D_{j(s)} \delta_{\tau,j} + \sum_j \sum_{\tau=0}^{2} 1(t = k+\tau) D_j(s) \delta_{\tau,j} \\ + \sum_j 1(t \geq k+3) D_{j(s)} \delta_{3,j} + \epsilon_{st}. \end{aligned} \tag{2}$$

We show the estimated treatment effects for wine sales in Figure **??** and we see that the leads are close to zero and not statistically significant. We also see the large treatment effects closest to the border then get smaller the further away from the border that a store is.

[Figure 4 about here]

4 Heterogeneous effects of cross-border shopping across products

The aggregate patterns that we established above rely on effects across products with different characteristics, the effects of which we unpack in the following, estimating the effect of cross-border trade for different packaging sizes and price groups. Columns (1)-(3) in Table 6 report the results for

regressions with the same specification as in Table 6 but estimated separately for low, intermediate and high priced liquors. Across all these columns effects are large and highly statistically significant for stores within one hour of the closest Swedish store and effects stretch far inland, gradually dying off with distance. Effects are strongest for low-priced products and somewhat weaker for high-priced products. The pattern is consistent with a situation where it is more price sensitive consumers who shop across the border and who mainly purchase lower priced products.

Columns (4)-(6) of Table 6 presents the corresponding estimates for wine. Across all these columns effects are large and highly statistically significant for stores within one hour of the closest Swedish store and effects stretch far inland, gradually dying off with distance. Effects are strongest for low-priced products and somewhat weaker for high-priced products.

[Table 6 about here]

In columns (7) and (8) we report the same specification as in the other columns but estimated separately for bag-in-box and lower priced wines. Again similar patterns emerge and for bag-in-box wines an open border lowers sales by 56.5% ($(e^{(-.8322)} - 1) \times 100$). An interesting feature to note for the wine sales is that packaging seems most important for the effect of distance. Comparing the estimated effects for all bottles (Column 8) with those for high priced wines (Column 6) we see that coefficients are almost identical. This suggests that the differential effects for different price classes of wine are mainly shaped by packaging: bag-in-box wines make up a large share of sales in the low priced wines.

Thus, there is some tendency that demand for lower-cost products is more sensitive to the availability of cross-border shopping (mainly seen for liquor where transport cost are less important as a share of the value of the product). For wine we see that bag-in-box wines are much more sensitive to the border being open at distances close to the border. This is consistent with a model where package-specific transport cost matter for cross-border shopping. However, if differences in transport costs were the only driver of results we would expect larger differences also further away from the border.

To explore the role of different products in cross-border shopping we proceed to an analysis of product-level effects of cross-border shopping of sales. Vinmonopolet has a very wide range of available products and six assortment groups across different stores. We restrict to product sample to products that are in the main assortment of Vinmonopolet and therefore widely available across stores.To limit the problem of time periods with zero sales of a given product in a given store, we now use weeks as the time period.

We run separate regressions for each product i and explore how the estimated effects of cross-border shopping are distributed across products. Using the same notation and similar specifications as above, the models we estimate are of the following form, with the natural logarithm of product-level sales volume as the dependent variable:

$$Y_{ist} = \gamma_{is} + \lambda_t + \sigma_{rm} + \sum_j \delta_j (B_t \times D_{j(s)}) + \epsilon_{ist}. \quad (3)$$

Before reporting on the results it may be useful to examine summary statistics on the set of products on which we estimate the specification in Equation (3). In Table 5 we see that wines sold as bag-in-box are by far the largest in terms of average volume and revenue per product and prices per liter are lower than for wine in bottles. There is considerable dispersion across products in volumes (with more weight in the right hand tail of the distribution, which is reflected in the observation that the mean is greater than the median for volumes sold for all three categories). We also see that there are many products, around 1,000, even in this somewhat restricted sample. Within wines sold in bottle alone, there are 647 different products.

[Table 5 about here]

Panel a) of Figure 5 displays density plots of the estimated coefficients for the product level regressions as specified in Equation (3). We display the coefficients for wine sold in bag-in-box and wine sold in bottles for the stores within 60 minutes of the closest Swedish store. As seen, both are overwhelmingly negative and large in absolute value, mirroring what we observed in the more aggregated data. This shows that the effects that we saw in the overall volume of bag-in-box wines were not just generated by a few products, all the estimated coefficients on open borders are negative for bag-in-box wines.[12]

The large effect on bag-in-box sales of an open border is an important contributor to the overall effect of cross-border shopping on sales. To highlight this, Panel b) of Figure 5 displays the national market share of wines (for the products used in the product-level regressions) against the share of products. The products are arranged from small volumes to large with bag-in-box wines coming first. We see that less than 20% of the products, the bag-in-box wines, account for around half of volume. The relatively flat curve as we move to bottles shows that for wine sold in bottles there are many products with limited sales, such that the effect of each of them is likely to be much less in the aggregate.

[Figure 5 about here]

We can also use the estimated product-level coefficients as dependent variables in regressions that aim to tease out what product-level factors that correlate with an important effect of cross-border shopping on volumes. In Column (1) of Table 7 we regress the estimated coefficients for wines in the first 60-minute bin on a number of indicator variables for whether it is a bag-in-box,

[12]The mean estimated coefficient on the open border for bag-in-box wines in the closest 60 minutes to a Swedish store is -0.702. At the 90th percentile it is -0.312 and the maximum value is -0.040. For wines sold in bottles the mean is -0.436. At the 90th percentile it is -0.069, here we have some positive outliers however, and the highest estimate is 0.814.

in the top or bottom quartile of prices (if it is sold in a bottle). Not surprisingly, these results tell a similar store as the regressions reported in Table 6. The novel information here is that it is not just a few products that drive the relation, it is a pattern that is highly visible also at the level of individual products. We also include an indicator variable for whether the wine is available in Sweden. If customers have a high degree of brand loyalty we would expect this to be negative – the same product in Sweden is a closer substitute than other wines in Sweden and when a closer substitute is available we would expect a larger fall in sales when the border is open. This prediction is not borne out for wine. This is perhaps not so surprising, there are a large number of different wines and close substitutes are available for typical grape/region combinations. Columns (3) and (4) report the corresponding results for liquor, where we see a negative point estimate on an indicator variable for whether a product is available in Sweden. This is consistent with the notion that brands matter more for liquor than for wine.

Finally, Columns (5) and (6) report results for the subset of products that are also available in Sweden and relate the effect of an open border to the price difference (price per liter in Norway minus price per liter in Sweden (in NOK)). A negative coefficient implies that the effect of an open border is greater the greater the price difference relative to Sweden. The coefficient is essentially zero however. The results suggests that, given the large overall price difference, the product-level variation is of minor importance.

[Table 7 about here]

5 The effects of cross-border shopping on sales in Sweden

As discussed we also have access to sales of alcohol on the Swedish side of the border, which allows for a valuable validation exercise. If the patterns that we see on the Norwegian side are indeed generated by cross-border shopping we would see higher volumes on the Swedish side of the border when it is open in relation to other counties that don't border on Norway (no other borders in Sweden are associated with major inflows of cross-border shoppers of alcohol. There is some inflow in the South from Denmark and Germany, but mainly in beer, Asplund, Friberg, and Wilander (2007)). We do not have access to store-level data for Sweden, instead having to rely on county-level sales at the quarterly level. Some of these counties are close to major Norwegian population centers and have relatively limited population (e.g Värmlands län, population 280,000 in 2019 or Jämtlands län, population 131,000 in 2019).[13] The county with presumable the most inflow of Norwegian cross-border shoppers is Västra Götalands län that has a population of 1.7 million in 2019, implying that effects of Norwegian cross-border shoppers will be quite diluted. To estimate the effect of cross-border shopping in Sweden, we estimate models of the following form.

[13]Source for the Swedish population data: Statistics Sweden (2024).

$$Y_{ct} = \gamma_c + \lambda_t + \sum_c \delta_c (O_{ct} \times C_c) + \epsilon_{ct}, \tag{4}$$

where c denotes county and t denotes time periods (quarters in this case) and Y_{ct} is the dependent variable of interest. The variable O_{ct} is a continuous treatment variable capturing the proportion of days in time period t that county c was exposed to cross-border shopping from Norway. A county bordering Norway is defined as exposed to cross-border shopping from Norway in days when Norwegians can visit the county without triggering a quarantine stay upon re-entering Norway. For non-border counties, O_{ct} is zero in all periods, capturing the assumption that Norwegians crossing the border will shop alcohol in border counties, rather than in more distant regions. The non-border counties will thus function as a control group by providing a reference point from which we can estimate the effect of the exposure to cross-border shopping in the border counties. Because cross-border shopping may have different effects in different border counties, we interact O_{ct} with county dummies C_c, thereby estimating separate effects for each border county. γ_c and λ_t are county and time fixed effects.

In Table 8, we report the results from the estimation of (4) with three different county level outcome variables: the natural logarithm of quarterly sales volume in liters of liquor, the natural logarithm of the quarterly sales volume in liters of wine, and the natural logarithm of the total quarterly sales volume measured in pure alcohol.

[Table 8 about here]

As expected we see statistically significant increases of sales in Swedish border counties when the border is open. The ranking of effects matches broadly to an intuition where quicker access for many Norwegians and smaller population are associated with greater percentage changes. For the case of wine, Värmlands län for instance, located close to the Oslo area, is predicted to sell 47.7% ($(e^{(.390)} - 1) \times 100$) more wine when the border is open.

Using the same approach as above, we also estimate the effect of cross-border shopping on sales in Sweden, in terms of liters of liquor and wine as well as liters of pure alcohol. The results are reported in Table 9. We note that even though the percentage changes are largest in smaller counties like Värmland, the largest overall effect is in the large county of Västra Götaland. In percentage terms the impact is lower there but in absolute volume it dominates, both in sales of wine and in terms of liters of pure alcohol.

[Table 9 about here]

Our estimate of cross-border shopping in Sweden is closely aligned with a more direct measure reported in Guttormsson and Trolldal (2020). Guttormsson and Trolldal (2020) calculate the amount of alcohol bought with Norwegian cash or payment cards in Systembolagets stores in municipalities bordering Norway. For 2018, they find that the cross-border trade amounted to

2,348,867 liters of pure alcohol, which is very close to our estimate of 2,398,200 liters reported in Table 9.

6 Conclusion

In this paper, we utilize daily store and product-level sales data of liquor and wine from Norway's monopoly alcohol retailer, spanning January 1, 2018, to December 31, 2021. By combining this dataset with the COVID-19-induced border closure, we make two significant contributions to the literature on cross-border shopping of alcohol. First, the border closure allows us to estimate the overall loss in sales and tax revenue (excise taxes and VAT) attributable to cross-border shopping. Second, while previous studies have predominantly relied on category-level data — such as the total amount of wine sold — without examining differential effects across various price levels or packaging types, we focus on detailed product-level effects.

Our findings indicate that the impact of cross-border shopping is substantial near the border and remains evident in areas located more than two hours away. We also observe significant product-level heterogeneity, with cheaper products and bag-in-box wines experiencing the strongest effects. The product-level analysis reveals that the impact is not limited to a small subset of products but affects a broad range of items.

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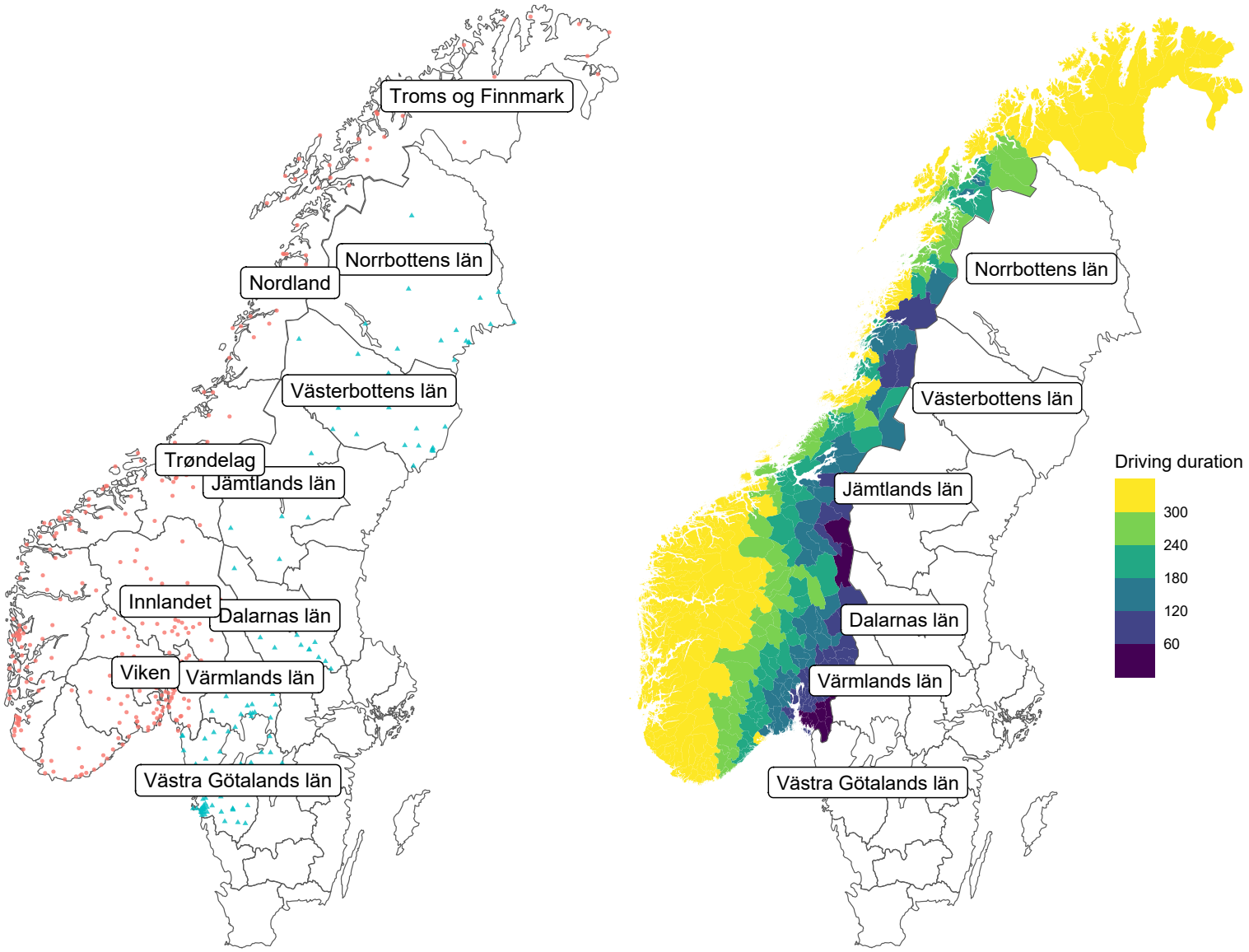
Figures and tables

Figure 1: Stores and driving duration



Note: Left panel: Border counties in Norway and Sweden. The points represent all Vinmonopolet stores in Norway and Systembolaget stores in border counties in Sweden. Right panel: Driving duration in minutes from centroid of Norwegian municipalities to closest Swedish Systembolaget store.

Figure 2: Accessibility of Swedish border counties

Note: This figure indicates which weeks the Swedish border counties were closed to cross-border shopping in 2020. We define a county as closed in a given week if in the majority of the days of the week visiting the county triggered a quarantine upon returning to Norway. The first week shown is the week starting on Monday March 16, 2020. Travels to Sweden were restricted from Tuesday March 17, 2020.

Figure 3: Wine sales in revenue

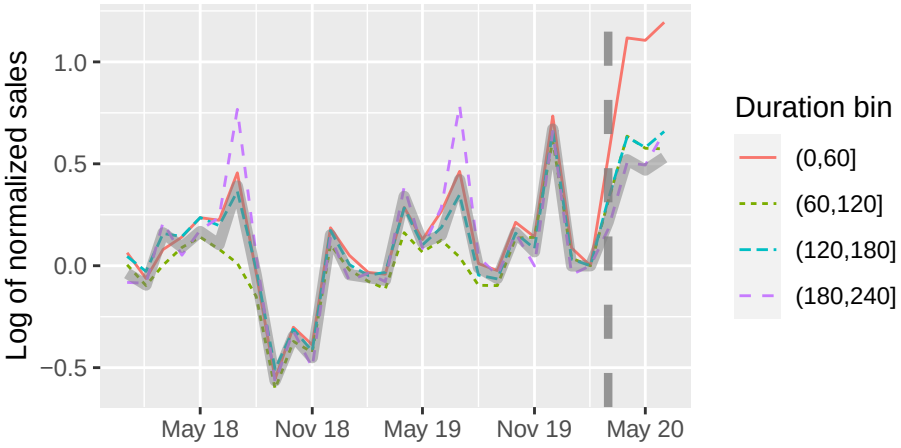


Figure 4: Wine sales in revenue - event study

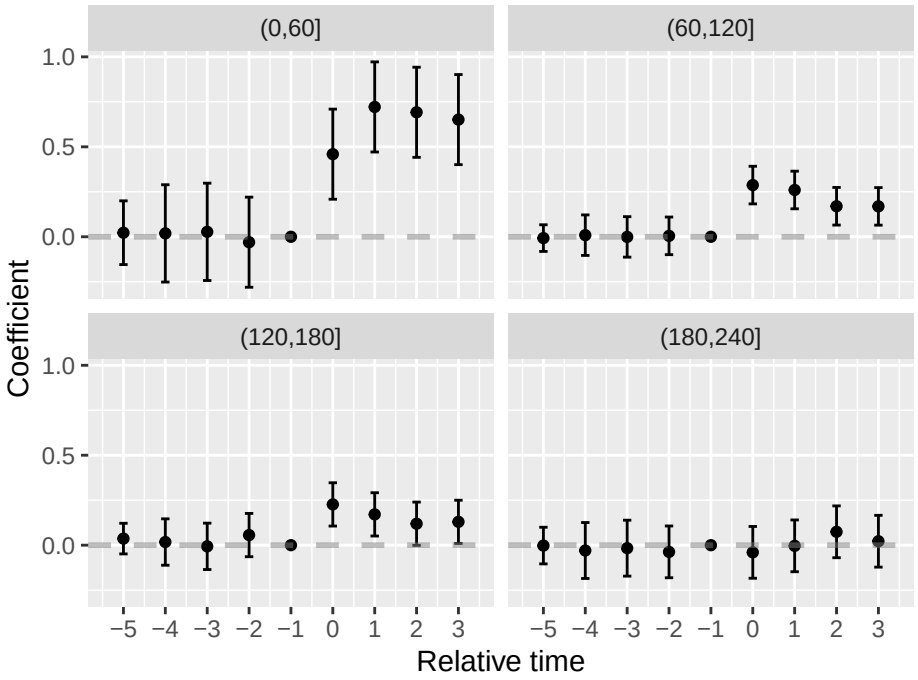
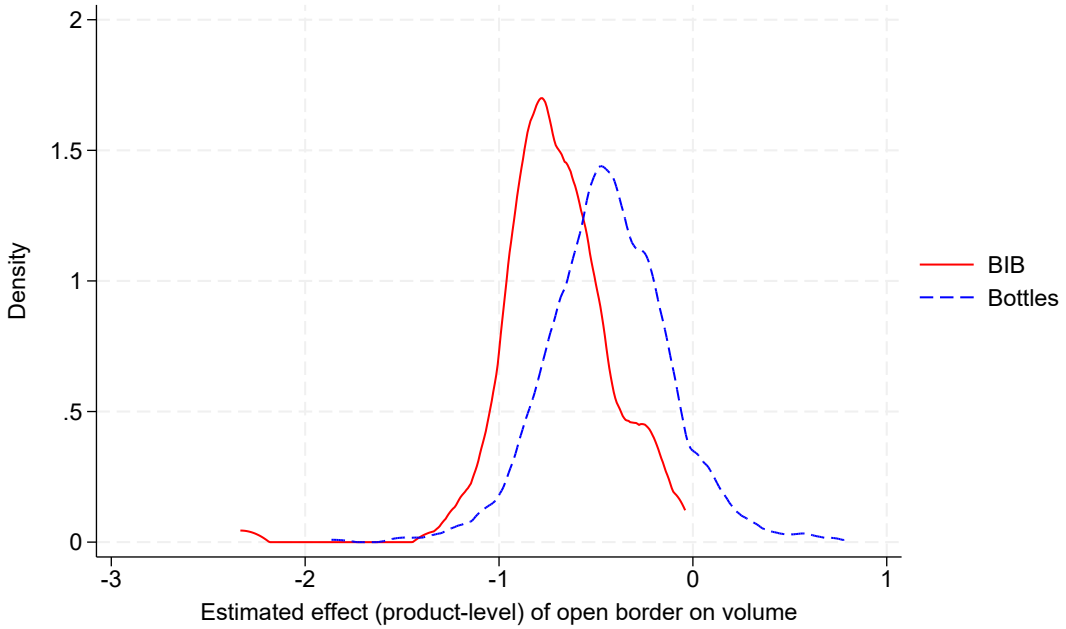


Figure 5: Product level examination of wine

(a) The distribution of estimated effects (at product level) of open border on sales



(b) The relation between the number of products and market share

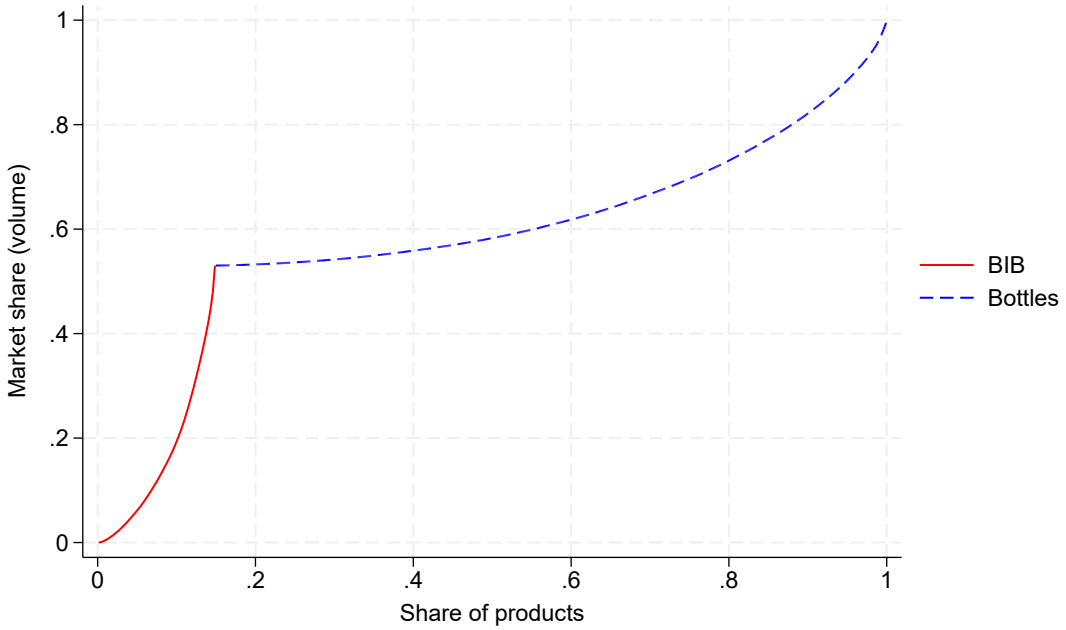


Table 1: Alcohol use, consequences and prices

	Brazil	China	Germany	Norway	Sweden	USA
Consumption						
Alcohol consumption (liters of pure alcohol per capita, age 15+)	7.32	6.04	12.79	7.14	9.04	9.97
Problematic use						
Alcohol use disorders (proportion of population, age 15+)	0.04	0.04	0.07	0.07	0.11	0.14
Alcohol dependence (proportion of population, age 15+)	0.01	0.02	0.04	0.04	0.05	0.08
Harmful alcohol use (proportion of population, age 15+)	0.03	0.02	0.03	0.03	0.06	0.06
Alcohol related deaths						
Alcohol-attributable fraction, all deaths	0.06	0.04	0.05	0.03	0.04	0.05
Liver cirrhosis deaths						
Liver cirrhosis death rate (per 100,000 population, age 15+)	16.25	11.45	13.35	3.70	6.30	14.85
Alcohol-attributable fraction, liver cirrhosis deaths	0.56	0.52	0.72	0.59	0.63	0.67
Cancer deaths						
Cancer death rate (per 100,000 population, age 15+)	149.65	183.20	164.95	155.10	144.55	156.10
Alcohol-attributable fraction, cancer deaths	0.05	0.03	0.06	0.04	0.04	0.05
Road traffic deaths						
Road traffic death rate (per 100,000 population, age 15+)	26.45	21.90	4.20	3.25	2.95	14.10
Alcohol-attributable fraction, road traffic deaths	0.30	0.29	0.41	0.36	0.36	0.34
Price level						
Price level index alcoholic beverages (EU27 = 100)			92.80	264.80	159.50	

Note: WHO and Eurostat data.

Table 2: Alcohol sales in Norway

	$(0, 60]$	$(60, 120]$	$(120, 180]$	$(180, 240]$	> 240
Liquor					
Sales (million NOKs)	22.26	147.55	127.50	52.06	232.36
Sales (NOK per capita)	781.56	1067.16	1028.11	1467.49	1152.16
Volume (1000 liters)	453.50	2908.14	2540.41	1051.12	4689.80
Volume (liters per capita)	1.59	2.10	2.05	2.96	2.33
Alcohol (1000 liters)	133.20	859.37	752.87	312.00	1379.26
Alcohol (liters per capita)	0.47	0.62	0.61	0.88	0.68
Mean price (NOK per liter)	490.89	507.38	501.87	495.24	495.46
Wine					
Sales (million NOKs)	36.86	428.47	241.64	78.13	451.91
Sales (NOK per capita)	1293.93	3098.88	1948.57	2202.58	2240.76
Volume (1000 liters)	2180.71	23064.48	14555.27	4915.92	27475.37
Volume (liters per capita)	7.66	16.68	11.74	13.86	13.62
Alcohol (1000 liters)	241.42	2547.64	1639.98	557.95	3083.09
Alcohol (liters per capita)	0.85	1.84	1.32	1.57	1.53
Mean price (NOK per liter)	169.01	185.77	166.02	158.93	164.48

Table 3: Effects of cross-border shopping

	Liquor			Wine		
	Revenue	Volume	Alcohol	Revenue	Volume	Alcohol
	(1)	(2)	(3)	(4)	(5)	(6)
$B_{st} \times D_{j(s)} = (0, 60]$	-0.3986***	-0.4152***	-0.4269***	-0.5931***	-0.6518***	-0.6865***
	(0.0413)	(0.0422)	(0.0456)	(0.0622)	(0.0685)	(0.0723)
$B_{st} \times D_{j(s)} = (60, 120]$	-0.1790***	-0.1819***	-0.1874***	-0.2089***	-0.2130***	-0.2239***
	(0.0261)	(0.0253)	(0.0241)	(0.0347)	(0.0389)	(0.0377)
$B_{st} \times D_{j(s)} = (120, 180]$	-0.0694**	-0.0737***	-0.0725***	-0.1051***	-0.1158***	-0.1236***
	(0.0191)	(0.0196)	(0.0197)	(0.0250)	(0.0247)	(0.0238)
$B_{st} \times D_{j(s)} = (180, 240]$	0.0178	0.0114	0.0186	-0.0123	-0.0195	-0.0204
	(0.0154)	(0.0152)	(0.0158)	(0.0153)	(0.0152)	(0.0161)
R^2	0.91066	0.91354	0.90725	0.93027	0.93272	0.93277
Within R^2	0.01069	0.01136	0.01172	0.01139	0.01317	0.01562
Observations	235,465	235,465	235,176	241,349	241,349	240,246

$***< 0.001, **< 0.01, *< 0.05$

Note: Standard errors clustered on municipality and month reported in parentheses.

Table 4: Effects (absolute value) of cross-border shopping on alcohol tax revenue in percent

Duration bin	Liquor	Wine	Total
(0,60]	42.1	66.1	56.1
(60,120]	18.7	22.3	21.1
(120,180]	7.2	12.3	10.3
(180,240]	-1.9	2.0	0.3
Total	13.5	19.9	17.5

Table 5: Summary statistics at product level

	Mean	Sd	P10	P50	P90	N
Liquor						
Price per liter (NOK)	542.534	161.206	314.982	527.817	769.215	260
Liters (thousands)	74.157	100.451	9.680	40.457	177.244	260
Revenue (Million NOK)	36.466	45.704	5.557	19.403	83.926	260
Wine BIB						
Price per liter (NOK)	140.650	21.269	117.504	138.088	162.405	113
Liters (thousands)	612.850	540.002	175.185	442.179	1211.421	113
Revenue (Million NOK)	83.385	71.800	25.483	60.770	151.099	113
Wine Bottle						
Price per liter (NOK)	237.493	109.777	146.910	202.571	385.745	647
Liters (thousands)	94.805	101.842	14.252	66.051	208.411	647
Revenue (Million NOK)	18.301	17.653	4.677	13.485	35.456	647

Table 6: Effects of cross-border shopping - by price level and package type

	Liquor			Wine				
	Price level			Price level			Package type	
	Low	Intermediate	High	Low	Intermediate	High	BIB	Bottle
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$B_{st} \times D_{j(s)} = (0, 60]$	-0.4508***	-0.3817***	-0.3576***	-0.7512***	-0.6696***	-0.4509***	-0.8322***	-0.4568***
	(0.0436)	(0.0432)	(0.0418)	(0.0834)	(0.0588)	(0.0464)	(0.0906)	(0.0402)
$B_{st} \times D_{j(s)} = (60, 120]$	-0.2173***	-0.1331***	-0.1672***	-0.2374***	-0.2127***	-0.2138***	-0.2649***	-0.2034***
	(0.0254)	(0.0334)	(0.0277)	(0.0538)	(0.0483)	(0.0342)	(0.0447)	(0.0354)
$B_{st} \times D_{j(s)} = (120, 180]$	-0.0936***	-0.0571*	-0.0611**	-0.1553***	-0.1059***	-0.0933**	-0.1473***	-0.0951***
	(0.0220)	(0.0215)	(0.0218)	(0.0242)	(0.0287)	(0.0294)	(0.0241)	(0.0241)
$B_{st} \times D_{j(s)} = (180, 240]$	0.0003	0.0065	0.0131	-0.0584*	-0.0015	0.0399	-0.0294	0.0098
	(0.0206)	(0.0222)	(0.0254)	(0.0247)	(0.0230)	(0.0233)	(0.0246)	(0.0193)
R^2	0.967	0.965	0.959	0.974	0.971	0.971	0.977	0.972
Within R^2	0.041	0.019	0.018	0.072	0.048	0.027	0.100	0.027
Observations	43,298	43,299	43,299	43,302	43,304	43,309	43,301	43,310

$***< 0.001, **< 0.01, *< 0.05$

Note: Standard errors clustered on municipality and month reported in parentheses.

Table 7: Product-level regressions

	Wine (0,60]	Wine (60,120]	Liquor (0,60]	Liquor (60,120]	Wine (0,60]	Liquor (0,60]
BIB=1	-0.285***	-0.077***			-0.416***	
	(0.034)	(0.023)			(0.055)	
In Sweden=1	0.003	0.013	-0.070*	-0.025		
	(0.023)	(0.016)	(0.038)	(0.021)		
Price high=1	-0.006	-0.044**	-0.018	-0.007		
	(0.030)	(0.020)	(0.045)	(0.025)		
Price low=1	-0.075**	-0.037*	-0.035	-0.032		
	(0.030)	(0.020)	(0.045)	(0.025)		
Price difference/10					0.007	0.004
					(0.006)	(0.004)
Constant	-0.417***	-0.144***	-0.404***	-0.151***	-0.467***	-0.545***
	(0.020)	(0.013)	(0.032)	(0.018)	(0.041)	(0.064)
N	758	758	259	260	269	104

Table 8: Estimated effect of cross-border shopping in Sweden

	Liquor	Wine	Alcohol
Dalarnas län × O	0.127***	0.084***	0.082***
	(0.018)	(0.012)	(0.014)
Jämtlands län × O	0.438***	0.352***	0.358***
	(0.056)	(0.056)	(0.060)
Norrbottens län × O	0.229***	0.194***	0.190***
	(0.018)	(0.016)	(0.015)
Värmlands län × O	0.435***	0.390***	0.339***
	(0.061)	(0.060)	(0.055)
Västerbottens län × O	0.213***	0.117***	0.151***
	(0.016)	(0.012)	(0.012)
Västra Götalands län × o	0.063***	0.122***	0.092***
	(0.012)	(0.013)	(0.013)
Observations	1008	1008	1008

Note: The dependent variable is the natural logarithm of sales (in 1000 liters).

Table 9: Estimated effects of cross-border shopping in Sweden

	Liquor	Wine	Alcohol
Västerbottens län			
Actual	683.0	5614.0	1547.0
Counterfactual	601.3	5159.3	1424.6
Cross-border sales	81.7	454.7	122.4
Norrbottens län			
Actual	576.0	4252.0	1205.0
Counterfactual	371.7	2991.1	842.3
Cross-border sales	204.3	1260.9	362.7
Jämtlands län			
Actual	702.0	5723.0	1634.0
Counterfactual	558.5	4713.5	1351.2
Cross-border sales	143.5	1009.5	282.8
Dalarnas län			
Actual	1027.0	8327.0	2283.0
Counterfactual	664.8	5636.0	1626.6
Cross-border sales	362.2	2691.0	656.4
Värmlands län			
Actual	721.0	5687.0	1580.0
Counterfactual	582.5	5058.7	1359.1
Cross-border sales	138.5	628.3	220.9
Västra Götalands län			
Actual	3355.0	36208.0	8574.0
Counterfactual	3150.3	32041.4	7821.0
Cross-border sales	204.7	4166.6	753.0
Total			
Actual	7064.0	65811.0	16823.0
Counterfactual	5929.1	55600.1	14424.8
Cross-border sales	1134.9	10210.9	2398.2

Online Appendix

Figure IA.1: Liquor sales in revenue

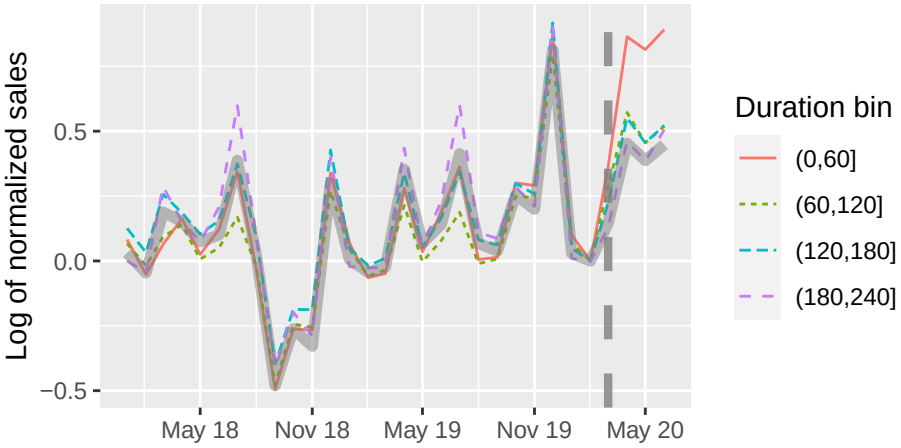


Figure IA.2: Liquor sales in liters

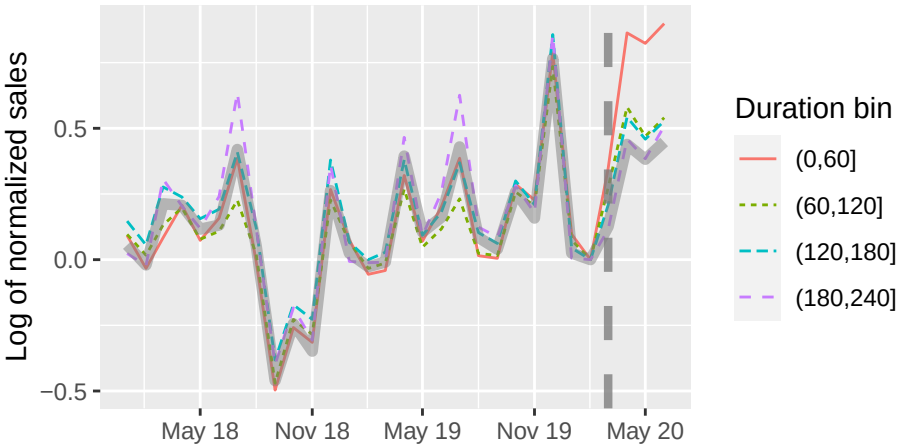


Figure IA.3: Liquor sales in liters alcohol

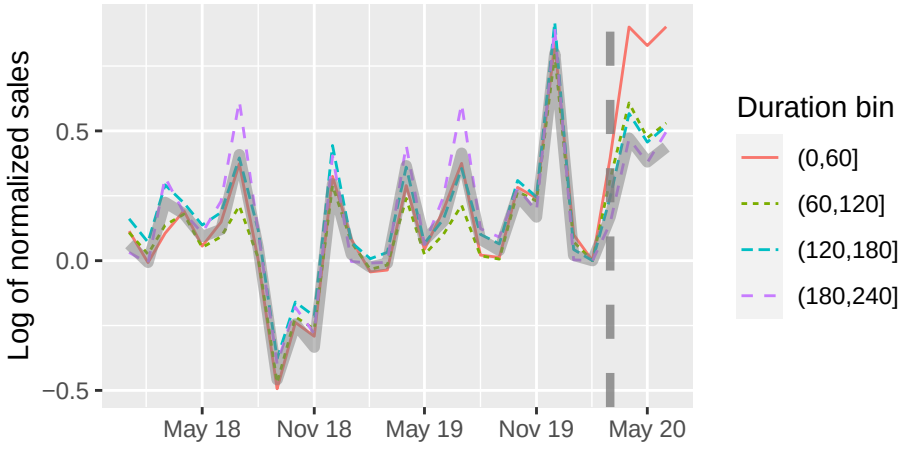


Figure IA.4: Wine sales in liters

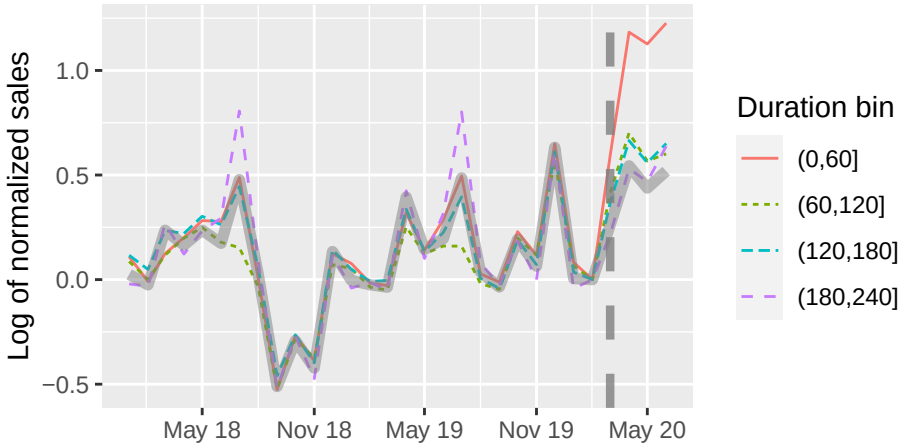


Figure IA.5: Wine sales in liters alcohol

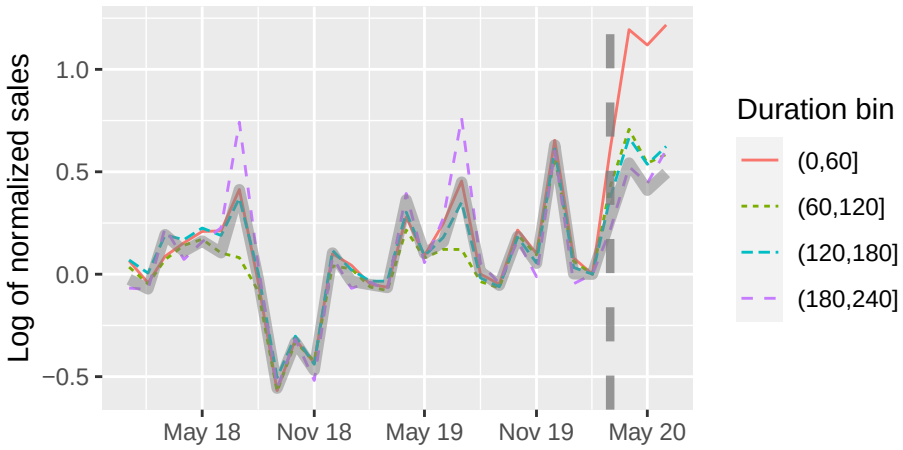


Figure IA.6: Liquor sales in revenue - event study

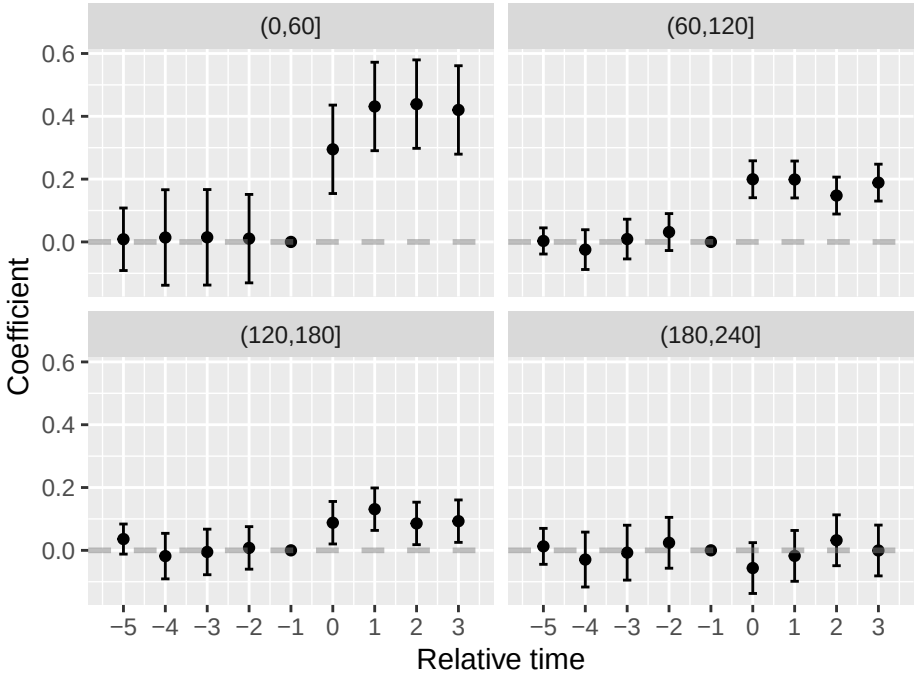


Figure IA.7: Liquor sales in liters - event study

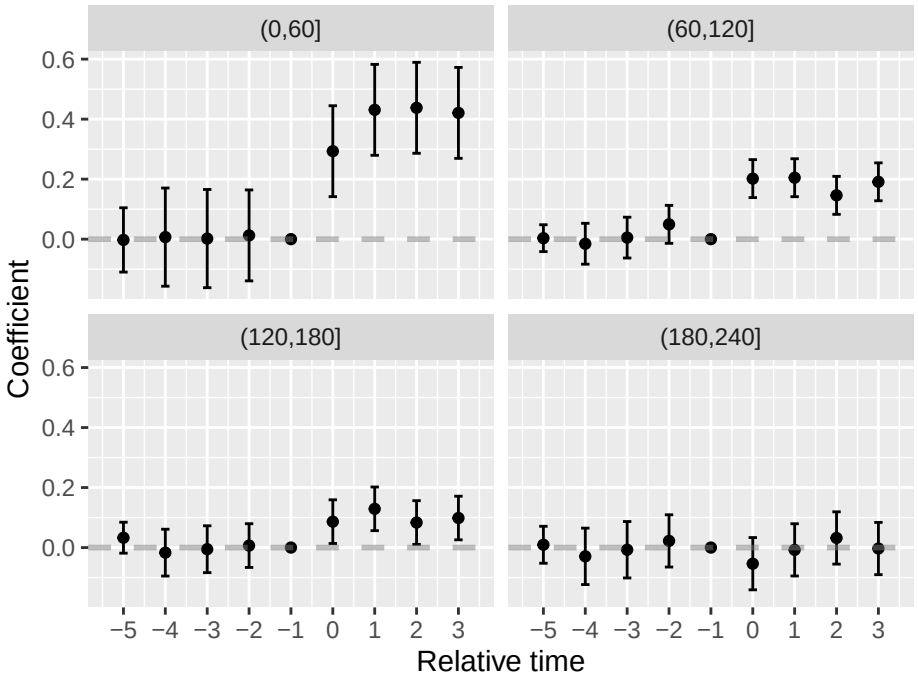


Figure IA.8: Liquor sales in liters alcohol - event study

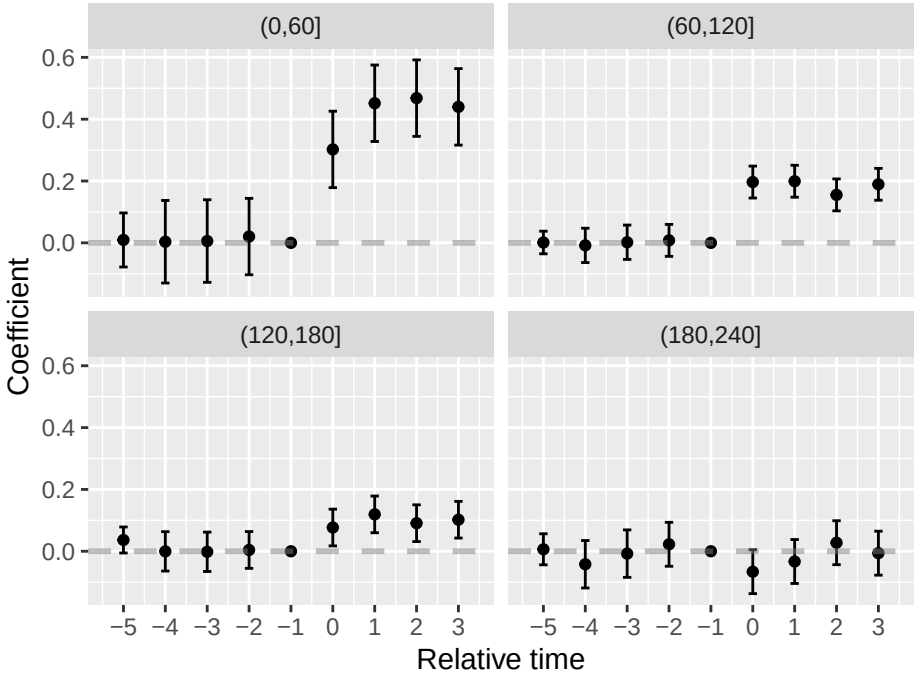


Figure IA.9: Wine sales in liters - event study

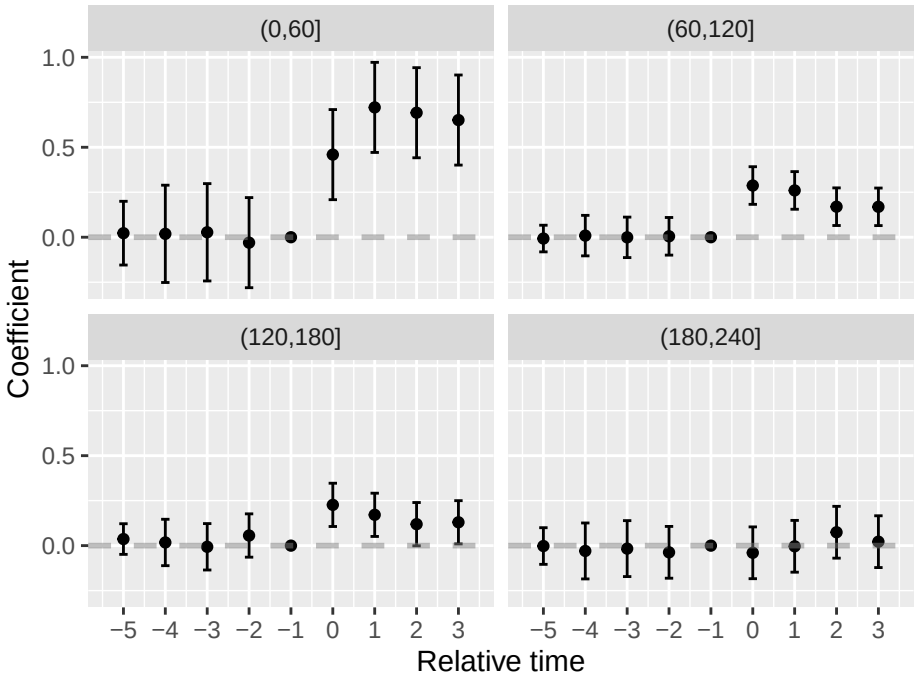


Figure IA.10: Wine sales in liters alcohol - event study

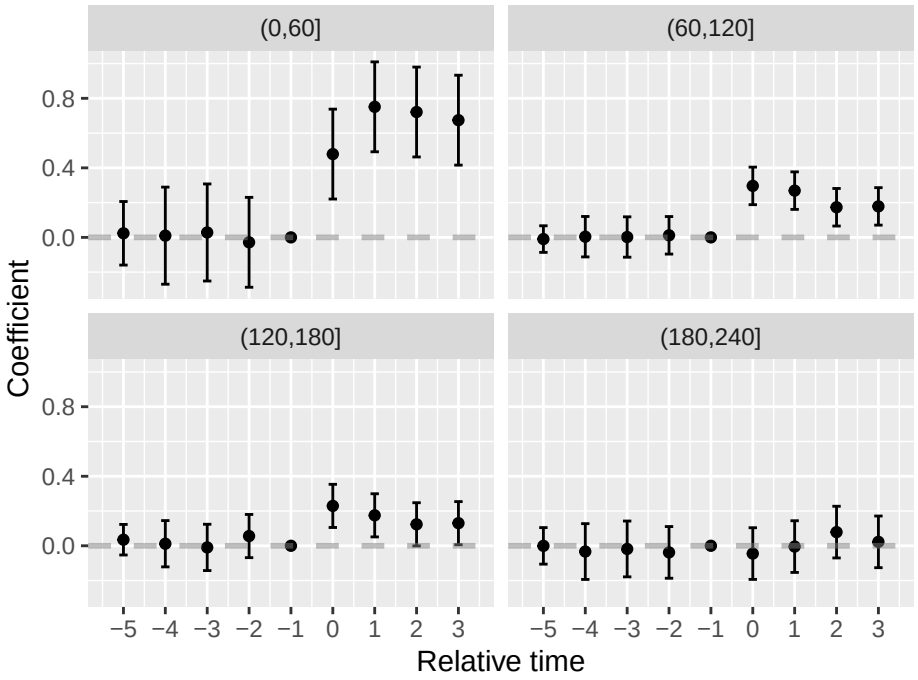


Figure IA.11: Sweden -

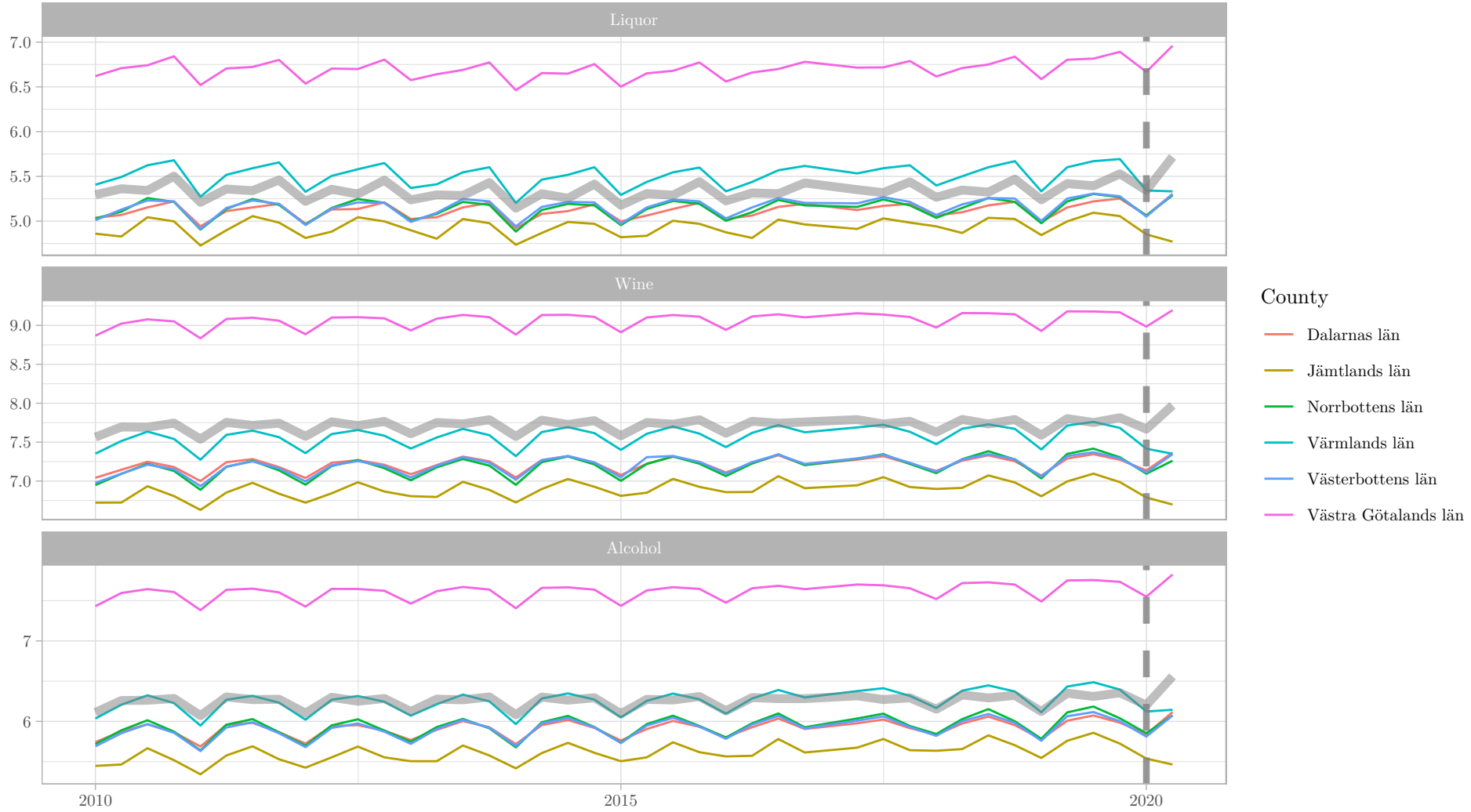
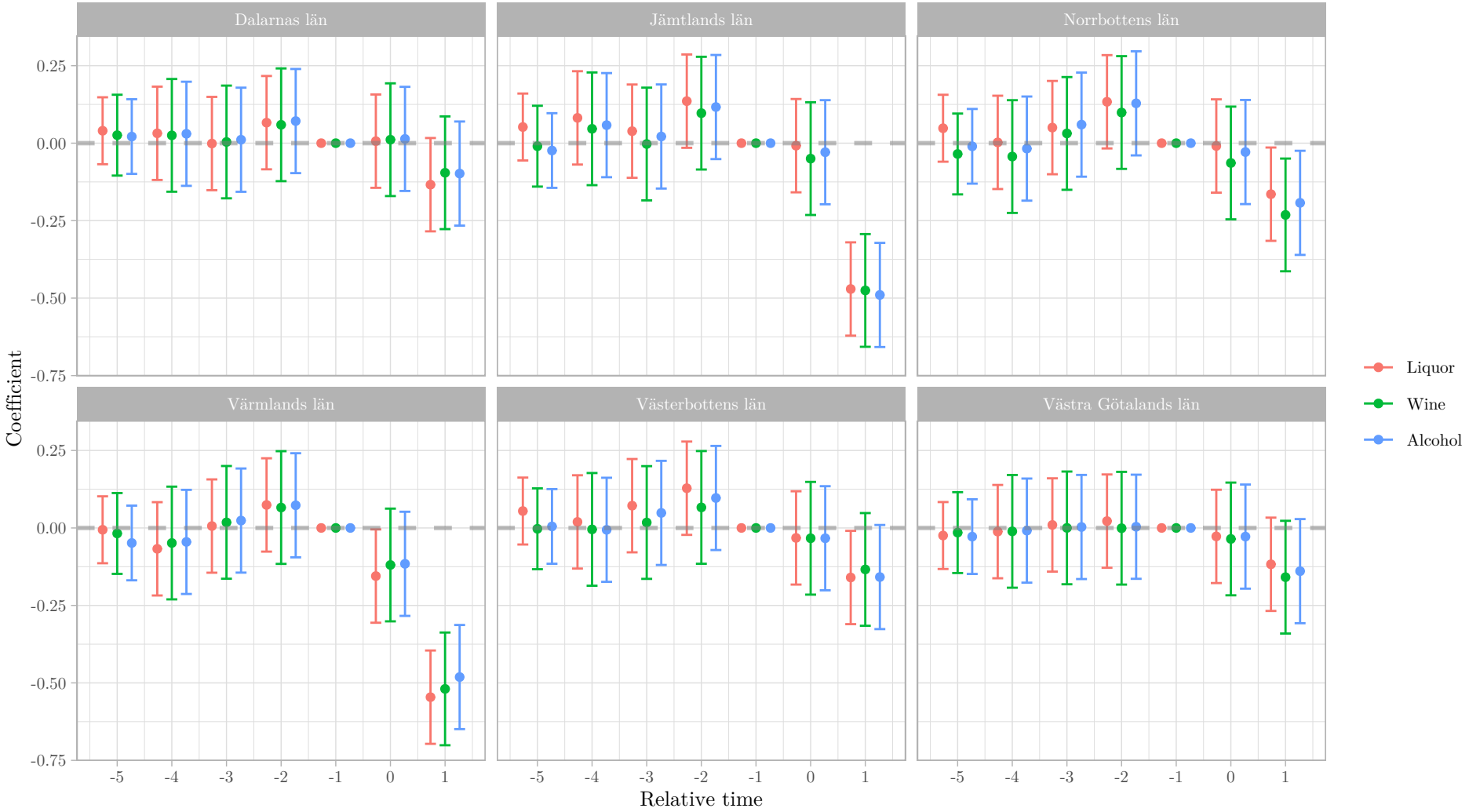


Figure IA.12: Event study plot - sales in Sweden



Note: This figure indicates which weeks the Swedish border counties were closed to cross-border shopping in 2020. We define a county as closed in a given week if in the majority of the days of the week visiting the county triggered a quarantine upon returning to Norway. The first week shown is the week starting on Monday March 16, 2020. Travels to Sweden were restricted from Tuesday March 17, 2020.

Table IA.1: Estimated effects of cross-border shopping in Norway

	Liquor				Wine				Total			
	Revenue	Volume	Alcohol	Tax	Revenue	Volume	Alcohol	Tax	Revenue	Volume	Alcohol	Tax
(0,60]												
Actual	189581.9	389.1	113.9	86344.4	318993.3	1897.7	209.8	103637.2	508575.1	2286.8	323.7	189981.6
Counterfactual	282426.4	589.3	174.6	132327.0	577238.6	3641.9	416.8	205909.6	859664.9	4231.2	591.4	338236.6
Cross-border loss	92844.5	200.2	60.7	45982.6	258245.3	1744.2	207.0	102272.4	351089.8	1944.4	267.7	148255.0
Cross-border loss (%)	39.3	40.9	42.1	42.1	57.6	63.0	66.1	66.1	51.3	59.7	58.5	56.1
(60,120]												
Actual	1252319.5	2484.8	731.3	554347.1	3675071.0	19927.3	2197.8	1085705.0	4927390.4	22412.0	2929.1	1640052.1
Counterfactual	1497790.6	2980.4	882.1	668598.5	4528744.8	24657.6	2749.4	1358179.7	6026535.4	27638.0	3631.4	2026778.1
Cross-border loss	245471.1	495.6	150.7	114251.4	853673.8	4730.4	551.6	272474.7	1099145.0	5226.0	702.3	386726.0
Cross-border loss (%)	17.9	18.1	18.7	18.7	20.8	21.2	22.3	22.3	20.1	20.9	21.4	21.1
(120,180]												
Actual	1081107.0	2166.2	639.5	484706.5	2086408.3	12643.4	1421.3	702123.9	3167515.2	14809.7	2060.8	1186830.4
Counterfactual	1158764.5	2332.0	687.6	521163.5	2317681.9	14195.5	1608.3	794510.4	3476446.4	16527.5	2295.9	1315673.9
Cross-border loss	77657.6	165.8	48.1	36457.0	231273.6	1552.1	187.0	92386.4	308931.2	1717.9	235.1	128843.5
Cross-border loss (%)	6.9	7.4	7.2	7.2	10.5	11.6	12.3	12.3	9.3	11.0	10.8	10.3
(180,240]												
Actual	445243.6	903.1	267.5	202743.7	683047.5	4313.1	489.0	241567.9	1128291.2	5216.2	756.5	444311.6
Counterfactual	437389.4	892.9	262.6	199017.1	691538.3	4397.9	499.1	246552.6	1128927.7	5290.8	761.6	445569.7
Cross-border loss	-7854.2	-10.2	-4.9	-3726.6	8490.8	84.8	10.1	4984.7	636.6	74.6	5.2	1258.1
Cross-border loss (%)	-1.8	-1.1	-1.9	-1.9	1.2	1.9	2.0	2.0	0.1	1.4	0.7	0.3
Total												
Actual	2968251.9	5943.2	1752.2	1328141.7	6763520.0	38781.5	4317.9	2133034.1	9731772.0	44724.7	6070.0	3461175.8
Counterfactual	3376370.9	6794.6	2006.7	1521106.0	8115203.5	46892.9	5273.6	2605152.3	11491574.5	53687.5	7280.3	4126258.3
Cross-border loss	408119.0	851.4	254.6	192964.3	1351683.5	8111.4	955.7	472118.2	1759802.5	8962.8	1210.3	665082.5
Cross-border loss (%)	12.9	13.4	13.5	13.5	18.2	18.9	19.9	19.9	16.6	18.2	18.1	17.5

Note: Revenue is the total sales revenue in million NOKs. *Volume* is the total volume measured in 1000 liters. *Alcohol* is the total volume of pure alcohol in 1000 liters. *Actual* is the total sales in 2018. *Counterfactual* is the level in a counterfactual situation with closed borders. *Cross-border loss* is the difference between the counterfactual and actual values.

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