Crossing the border
- a study of cross-border shopping in alcoholic beverages

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March 23, 2010

Abstract

In recent years, cross-border shopping has received more attention as the concerns for demand effects on local retailers and tax implications of the trade flows has increased. The extent to which changes in the foreign price affect cross-border shopping is an important factor for the magnitude of these effects. In this context, it is examined how sensitive sales of alcohol are relative to domestic and foreign prices in Sweden and Norway. The findings show that sales on both sides of the border are sensitive to changes in the foreign price, and provide indications that the price sensitivity is negatively related to the distance to the border.

Keywords: Cross-border shopping, Alcohol, Norway, Prices, Distance

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1. Introduction

Since the end of the 1990's, cross-border shopping by Norwegian visitors to Sweden has increased explosively. From 1997 to 2002, the retail turnover in Strömstad – the single most important border crossing – grew by 150% (NOU 2003). In 2004, approximately 6.6 million trips were made across the border and the estimated Norwegian expenditure in Sweden was 8 804 million NOK (Statistics Norway). Considering that the population of Norway is only 4.58 million, these numbers imply that the magnitude of cross-border trade is fairly extensive. Large price differences between the countries (see fig. 1) and a strengthened Norwegian krone (making prices in Sweden fall relative to prices in Norway) have been suggested as the main reasons for the increased border trade.

Cross-border trade in different commodities has taken place for as long as borders have existed. If the price of a commodity is cheaper across the border, then consumers have throughout the existence of civilization tried to take advantage of the price difference and engaged in cross-border trade. If it is fairly easy for consumers to shift their expenditure from one country to another, then it seems logical that changes in the relative price will lead to shifts in demand for the border areas' retailers. Although observations suggest that cross-border shopping can be fairly large in magnitude, few studies present palpable evidence on the impact of foreign price changes on local demand.

1.1 The purpose of the study

A study of the economic determinants of Norwegian cross-border shopping can provide insights into the magnitude and driving forces of the phenomenon. In this paper, data from the Swedish and the Norwegian government retail monopolies (Systembolaget and Vinmonopolet respectively) are used to estimate the sensitivity of cross-border trade in alcoholic beverages.

Two features make this study interesting. Firstly, previous studies on the relationship between cross-border trade and price differentials between Norway and Sweden lack the rigorous data analysis needed to generate representative results, and no study has been able to confirm a clear connection between the development of border trade and the foreign price. Secondly, as can be observed in Figures 1a-c, the price difference between the two countries remains very high during the entire sample period. Studies of cross-border trade in other regions have suggested that prices across the border are important for sales, and it is interesting to see if demand is responsive to changes in price also when the price difference is constantly high.

In conclusion, the purpose of this thesis is to estimate the sensitivity of cross-border trade relative to domestic and foreign prices. There will also be an attempt to provide indications that the price sensitivity is related to the distance to the border.

Figure1a

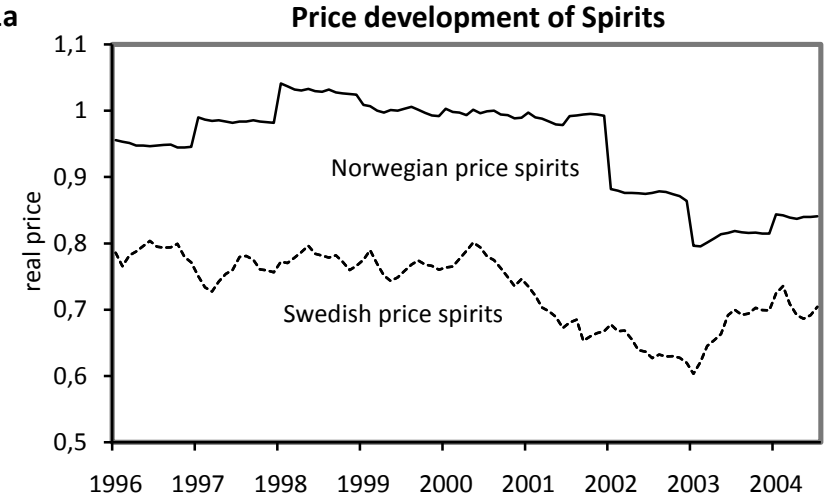


Figure 1b

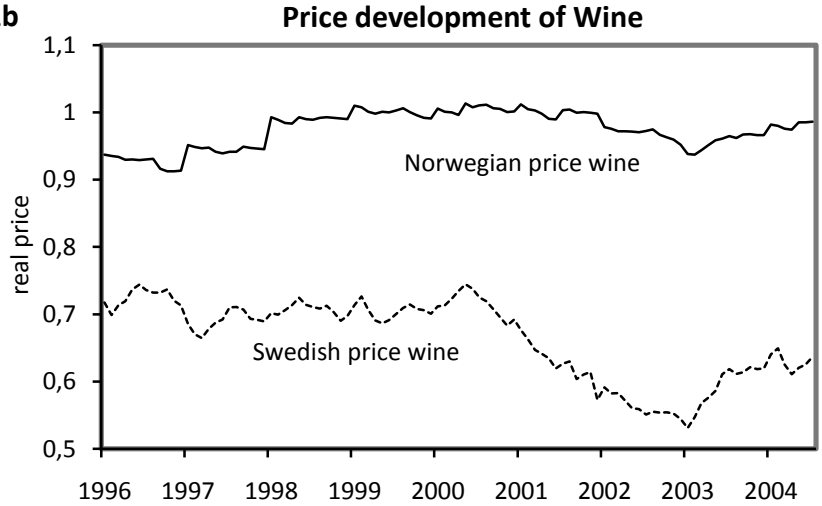


Figure 1c

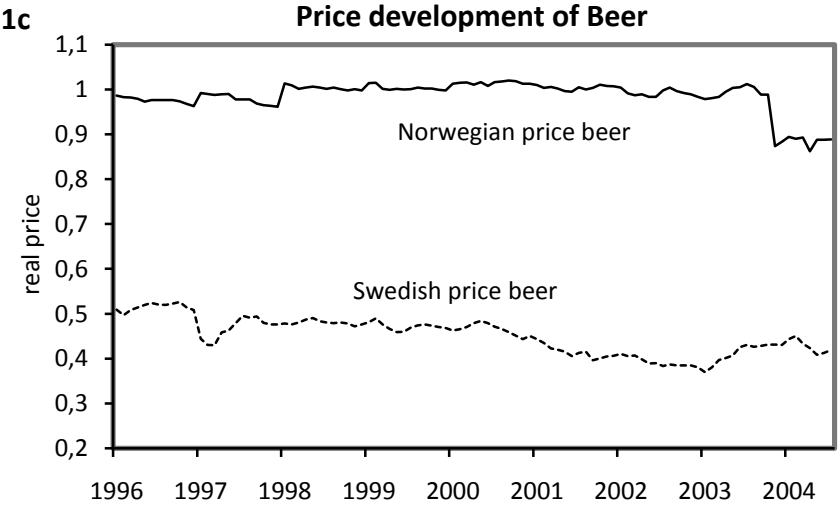


Fig 1a-c. Real prices of spirits, wine and beer for Norway and Sweden January 1996 -July 2004. Eurostat Harmonized Consumer Price indices for wine, spirits and beer are used to disclose how price levels have evolved during the studied period. Swedish prices are translated into Norwegian prices using monthly exchange rates and all prices are deflated by the Norwegian Consumer price index. A basket of identical goods is used to identify absolute price difference between the two counties (see Horverak and Österberg (2002)). Indices are normalized so that the Norwegian price index equals 1 in June 1999 and the Swedish price index in this month set to 0.75 for spirits, 0.69 for wine and 0.46 for beer.

Three characteristics are important for our analysis. Firstly, both retail monopolies maintain the same prices and provide the same assortment in all of their stores. This implies that any variation in per capita consumption across municipalities is not driven by price or selection differences within the country. Secondly, consumers can shift their purchases between the two countries relatively easily. This implies that consumers should, at least to some extent, take advantage of price differentials and engage in cross-border arbitrage when the possibility exists. Thirdly, since prices and assortments are identical across stores, the demand effect of cross-border shopping is in Sweden confined to border municipalities[1].

The structure of the thesis is as follows: Section 2 will summarize previous findings on the magnitude and causes of cross-border trade, and section 3 provides initial evidence on the occurrence of border trade between Norway and Sweden. Section 4 will discuss the underlying dataset, and Section 5 will introduce the general model. Section 6 will describe the results and offer analyses of the outcome. And finally, section 7 will sum up the findings.

2. Cross-border trade - Previous Research

In recent years, cross-border shopping has received more attention as the concerns for demand effects and tax implications of the cross-border trade flows has increased. Over the past few years, a multitude of studies on cross-border trade have been conducted. Despite this, relatively little palpable evidence exists on the relationship between foreign price levels and the level of cross-border trade. This section of the thesis will provide an overview of some previous findings of demand effects of cross-border trade and relative prices.

When analysing Canadian cross-border travel in bordering U.S. provinces, Di Matteo and Di Matteo (1996) found that the increase in per-capita trips and expenditure across the border was largely determined by the per capita income, real exchange rate, tax level and the gasoline prices. The high elasticities of the variables imply that Canadian consumers are quite responsive to changes in relative prices across the border. The estimates of Canadian expenditure in the U.S during 1991 ranged from 4 to 11 billion Canadian dollars. While these are small numbers relative to the U.S and Canadian economies, the impact on border communities can be substantial. This suggests that relative price changes can result in substantial cross-border flows with equally substantial changes in demand. A study by Campbell and Lapham (2002), consistent with the above findings, suggests that those changes in real exchange rates can act as demand shocks to border area's retailers. They studied firms along the U.S-Canada border and found that when prices in the U.S fall relative to prices in Canada, the number of establishments and their average employment on the U.S side significantly increase for the four retail industries studied.

Most studies only consider the effect in border areas, and pay little attention to the effects in the interior of the country. A study by Bygvrå (2009) based on data gathered by face-to-face interviews with Danes crossing the border on their way back from Germany concluded that distance plays a decisive role in cross-border shopping for alcoholic beverages. Similarly

[1] Since prices are the same across the country, there is no incentive for border shoppers to go any further in to the country than the closest alcohol retail outlet. However, when it comes to the demand effect seen on the Norwegian side, the geographical spread will depend on the distance a consumer is willing to travel to engage in cross-border arbitrage.

an interview study in Denmark by Grittner and Bloomfield finds that distance to the German border was inversely related to the likelihood of importing and the level of imported amounts. Another study where special attention is paid to the distance is a study by Asplund, Friberg and Wilander (2007), where the responsiveness of alcohol sales in Sweden is related to the Danish price and the distance to the Danish border. They found that sales are responsive in regard to the foreign price, and that the price sensitivity is negatively related to the distance to the border. The effect varies between the beverage types examined, with the Danish price having an impact on spirit sales of almost 700 km from the border. For wine and beer, the corresponding distances are 200 km and 400-500 km respectively.

Studies based on interviews with Norwegians suggest that the effect of border trade with Sweden might be substantial, with spirits acquired in Sweden constituting up to 8 percent of the total consumption in Norway in 2003 (NOU 2003). In another study of regional trade patterns, Lund, Trolldal and Ugland (1999) have tried to estimate the effect of changes in relative price on Swedish-Norwegian border trade by comparing alcohol sales in pre-defined border regions and base regions. It is assumed that the relative price between the countries drives sales in border regions, so an increase in the relative price, P^{NO}/ P^{SE}, should lead to a lower than base sales in Norwegian border regions, and vice versa in Swedish regions[2]. They studied three time periods, and the results were ambiguous. While the study confirmed a substantial and increasing demand effect of border trade, sales did not develop as expected by the relative price changes in two out of the three time periods[3]. In fact, border trade even seemed to increase in periods where alcohol became relatively more expensive in Sweden. The research method has many limitations and therefore no clear conclusions can be drawn, but the study suggests that there is no clear connection between the development of border trade of alcohol and the relative price difference between the domestic and foreign price.

In summary, previous studies on cross-border shopping between various countries suggest substantial changes in demand as a result of relative price changes. However, past studies of cross-border trade between Sweden and Norway have been unable to determine any relationship between foreign price levels and sales. This thesis aspires to provide evidence on the responsiveness of sales to domestic and foreign prices.

3. Indications of cross-border trade between Norway and Sweden

[2] If prices in Sweden decrease 10%, it is unlikely that this has a large effect on demand in border municipalities if prices in Norway simultaneously decrease by the same amount. In this case, the relative price remains unchanged. If the prices in Sweden decrease (or prices in Norway increase) and other prices remain unchanged, it becomes *relatively* less expensive in Sweden and sales in Swedish border municipalities should increase. Therefore, we would expect sales in Swedish border regions to increase and sales in Norwegian border regions to decrease when there is an increase in the relative price, P^{NO}/ P^{SE}, of alcohol.

[3] In the period 1991-1993, the price of alcohol in Norway became relatively more expensive compared to prices in Sweden, and sales on both sides of the border suggests a higher level of border trade (higher sales in Swedish border municipalities and lower sales in Norwegian municipalities). In the period 1993-1994, the relative price of alcohol in Norway decreased and the level of border trade was therefore expected to decrease. However, sales on both sides of the border instead suggest that the level of cross-border shopping in the southern region, where the majority of border sales occur, actually increased during the period. In the third period, 1996-1997, the relative price increased again suggesting an increased level of cross-border shopping. While this was true for the southern regions, cross-border trade actually seemed to decrease in the northern regions.

Cross-border trade is in this thesis defined as the purchase by private individuals in neighbouring countries for domestic consumption. It should be noted that the terms cross-border trade and cross border shopping are used interchangeably throughout the thesis. Cross-border trade consists of purchases in foreign shops, but also purchases made in connection with the actual crossing of the border. No distinction is made between legal and illegal import, or between tax-free and taxed products.

Norway and Sweden share the longest common border between any two European states (1,619 km), and the border is controlled through a combination of permanent and mobile checkpoints. Only 23 out of the 68 border crossings possible to pass by car are permanently served by customs officers. Norway has quite restrictive quota for duty free import on alcohol, which limits the legal trade over the border[4]. However, when asked about their purchases, 25% of Norwegian travellers admitted to brining more than the allowed amount (Larvik and Nordlund, 2009). Furthermore, the risk of being controlled by customs officers when entering Norway was about 0.17 percent in 1997 (Lund, Trolldal and Ugland, 1999).

A good indicator of cross-border trade is the number of private cars and individuals crossing national borders. If only a few people cross the border, it would be counterintuitive to anticipate a large border trade. Car traffic over the border increased by 15% on average between 2000 and 2002 and the three main border crossings - Svinesund-Strömstad, Ørje-Årjäng, Magnor-Eda – represent 78% of all border crossings (NOU 2003)[5]. There are even special "shopping busses" that cross the border[6].

Although the traffic streams indicate extensive border trade, they alone are not sufficient to determine if there is a demand effect associated with the trade. An indication of this could be given by comparing the level of alcohol sales in Swedish municipalities bordering Norway, and in municipalities unexposed to the border. Since prices are the same across the country, there is no incentive for border shoppers to go any further into the neighbouring country than the closest alcohol retail outlet. If border trade occurs, we should therefore expect sales in border municipalities to be higher than in the municipalities where no cross-border shopping takes place. Figure 2 shows the average per capita sales of alcohol in three border counties compared to the average monthly level of sales in the country[7]. It is evident from the figure that sales in these municipalities are much higher than average, and growing at a faster rate. In Strömstad, the average purchase of alcohol per inhabitant was over 53 litres per month in 2003 which is 16 times the country average. Per beverage category, this implies that each inhabitant on average purchase 4 litres of spirits, 31 litres of wine and 18

[4] The following quotas apply:

(a) 1 liter of alcohol with 22-60 volume percent strength, and 1 liter of alcohol with 2,5-22 volume percent. Or, 2 liters of alcohol with 2.5 -22 volume percent.

(b) 2 liters of beer or other drink with 2.5 -4.75 volume percent.

One can import both (a) and (b). Since 2003, beer can now be included in (a), so one could potentially bring in 4 liters of beer. In addition to the free allowed import, one can bring an additional amount of alcohol against a small customs fee.

[5] Furthermore, nearly 85% of all crossings occur at Magnor (Eda) or further south. In Svinesund (Strömstad) alone, half of all the crossings occur.

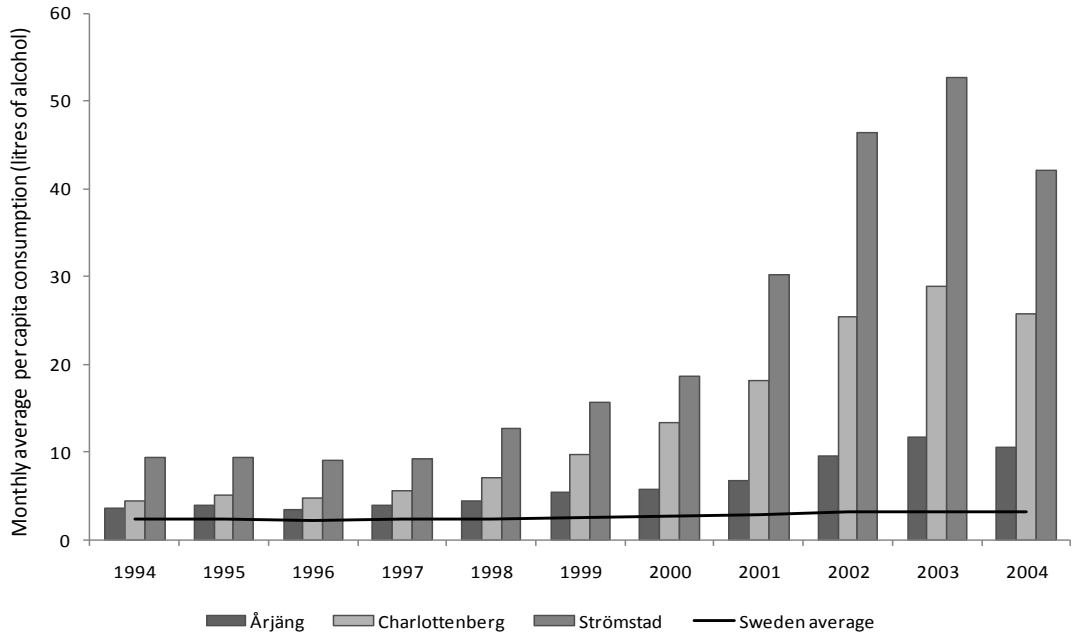
[6] These are normally dependent on the season, and most occur in summer and around Christmas (NOU 2003).

[7] To reduce the influence of factors such as cross-border shopping from other Nordic countries, municipalities in proximity to the Finnish border are excluded from the average. Furthermore, municipalities closer than 200 km to the Danish border are excluded, following the findings of Asplund, Friberg and Wilander (2007).

litres of strong beer each month[8]. It seems very unlikely that all of this would be consumed by the local inhabitants, so the figures should be compared to data on the consumption level of alcohol.

The Centre for Social Research on Alcohol and Drugs (SoRAD) yearly performs interview studies to provide statistics on consumption and sources of alcohol[9]. The studies suggest that the alcohol consumption in the region to which Strömstad belongs has been 5-7 percent higher than the country average in the period 2001 to 2004 (SoRAD, 2008). The study also indicates that the consumption of alcohol originating from Systembolaget in this region is actually lower than the country average[10]. If sales of Systembolaget were purely driven by the locals' purchases, we would thus expect lower sales per capita in Strömstad compared to the average. The regional consumption patterns can therefore not explain the exceptionally high level of alcohol sales in this region. The data therefore suggest that border trade between Sweden and Norway is considerable and increasing, a more quantitative analysis is needed to unravel the relationship between demand and foreign and domestic prices.

Figure 2



Data on sales are provided by Systembolaget. Data are aggregated to the municipality level and presented as monthly average per capita consumption (for inhabitants over the age of 16) per year. The Sweden average is the average per capita consumption in the country.

[8] Expressed in terms of bottles and cans, this means 5.3 bottles of spirits (75 cl), 41.3 bottles of wine (75 cl) and 36 cans of strong beer (50 cl).

[9] Since 2001, 18,000 randomly selected Swedes have been asked about their consumption of alcohol, the sources, drinking habits and alcohol related problems.

[10] The average alcohol consumption in Sweden obtained at Systembolaget varied between 4.6 to 5,1 litres per capita (46 to 51% of total consumption) during 2001-2004. The equivalent number for Västra Götaland is 4.3 to 4.9 litres (42-45%) and the number is lower than the country average for every individual year.

4. Data

The following section provides an introduction to the underlying data in use, as well as a first discussion around the statistics and sale patterns observed.

Two main datasets are used in this paper, one from the Swedish government retail monopoly (Systembolaget) and one from its Norwegian counterpart (Vinmonopolet). The first data set consists of monthly sales volumes from January 1994 to July 2004 for the approximately 400[11] Systembolaget stores across Sweden[12]. This dataset was previously used for studying cross-border trade between Sweden and Denmark in Asplund, Friberg and Wilander (2007) and this study partially parallel theirs. Data is aggregated to municipality level. Population and income in the municipality is derived from by Statistics Sweden[13]. Store density is defined as the number of stores per municipality and thousand inhabitants. Fridays and Holidays represent the number of Fridays and Swedish holidays per month. Descriptive statistics of raw data are to be found in Table 1.

Table 1

	Observations	Mean	Standard deviation	Min	10th	25th	50th	75th	90th	Max
Sales spirits	28,372	0.346	0.259	0.066	0.191	0.232	0.295	0.390	0.521	7.142
Sales wine	28,372	1.224	1.381	0.224	0.581	0.723	0.968	1.333	1.953	56.19
Sales beer	28,372	1.869	1.190	0.332	0.920	1.195	1.622	2.217	3.630	37.21
P^D spirits	28,372	1.009	0.035	0.936	0.946	0.987	1.022	1.041	1.045	1.046
P^D wine	28,372	0.999	0.030	0.925	0.947	0.969	0.994	1.023	1.029	1.038
P^D beer	28,372	1.011	0.024	0.920	0.987	1.000	1.001	1.030	1.042	1.048
P^F spirits	28,372	0.996	0.057	0.879	0.889	0.927	0.945	1.009	1.049	1.057
P^F wine	28,372	1.000	0.070	0.859	0.869	0.960	1.041	1.052	1.064	1.092
P^F beer	28,372	1.001	0.060	0.904	0.916	0.973	1.005	1.064	1.086	1.104
Income/cap	28,372	161.5	27.30	109.9	131.0	141.6	158.1	176.1	192.5	351.7
Store density	28,372	0.103	0.075	0.017	0.025	0.043	0.085	0.133	0.205	0.472
Fridays	28,372	4.350	0.476	4.000	4.000	4.000	4.000	5.000	5.000	5.000
Holidays	28,372	0.655	0.918	0.000	0.000	0.000	0.000	2.000	2.000	3.000

Data on sales and number of stores are provided by Systembolaget. Price data are Harmonized Price Index from Eurostat database. Population and per capita income per municipality is from Statistics Sweden. "Min" and "Max" indicate minimum and maximum value of each variable, "10th", "25th", "50th", "75th" and "90th" specify the respective centiles.

The second data set, provided by Vinmonopolet, consists of monthly sales volumes from January 1996 to December 2004 for its over 200[14] stores across Norway[15]. Again, the data are aggregated to municipality level. Population and income in the municipality is derived from Statistics Norway[16]. As with the Swedish dataset, store density denotes the number of stores per municipality and thousand inhabitants. Fridays and Holidays represent the

[11] In smaller towns where no outlet is present, any item in Systembolaget's product range can be ordered and delivered free of charge to a local agent (often a country convenience store). Sales through these approximately 520 local agents scattered throughout the country are not included in the data set.

[12] Non-alcoholic beverages or alcohol with less than 3.5% alcohol volume are not included in the analysis as these can be purchased in grocery stores and supermarkets in Sweden.

[13] Population and all per capita measures relate to inhabitants over the age of 16. Data can be found at: www.scb.se

[14] Since 2002, online sale of alcohol is possible through Vinmonopolet's webpage. The purchases can be collected at the closest post office free of charge, or be delivered directly to the customer for a small fee. Online sales are not included in the analysed data set.

[15] Non-alcoholic beverages or alcohol with less than 4.75% alcohol volume are not included in the analysis as these can be purchased in grocery stores and supermarkets in Norway.

16 As for the Swedish data set, population and all per capita measures relate to inhabitants over the age of 16. Data can be found at: www.ssb.no

number of Fridays and Norwegian holidays per month. Descriptive statistics of raw data are to be found in Table 2.

The two datasets together represent a very extensive source for analyzing the determining factors of alcohol sales by providing monthly sales for each store in Sweden and Norway over almost a decade.

Table 2

	Observations	Mean	Standard deviation	Min	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}	Max
Sales spirits	10,346	0.442	0.280	0.070	0.206	0.273	0.366	0.504	0.777	2.790
Sales wine	10,346	1.396	0.759	0.161	0.634	0.884	1.247	1.719	2.289	7.921
Sales beer	10,346	0.030	0.043	0.002	0.006	0.009	0.015	0.030	0.011	0.628
P^D spirits	10,346	0.963	0.057	0.878	0.891	0.927	0.945	1.001	1.049	1.057
P^D wine	10,346	1.011	0.068	0.859	0.899	0.976	1.042	1.061	1.064	1.092
P^D beer	10,346	1.017	0.060	0.904	0.926	0.980	1.030	1.069	1.094	1.104
P^F spirits	10,346	1.014	0.034	0.936	0.963	0.992	1.032	1.043	1.045	1.046
P^F wine	10,346	0.993	0.029	0.925	0.953	0.975	9.995	1.023	1.029	1.038
P^F beer	10,346	1.016	0.034	0.920	0.991	1.003	1.013	1.040	1.043	1.048
Income/cap	10,346	225.4	41.21	144.1	172.8	195.6	223.1	248.0	277.5	401.3
Store density	10,346	0.110	0.072	0.025	0.040	0.050	0.085	0.167	0.222	0.498
Distance	10,346	213.2	153.0	12.00	50.00	95.00	171.0	265.0	490.0	590.0
Fridays	10,346	4.350	0.476	4.000	4.000	4.000	4.000	5.000	5.000	5.000
Holidays	10,346	0.818	1.205	0.000	0.000	0.000	0.000	2.000	3.000	4.000

Data on sales and number of stores are provided by Vinmonopolet. Price data are Harmonized Price Index from Eurostat database. Population and per capita income per municipality are from Statistics Norway. "Min" and "Max" indicate minimum and maximum value of each variable, and "10th", "25th", "50th", "75th" and "90th" specify the respective centiles.

Eurostat Harmonized Consumer Price indices for wine, spirits and beer are used as price data to disclose how price levels in Norway and Sweden have evolved during the studied period[17]. Foreign prices are converted into domestic by the corresponding monthly average exchange rate provided by the Swedish Central Bank[18]. All prices are deflated by the domestic Consumer Price Index[19]. The distance measure used for Norway is defined as the number of kilometres by car to the closest alcohol retail outlet in Sweden[20].

5. The empirical model

That cross-border trade occurs and that there are high price differences across the border was shown above. In this section, the sensitivity of sales to domestic prices and prices across the border is estimated. The effects are estimated both from the Norwegian and Swedish side. Even if sales in Swedish border regions prove to be responsive to changes in the Norwegian price, we cannot be certain that the effect is also noticeable in Norway. Increased sales in Swedish border municipalities can suggest two things – either that Norwegians' purchases in Sweden are bought as a complement to local purchases (in which case their total consumption increase and there would be no noticeable effect on sales in Norway) or

[17] Sprits: cp0211, wine: cp0212, beer cp0213. Data can be found at: http://epp.eurostat.ec.europa.eu

[18] Data can be found at: www.riksbank.com

[19] In the analysis of sales at Systembolaget, prices are deflated by the Swedish Consumer Price Index (CPI), and in the analysis of sales at Vinmonopolet prices are deflated by the Norwegian CPI. Data on CPI is provided by Statistics Sweden (www.scb.se) and Statistics Norway (www.ssb.no) respectively.

[20] By fastest route. Distance measures were collected through Viamichelin.com. Using shortest travel time did not yield any changes in the results.

that Norwegians have switched to do their purchases across the border (in which case the level of sales in Norway would decrease).

5.1 Model specification for the analysis of sales in Sweden

As previously discussed, the demand effect of Norwegian cross-border shopping in Sweden is assumed to be confined to Swedish border municipalities. So while domestic price, P^D, is expected to have an impact on sales in all municipalities, foreign price, P^F, is estimated to affect demand only in municipalities bordering Norway. In addition to foreign and domestic price, a number of variables may affect sales in regions and over time. Two municipality specific control variables are used in this model estimation: income per capita and store density. Furthermore, two monthly control variables are utilized; the number of Fridays per month and the number of holidays per month[21].

A few factors such as store design and opening hours that may affect accessibility of alcoholic beverages - and therefore may have an effect on sales - have not been included due to the scope of this thesis. Previous studies have shown that retail outlets in Sweden converted to self-service stores have lead to increases in alcohol sales (Lutterbeck 2008). Several outlets on both sides of the border where converted to self-service stores during the sample period, and including the conversion as a variable may improve the accuracy of the model[22]. During the sample period, Systembolaget introduced opening hours also on Saturdays[23]. A study by Nordström and Ramstedt (2009) suggest that Saturday opening hours have a very high impact on sales and according to a first evaluation, the extended opening hours brought about a 4% increase in sales in Sweden. Moreover, the analysis does not take into account the price movements of other goods.

To reduce the influence of cross-border shopping from other Nordic countries, several municipalities in proximity to the Finnish and Danish borders are excluded from the dataset[24]. Since prices and assortments are identical across stores, the demand effect in Sweden of cross-border shopping from Finland is confined to border municipalities. Subsequently, four Swedish municipalities bordering Finland are eliminated. According to Asplund, Friberg and Wilander (2007), the cross-price elasticity with respect to Danish alcohol prices is significant in the southern part of Sweden. They also found that the effect declines considerably after 200 km, so eliminating municipalities closer than 200 km to the southern border should sufficiently decrease the influence of cross-border shopping from Denmark. Consequently, another 45 municipalities close to the southern border are eliminated.

[21] Other variables such as opening hours and type of outlet (clerk service or self-service) are not included in this model but could be incorporated.

[22] During the period 1994 to 2006, the number of self-service outlets as percentage of total increased from 0% to 90%. In 2006, 61% of Systembolagets outlets were self-service stores (Örnberg and Olafsdottir, 2007).

[23] Saturday opening hours started as an experiment in February 2000 and was introduced in the whole country in July 2001.

[24] The main gateways from southern Sweden to continental Europe and cheaper alcohol prices are Malmö (to Copenhagen, Denmark), Helsingborg (to Helsingör, Denmark) and Trelleborg (to various locations in Germany and Poland). Asplund, Friberg and Wilander (2007) found that the correlation between distance measures to these cities is close to one, so here Malmö is used as a proxy for the Danish border and distance to the border is defined as the number of kilometers (by the closest route) to Malmö.

The variables of the model are estimated in logarithmic form to facilitate the interpretation of their coefficients. The demand per capita for alcohol type $j = \{\text{spirits, wine, beer}\}$ in municipality *i* at time *t* is assumed to be given by

$$(1) \quad ln[q_{i,j,t}] = b_{j,0} + b_{j,1} ln[P^D_{j,t}] + b_{j,2} ln[P^F_{j,t}] Dum_{,ij} + b_{i,3} ln[income/cap_{i,t}] + b_{i,4} ln[storedensity_{i,t}] + b_{i,5} ln[fridays_t] + b_{i,6}[holidays_t] + u_{j,i} + e_{j,i,t}$$

where $q_{i,j,t}$ refers to the number of litres of alcohol sold per capita. P^D is the price in Sweden and $b_{j,1}$ is the elasticity with respect to the domestic price. $Dum_{j,i}$ is a dummy variable for the 20[25] municipalities bordering Norway, and P^F the price of alcohol in Norway. Consequently, $b_{j,2}$ gives the elasticity in border municipalities with respect to the price of alcohol in Norway. $u_{j,i}$ captures unobserved heterogeneity that may be constant over time but differs between municipalities, and $e_{j,i,t}$ is a standard error term.

Sales in alcohol tend to exhibit strong seasonality (high sales in summer and over holidays such as Christmas and New Year). To reduce the seasonal effects, 12 month differences, Δ_{12}, are used and the model is estimated as follows:

$$(2) \quad \Delta_{12} ln[q_{i,j,t}] = b_{j,1} \Delta_{12} ln[P^D_{j,t}] + b_{j,2} \Delta_{12} ln[P^F_{j,t}] Dum_j + b_{i,3} \Delta_{12} ln[income/cap_{i,t}] + b_{i,4} \Delta_{12} ln[storedensity_{i,t}] + b_{i,5} \Delta_{12} ln[fridays_t] + b_{i,6} \Delta_{12} [holidays_t] + \varepsilon_{j,i,t}$$

5.2 Model specification for the analysis of sales in Norway

In this section, the sensitivity of sales in Norway to domestic prices and prices across the border is estimated. The same control variables as in the previous estimation are applied: the income per capita, store density, the number of Fridays per month and the number of holidays per month.

Even though the border trade with Sweden is by far the most extensive, border trade with Finland and Russia does occur. To eliminate the effect of this, municipalities within 200 km of the Finnish and Russian border are excluded from the dataset[26]. Subsequently, 15 municipalities in the northern part of Norway are eliminated. Norwegians may also access cheaper alcohol by ferries linking Norway with Denmark. There are ferries from Kristiansand, Stavanger, Larvik and Bergen to Hirtshals, Denmark, and from Larvik to Fredrikshavn, Denmark. There are also ferries from Oslo to Fredrikshavn and Copenhagen, Denmark. The ferry lines from Kristiansand provide the fastest, cheapest and quickest crossing to Denmark, and will be used as a proxy for the border to Denmark. It is likely that the cross-price elasticity with respect to Danish alcohol prices declines considerably even before 200 km as the additional ferry ride increases transport costs (in time and money)[27]. However, since no studies have been made on the distance effect in Norway, the distance impediment

[25] There are 21 municipalities bordering Norway. However, the municipality of Kiruna also borders Finland and is therefore removed to eliminate any effect of Finnish cross-border trade.

[26] Distance is defined as the distance in kms to the closest border crossing to Finland/Russia.

[27] Kristiansand–Hirtshals is the most frequently operated distance with 6 sailings daily. The shortest travel time is 2 hours and 15 minutes. Larvik–Hirtshals has on average 2 sailings a day and the crossing takes approximately 4 hours. Oslo–Fredrikshavn and Oslo–Copenhagen have one sailing a day and the crossings take approximately [12] and 17 hours respectively. Stavanger–Hirtshals has 4 sailings weekly and the crossing takes 11 hours and 30 minutes. Bergen–Hirtshals has 3 sailings weekly and the crossing takes 19 hours and 30 minutes.

suggested by Asplund, Friberg and Wilander (2007) will be applied. Consequently, another 24 municipalities in the southern part of Norway are excluded from the data set.

As people living at different distances from the border face different travel costs, it is likely that they have different purchasing behaviour and react dissimilarly to changes in the Swedish price. In line with the study performed by Asplund, Friberg and Wilander (2007), a variable designed to capture the price sensitivity to the foreign price in relation to the distance to the border is therefore introduced.

The demand per capita for alcohol type $j = \{\text{spirits, wine, beer}\}$ in municipality i at time t is assumed to be given by

(3) $$ln\left[q_{i,j,t}\right] = b_{j,0} + b_{j,1} ln\left[P_{j,t}^{D}\right] + b_{j,2} ln\left[P_{j,t}^{F}\right] + b_{j,3} ln\left[P_{j,t}^{F}\right] Dist_{,ij} + b_{i,4} ln\left[income/capi,t + bi,5\, lnstoredensityi,t + bi,6\, lnfridayst + bi,7\, holidayst + uj,i + ej,i,t\right.$$

where $q_{i,j,t}$ refers to the number of litres of alcohol sold per capita. P^D is the price in Norway and $b_{j,1}$ is the elasticity with respect to the domestic price. $Dist_{,i}$ is the distance to the Swedish border and P^F is the price in Sweden. The elasticity with respect to the Swedish price, $b_{j,2}$, is therefore contingent on the distance to the border. $u_{j,i}$ captures unobserved heterogeneity that may be constant over time but differs between municipalities, and $e_{j,i,t}$ is a standard error term.

To reduce the seasonal effects, 12 month differences, Δ_{12}, are used and the model is estimated as follows:

(4) $$\Delta_{12} ln\left[q_{i,j,t}\right] = b_{j,1}\Delta_{12} ln\left[P_{j,t}^{D}\right] + b_{j,2}\Delta_{12} ln\left[P_{j,t}^{F}\right] + b_{j,3}\Delta_{12} ln\left[P_{j,t}^{F}\right] Dist_{j} + b_{i,4}\Delta_{12} ln\left[income/cap_{i,t}\right] + b_{i,5}\Delta_{12} ln\left[storedensity_{i,t}\right] + b_{i,6}\Delta_{12} ln[fridays_{t}] + b_{i,7}\Delta_{12}[holidays_{t}] + \varepsilon_{j,i,t}$$

6. Econometric results

In this section, the results of the above estimated models are provided and analysed.

6.1 Estimation results for the sales in Sweden

Table 3 reports regression results for equation (2) for spirits, wine and beer. All variables proved to be significant at 1% level. The coefficients all have the expected sign and seem reasonable in size. Due to the model design, all coefficients, with the exception of holidays, have interpretations as elasticities. The descriptive statistics of the estimated variables can be found in the Appendix, Table 1.

Table 3

	Sprits (1)	Wine (2)	Beer (3)
$\Delta_{12}\ln[P^D]$	-1.623***	-1. 189***	-0 .457***
	[38.92]	[32.02]	[7.18]
$\Delta_{12}\ln P^F$ Dum_border	0.361***	0.526***	0.362***
	[7.89]	[10.55]	[10.51]
$\Delta_{12}\ln[income/cap]$	1.511***	1. 190***	0.638***
	[28.44]	[15.20]	[9.05]
$\Delta_{12}\ln[storedensity]$	0.121***	0.132***	0.164***
	[16.28]	[10.19]	[13.48]
$\Delta_{12}\ln[fridays]$	0.086***	0.156***	0.206***
	[13.90]	[21.32]	[30.09]
$\Delta_{12}[holidays]$	0.044***	0.036***	0.022***
	[37.98]	[23.47]	[29.29]
Constant	-0.070***	0.024**	0.008***
	[29.69]	[3.36]	[30.33]
Observations	20 626	20 626	20 626
$"R^2"$	0.144	0. 132	0.105

The dependent variable is the twelve month difference in log of sales volume, $\Delta_{12}\ln[q]$. ***, ** and * indicate significance at 1, 5 and 10% level respectively. Absolute value of t statistic is presented in parenthesis. Observations exclude municipalities bordering Finland and municipalities in close proximity to Denmark.

The estimation indicates that the municipal control variables, store density and average income per capita, have a positive effect on sales. The interpretation of the income elasticity varies between the alcohol categories, from 1.511 for spirits to 0.638 for beer. It is also evident from the estimation that the number of Fridays and holidays in a month positively affect the level of sales. Both coefficients suggest that the purchasing pattern varies between the beverage categories. Beer and wine sales seem more sensitive to the number of Fridays in a month than sales in spirits.

In the estimated model, the price elasticities in respect to domestic price varies from -0.457 (beer) to -1.623 (spirits). These price elasticities should be interpreted as an average across the country. The elasticities may be higher closer to the Norwegian border where the Swedish price may induce or deter cross-border trade. At the border, the elasticity with respect to the Norwegian price of alcohol is 0.361, 0.526 and 0.362 for spirits, wine and beer respectively. The interpretation is that a 10 percent increase in the Norwegian price leads to a 3.61 percent (spirits), 5.26 percent (wine) and 3.62 (beer) increase in sales in the Swedish municipalities bordering Norway. It is evident that, despite a constantly higher price level across the border, changes in the relative price affect border trade.

The price elasticities in respect to foreign prices are in line with previous estimates[28], and it must be recognized that the border areas investigated have a considerable measure of tourism, which may make it harder to isolate the cross-border effect with the help of Swedish trade statistics. With many visiting tourists, the demand for alcohol in the region will be higher than the Swedish average. However, tourists tend to visit during the same time each year (mostly the summer months) so the effect is somewhat diffused by the use of 12 month differences. However, changes in tourism patterns will affect the results.

[28] In an analysis of alcohol sales in Sweden, Asplund, Friberg and Wilander (2007) estimate that the price elasticity with respect to Danish price ranges from 0.17 (wine) to 0.47 (beer).

6.2 Empirical results for the analysis of sales in Norway

The outcome of the estimated model (4) for spirits, wine and beer respectively is reported in Table 4. The distance variable for beer had the expected sign but proved not to be statistically significant. The remaining variables are significant and the coefficients have the hypothesized sign. The descriptive statistics can be found in the Appendix, Table 2.

The estimation indicates that the control variables have a positive effect on sales. As in the Swedish estimation above, beer is more sensitive to the occurrence of Fridays than spirit sales are. However, when it comes to holidays, wine sales are more responsive to holidays than the other categories are.

As in the previously estimated model, the price elasticities in respect to domestic price are the highest for spirits, followed by wine and beer. One possible explanation for the lower price elasticity for beer may be that it is the most common alcoholic beverage in the Nordic countries and may therefore be seen more as a necessity for the beer drinkers[29]. Wine on the other hand may be seen more as a luxury beverage, and therefore have a higher price sensitivity. The price elasticity in respect to foreign price is correspondingly higher for wine than for beer.

Table 4

	Sprits (1)	**Wine (2)**	**Beer (3)**
$\Delta_{12}\ln[P^D]$	-1.287***	-1.288***	-0.434***
	[32.66]	[19.91]	[10.15]
$\Delta_{12}\ln P^F$	0.259 ***	0.315***	0.389***
	[9.19]	[7.14]	[6.09]
$\Delta_{12}\ln P^F$ x Dist	-0.002***	-0.014***	-0.001
	[3.67]	[3.81]	[1.92]
$\Delta_{12}\ln[income/cap]$	0. 815***	0.639***	0.378***
	[11.53]	[9.37]	[3.79]
$\Delta_{12}\ln[storedensity]$	0.306***	0.430***	0.486***
	[8.77]	[12.81]	[3.58]
$\Delta_{12}\ln[fridays]$	0. 098***	0. 078***	0. 178***
	[6.64]	[5.33]	[5.95]
$\Delta_{12}[holidays]$	0. 026***	0. 052***	0. 020***
	[20.93]	[26.27]	[4.62]
Constant	-0.030***	-0. 022***	-0. 057***
	[7.93]	[6.76]	[3.32]
Observations	6 526	6 526	6 526
$"R^2"$	0.238	0. 150	0. 071

The dependent variable is the twelve month difference in log of sales volume, $\Delta_{12}\ln[q]$. ***, ** and * indicate significance at 1, 5 and 10% level respectively. Absolute value of t statistic is presented in parenthesis. Observations exclude municipalities bordering Finland and municipalities in close proximity to Denmark.

[29] According to SIRUS, beer is the single most consumed alcoholic beverage in Norway, equaling about 40% of total consumption during the sample period (spirits and wine each correspond to about 30% of consumption) (NOU 2003). Corresponding data for Sweden during the sample period are 40% for beer, 35% for wine and 25% for spirits (SoRAD 2009). It should be noted that this split is per litre of pure alcohol, and comparing the actual volumes sold would skew the results much more towards beer consumption (due to the lower alcohol percentage per litre sold).

Also in Norway, the sales proved to be sensitive with respect to foreign prices. The elasticity with respect to the Swedish price ranges between 0.259 (spirits) to 0.389 (beer). Although this does not say anything about the actual magnitude of the demand shift, it is evident that the increased cross-border trade has a negative impact on retail sales in Norway. Reviewing the distance variable for spirits and wine, it is evident that price elasticity with respect to the foreign price decreases with the distance to the border.

The distance variable for beer had the hypothesised sign, but was not statistically significant. That is, for beer, changes in sales are not significantly linked to distance, which contrasts with the findings for the other categories. There may be several reasons for this. Firstly, beer with less than 4.75% alcohol volume can be purchased in grocery stores and supermarkets across Norway. According to consumption statistics, only 1%-1.5% of the total beer consumption had a volume percent of 4.75% or more (BROM, 2003). It is therefore possible to assume that the majority of beer sales do not occur at Vinmonopolet but rather in local grocery stores, and that the model's inability to capture this distorts the results. Secondly, the estimated level of cross-border trade in beer with a volume percent of 4.75% or higher is minimal. Only 0.03% - 0.5% of beer consumption is estimated to have been purchased in Sweden, compared to 2-8% - 7.6% for spirits and 1.42% - 4% for wine (NOU, 2003)[30]. The low volume of border-trade, despite the high price differences between the countries, may suggest that other factors such as convenience and variety of goods are more important than price differentials and the possibility of cross-border arbitrage when it comes to beer.

The R^2 values of the estimations on both sides of the border vary, but are in some cases quite low. A plausible explanation is that cross-border shopping in alcoholic beverages is affected by the price of other goods. Low prices of goods such as tobacco and meat may attract Norwegians to shop across the border. Once there, they may seize the opportunity to also buy alcoholic beverages. In this case, the responsiveness of alcohol sales relates also to the price sensitivity for other goods possibly distorting the results and decreasing the explanatory value of the estimated model. Furthermore, the exclusion of factors such as store design and opening hours that affect accessibility of alcoholic beverages may also have affected the explanatory value negatively.

7. Conclusion

By estimating demand functions, this paper can present evidence that sales are sensitive with respect to foreign price. Sales in both Sweden and Norway were examined, and the effect is visible on both sides of the border. For the estimation on the Norwegian side, it was also analysed if the sensitivity of sales with respect to foreign prices depend on the distance to the border. For both spirits and wine, the results suggest that the elasticity vary with the distance to the border. The distance effect was not significant for beer. Plausible reasons for this insignificance is that beer sales covered in the data set only represent 1%-1.5% of the total beer consumption, and that there is a minimal level of cross-border trade in the investigated beer category.

[30] Based on interview studies, SIRUS estimates the amount of consumed alcohol that originates from Sweden. In 1999, the border-trade with Sweden was estimated to constitute 2.8%, 1.42% and 0.03% of total consumption for spirits, wine and beer respectively. In 2002, the corresponding numbers were 7.6%, 4% and 0.5% (As reported in NOU 2003).

Tax revenues from alcohol sales (and other traded goods) are large and important in Norway, and it is clear that cross-border shopping erodes some of these revenues. An interesting application of the estimated demand functions would be to estimate the consequences of foreign and domestic tax changes on tax revenues in Norway. Unfortunately, this is not possible in time frame provided. Instead, the evaluation of such effects is left for future researchers.

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Appendix

Table 3

	Observations	Mean	Standard deviation	Min	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}	Max
Δ_{12}ln[q]Spirits	20,626	-0.037	0.116	-0.308	-0.174	-0.105	-0.040	0.038	0.094	1.114
Δ_{12}ln[q]Wine	20,626	0.041	0.125	-0.636	-0.107	-0.036	0.038	0.111	0.186	1.423
Δ_{12}ln[q]Beer	20,626	0.029	0.131	-0.263	-0.116	-0.045	0.025	0.100	0.174	1.012
Δ_{12}ln[P^D]Spirits	20,626	0.002	0.016	-0.029	-0.017	-0.013	0.005	0.012	0.026	0.037
Δ_{12}ln[P^D]Wine	20,626	-0.003	0.030	-0.092	-0.059	-0.014	0.007	0.019	0.028	0.037
Δ_{12}ln[P^D]Beer	20,626	0.007	0.018	-0.026	-0.717	-0.007	0.010	0.022	0.030	0.037
Δ_{12}ln[P^F]Spirits	20,626	-0.012	0.080	-0.194	-0.104	-0.053	-0.012	0.044	0.096	0.144
Δ_{12}ln[P^F]Wine	20,626	0.013	0.061	-0.129	-0.104	-0.017	0.019	0.048	0.095	0.137
Δ_{12}ln[P^F]Beer	20,626	0.009	0.064	-0.129	-0.106	-0.022	0.016	0.053	0.095	0.137
Δ_{12}ln[Income/cap]	20,626	0.027	0.014	-0.041	0.009	0.017	0.026	0.037	0.046	0.095
Δ_{12}ln[Store density]	20,626	0.006	0.070	-0.706	-0.010	-0.002	0.002	0.008	0.015	1.091
Δ_{12}ln[Fridays]	20,626	0.002	0.130	-0.223	-0.223	0.000	0.000	0.000	0.223	0.223
Δ_{12}Holidays	20,626	0.000	0.698	-2.000	-1.000	0.000	0.000	0.000	1.000	2.000

Table 4

	Observations	Mean	Standard deviation	Min	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}	Max
Δ_{12}ln[q]Spirits	8,536	-0.001	0.180	-0.934	-0.186	-0.100	-0.017	0.780	0.234	1.158
Δ_{12}ln[q]Wine	8,536	0.048	0.161	-0.881	-0.128	-0.024	0.051	0.122	0.206	1.204
Δ_{12}ln[q]Beer	8,536	-0.001	0.235	-1.664	-0.263	-0.109	0.008	0.116	0.259	1.364
Δ_{12}ln[P^D]Spirits	8,536	-0.022	0.058	-0.139	-0.119	-0.070	-0.007	0.004	0.045	0.058
Δ_{12}ln[P^D]Wine	8,536	0.011	0.048	-0.140	-0.053	-0.005	0.024	0.040	0.061	0.074
Δ_{12}ln[P^D]Beer	8,536	-0.010	0.046	-0.143	-0.089	-0.023	-0.002	0.016	0.034	0.058
Δ_{12}ln[P^F]Spirits	8,536	-0.007	0.066	-0.142	-0.128	-0.050	-0.006	0.044	0.085	0.132
Δ_{12}ln[P^F]Wine	8,536	-0.008	0.019	-0.073	-0.010	0.003	0.010	0.020	0.025	0.076
Δ_{12}ln[P^F]Beer	8,536	-0.011	0.067	-0.143	-0.125	-0.050	-0.009	0.032	0.079	0.140
Distance	8,536	213.2	153.0	12.00	50.00	95.00	171.0	265.0	490.0	590.0
Δ_{12}ln[Income/cap]	8,536	0.401	0.289	-0.640	0.004	0.020	0.043	0.060	0.077	0.170
Δ_{12}ln[Store density]	8,536	0.001	0.050	-0.699	-0.013	-0.009	-0.003	0.002	0.007	0.688
Δ_{12}ln[Fridays]	8,536	0.003	0.127	-0.223	-0.223	0.000	0.000	0.000	0.223	0.223
Δ_{12}Holidays	8,536	-0.132	0.906	-3.000	-1.000	0.000	0.000	0.000	1.000	3.000