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Tax expenditures and behavioral responses: The case of duty-free exemptions

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Abstract

The conventional method of computing tax expenditures disregards behavioral effects. We consider the case of duty-free exemptions for alcohol and tobacco in Norway and show the effects of including these responses. Our results suggest that the tax expenditures computed by the conventional approach are reduced by more than one third when including all behavioral effects.

Keywords: Elastic tax bases, behavioral effects, revenue forgone method, revenue gained method, excise taxes, duty-free, cross-border shopping, alcohol, tobacco

JEL codes: C15, D11, H2, H31, E21

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1 Introduction

Introducing a new tax or altering the rate of an existing one will lead to a change in tax revenue, consisting of a mechanical and a behavioral effect (Saez et al., 2012). The mechanical effect is the change in revenue given a static tax base, while the behavioral effect measures the impact of a response in the tax base. Moreover, when parts of a tax base are exempted from taxation, a tax expenditure can be calculated to indicate the public costs of these tax exemptions. One approach is the revenue forgone method (RFM), which assumes a static tax base, another one the revenue gained method (RGM), that incorporates behavioral changes in the tax base (Dom and McCulloch, 2019).[1]

Tax expenditures are often calculated by the fiscal authorities in budgeting processes, but there is no single and all-encompassing definition of tax expenditures, making comparisons between countries non-trivial (Bratić, 2006; Dom and McCulloch, 2019). The revenue forgone method, ignoring behavioral responses, is the conventional method both in the United States (U.S. Department United States Department of the Treasury, 2023) and in the rest of the OECD (OECD, 2010, p. 60). A favorable property of RFM estimations are computational simplicity, placing a smaller bureaucratic burden on fiscal administrations. However, when the behavioral responses to a tax change are significant, the RFM gives a strongly biased estimate of the anticipated real-world effect of a tax change.[2]

As Thoresen et al. (2010) and Bluestone and Bourdeaux (2019) we will show how considering behavioral effects and changes in tax bases change estimates on tax revenue. However, we will draw the attention to tax expenditures and exemptions in the indirect tax system, i.e. duty-free exemptions for international travelers. Some commodities are taxed more than what the Ramsey rule suggests, and the behavioral responses are a part of the desirable effects due to externality and internality correcting motives. RFM and RGM estimates of the tax expenditure from exemption to taxation of these goods may differ significantly, depending on how elastic the tax base is.

[1] A third method is the "equivalent direct expenditure method", that assumes no behavioral responses, but instead emphasizes that a removal of a tax expenditure reduces the utility of taxpayers. Thus, the method estimates the gross transfer that would leave taxpayers the same after-tax income they had without the removal of the tax expenditure (Dom and McCulloch, 2019, p. 4)

[2] Gemmell and Hasseldine (2014) argue that this is the case in estimates of so-called "tax gaps" as well, which focuses on the discrepancy between actual tax collected and the potential tax collection under full compliance with the tax code. This approach is the primary measure of tax non-compliance via (legal) tax avoidance and/or (illegal) tax evasion.

By analyzing tax revenue effects from two hypothetical reforms that lifts an existing duty-free exemption on alcohol and tobacco, we highlight the difference between a purely mechanical approach (RFM) and an approach taking into consideration behavioral responses (RGM). These reforms clearly shed light on the potentially large discrepancy between conventional computations of tax expenditures and more realistic revenue estimates, since the purchasing pattern with respect to unrecorded and recorded consumption may be severely altered.

To carry out our computations we apply an empirically based demand model for Norway (KONSUM-G). The model includes both recorded and numerous sources of unrecorded consumption for different types of alcoholic beverages and tobacco products, in addition to other consumption goods and services.[3] Our estimates indicate that when allowing for behavioral responses in the tax base, the tax expenditure reduces by more than one third. This highlights the relevance of using more comprehensive analyses for tracking the behavioral effects when reforms are targeted towards elastic tax bases. Moreover, in computing tax expenditures one should be aware of the large discrepancy that might arise when using the conventional approach.

It is interesting to compare our findings with the estimates from the literature on dynamic scoring. Here we find behavioral (dynamic) effects with widely varying magnitude, ranging between 1% and 60% of static estimates (Bluestone and Bourdeaux, 2019; Barrios et al., 2019; Thoresen et al., 2010). These studies investigate effects of tax changes to major tax bases (income taxes, sales taxes, corporate taxes, property taxes, and social insurance contributions), while our results indicate that behavioral responses to minor tax bases for excise taxes might also be substantial, if the tax base is elastic.

We proceed by describing the institutional background in Section 2. Next, in Section 3, we present the empirical model, and we present the results in Section 4. In Section 5 we discuss the results, sum up and conclude. We also briefly indicate how reduced consumption from the reforms could impact public health and absenteeism in the labor market.

[3]The first version of this model was developed in 2003 by the Research Department at Statistics Norway to assist a governmental appointed committee with mandate to evaluate cross-border shopping and excise taxes in Norway (see NOU 2003:17). In later years the model is updated on an annual basis to serve the government in their budget process (Arbeidsnotat 2017/10). The model used in the current paper, is a slightly extended version, tailor-made to fit our problem.

2 Institutional background

Unlike recorded consumption of alcohol and tobacco, unrecorded consumption is untaxed and left out of official statistics in the jurisdiction where it is consumed. Unrecorded consumption can be divided into a legal or illegal part, exemplified by cross-border and duty-free shopping (legal) or smuggling (illegal). World Health Organization estimate that 25% of the worldwide alcohol consumption is unrecorded (Rehm et al., 2022). This type of unrecorded consumption reflects an inherent dilemma for policymakers: They would like to decrease the consumption of these harmful goods by imposing higher excise taxes, but they risk inducing tax avoidance behavior and more unrecorded consumption.

This tradeoff has been acknowledged in the theoretical literature for decades, and the seminal work on tax differentials and cross-border shopping is Kanbur and Keen (1993), which identified different strategies for welfare improvement in the presence of cross-border shopping, e.g. tax coordination. Several studies have emerged along these lines (Haufler, 1996; Nielsen, 2001, 2002; Wang, 1999), some also focusing on how the optimal tax rules are modified (Christiansen, 1994, 2003; Scharf, 1999; Kesseing and Koldert, 2013). A few theoretical studies have also directed attention to duty-free shopping, as Christiansen and Smith (2007) and Facchini and Willmann (1999).

In more recent years, also the empirical literature has drawn more attention to issues of unrecorded consumption, cross-border and duty-free shopping. Beatty et al. (2009) shows that large tax differentials near borders induce avoidance behavior, which may limit the governments' ability to raise revenue and potentially undermine public health and social policy goals. Friberg et al. (2022) shows how fluctuations in grocery store demand in Norwegian stores near the Norwegian-Swedish border can be explained by variation in price differentials. The responsivity is "hump-shaped", and the most price responsive margins are found 30-60 minutes driving distance from the closest foreign store. Johansson et al. (2014) examines the impact of a tax reduction on alcohol in Finland on mortality rates, alcohol-related illnesses, and absenteeism in the border regions of neighboring country Sweden, and find significant differences for absenteeism compared to a control region. Whereas the previous studies have discovered effects driven by price differentials, Stafström (2018) demonstrates that relaxed personal allowances for travelers may also impact the overall long-term alcohol population use.

2.1 Cross-border shopping and the duty-free arrangement in Norway

In the Scandinavian countries cross-border shopping is a highly relevant issue, with Danes travelling to Germany to shop alcohol as described by Bygvrå (2009). Swedes go cross-border shopping in Denmark and Finland (Asplund et al., 2007; Johansson et al., 2014), and Norwegians cross-border shop mainly in Sweden (Lavik and Nordlund, 2009; Aasness and Nygård, 2014; NOU 2003:17, 2003). Cross-border shopping receives much attention in Norway. The discussion often evolves around the need for decreasing unrecorded consumption and to lower the excise taxes on alcohol and tobacco. Duty-free shopping of alcohol and tobacco is highly debated as well. Norway allows on-arrival duty-free at airports and on ferries, making it an important source of unrecorded consumption.[4] Opponents concerned with public health argue that it undermines the otherwise restrictive Norwegian alcohol and tobacco policy, and that large shares of unrecorded consumption is a threat to this policy. Others view it as an extra incentive to travel and point to the negative environmental effects, while some point to the loss in tax revenue. One of the most prevailing arguments in favor of the system seems to be that duty-free shops generate substantial rental income to the state-owned company operating the airports in Norway (Avinor). They claim that this revenue source is crucial to keep other smaller airports running. Due to this persistent public interest for the topic, several reports have discussed the issue during the last decade (NOU 2022:20; NOU 2021:4; Ministry of Finance; NOU 2015:15; Bergsvik and Rossow; Bergsvik; Oslo Economics; Oslo Economics; Samfunnsøkonomisk Analyse; NOU 2007:8). Several Norwegian Official Reports have recommended to abolish the duty-free arrangement (NOU 2022:20; NOU 2021:4; NOU 2015:15; NOU 2007:8).

The Norwegian VAT and excise system is based on the destination principle, i.e. taxation are levied at the place of consumption. Hence, imports to Norway are tax liable, while exports are zero-rated. However, due to practical reasons, Norwegian travelers are allowed to import small amounts of goods without declaring them. When staying abroad more than 24 hours they are allowed to bring in duty-free goods, and the value limit of the sum

[4]On-arrival duty free is not only relevant for Norway. In fact, the issue of on-arrival duty-free at airports is an on-going discussion several places, as in Canada. See the discussion in https://www.moodiedavittreport.com/cac-calls-for-canadian-arrivals-duty-free-to-stimulate-post-coronavirus-recovery-effort/ and https://blog.aci.aero/unlocking-the-potential-of-on-arrival-duty-free-at-airports/. The latter also claim that on-arrival duty-free applies to 45 countries.

total for all items bought is 6,000 NOK.[5] When staying less than 24 hours, the value limit is 3,000 NOK, and it applies only to goods taxed at the place of purchase (e.g. cross-border shopping in Sweden). For alcohol and tobacco there are specific quotas, which amount to 1 liter of liquor, 1.5 liter of wine, 2 liter of beer, 100g cigarettes or 125g other tobacco products and 100 pieces of cigarette paper.[6] Travelers that do not buy any spirits can add 1.5 liter of wine or beer, and wine can be substituted for beer, liter by liter. The specific personal allowances for alcohol and tobacco do not distinguish between taxed or untaxed purchases.

Norway imposes some of the highest excise taxes on alcohol and tobacco in the world, which helps to explain why duty-free shopping, and cross-border shopping, remains a hot topic in the public debate. The excise taxes on alcohol and tobacco products in Norway are given in Table 1. We see that the taxes in Norway implies that for a half liter of beer you must pay more than 10 NOK in excise taxes, corresponding to about 1 Euro. Buying a bottle of wine (750ml) will imply that you pay 43 NOK, or about 4.3 Euro in such taxes. For comparison we have added the same taxes in the neighboring country Sweden, where most of the cross-border shopping takes place. We see that, apart for spirits, the excise taxes are often about twice as large in Norway. In an international context, the Swedish tax rates are also very high.

These high excise taxes explain much of the high price differentials we observe between taxed products in Norway and the products in duty-free shops or in Swedish stores. In Table 2 we present estimates on the average prices associated with the the different sources. We see that the price differentials are large for some groups, i.e for snuff and other tobacco products we find average prices almost twice as large in Norway. However, for some groups, e.g. wine, the price differentials seem more moderate. Note that these are estimates on the average prices. For specific products the price differentials may still be substantial.

In addition to this high excise policy, the retail market for alcohol is controlled by a state monopoly (called 'Vinmonopolet'). All alcoholic beverages above 4.75 alcohol content not bought at restaurants etc. are only allowed bought in specific stores.[7] Moreover, adding to this is the fact that pur-

[5]Alcohol and tobacco does not count towards the value limit. For more details, see https://www.toll.no/en/shopping-abroad/the-value-limit/

[6]The quota for tobacco products was reduced from 200g cigarettes or 250g other tobacco products and 200 pieces of cigarette paper on January 1, 2023.

[7]This monopoly may also explain why the price differentials are not even larger. Using their monopoly power Vinmonopolet are able to reach good deals when negotiating with the importers of alcoholic beverages.

Table 1: Excise taxes on alcohol and tobacco in Norway and Sweden, 2021

	Norway (NOK)	Sweden (NOK)
Beer (4,7%, per liter)	21.3	9.5
Wine (12%, per liter)	57.1	26.2
Spirits (40%, per liter)	324.4	206.6
Cigarettes, per unit	2.77	1.65
Snuff, per gram	0.85	0.46

Note. We assume 100NOK=100SEK for 2021.

Source: www.skatteetaten.no and www.skatteverket.se.

chases of beer (below 4.75%) in regular stores are not allowed after 8 p.m. at weekdays and after 6 p.m. in the weekends. Such regulations make it less convenient, hence more costly in a non-pecuniary sense, to purchase such goods recorded and taxed in Norway.

By using several sources we have reached estimates on unrecorded consumption, which we will return to when describing the calibration of our empirical model. We observe substantial duty-free shopping and cross-border shopping for these goods.

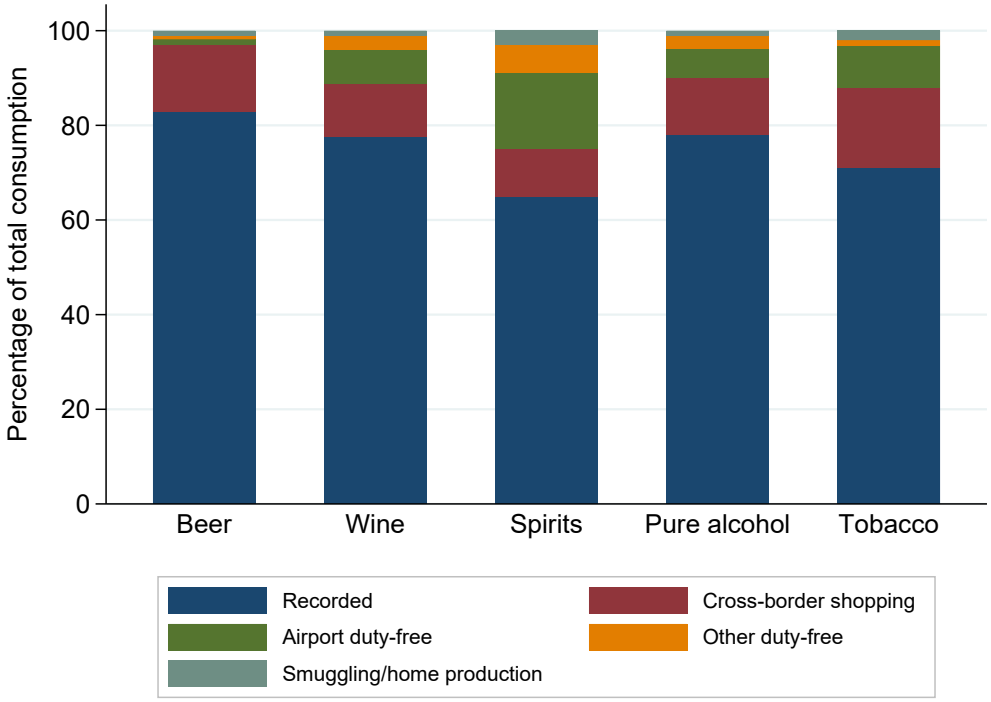
The composition of consumption for different categories, excluding consumption at restaurants, bars etc., are given in Figure 1. The recorded consumption as share of total consumption varies somewhat, with beer having the highest share of recorded consumption and duty-free almost negligible. However, we observe substantial cross-border shopping with beer. Moving to other consumption categories, duty-free shopping becomes more prominent. About 35% of total spirit purchases are carried out through unrecorded channels, and duty-free shopping at airports is the most important unrecorded consumption channel making up 16% of the consumption. Summing up in terms of pure liter of alcohol, more than 20% of the consumption consists of unrecorded sources. The same pattern can be observed for tobacco products, with about 30% originating from unrecorded channels.

Table 2: Price estimates on alcohol and tobacco products in 2021 (NOK per liter/kg))

	Duty-free	Sweden	Recorded in Norway
Beer	33	29	60
Wine	161	115	184
Spirits	252	359	506
Cigarettes etc.	2,713	3,371	6,413
Snuff	2,486	2,217	4,306

Source: Inflation adjusted prices taken from Bergsvik and Rossow (2016) and Kvam (2020).

Figure 1: Composition of consumption



Source: Main sources are the National account data, Sales figures from the State monopoly, Surveys from Statistics Norway on cross-border shopping etc., and the Institute of Public Health (FHI).

3 A model for consumer behavior

3.1 Theoretical framework

We consider a representative consumer maximizing utility

$$U = U(\mathbf{Q}_{\mathrm{R}}, \mathbf{Q}_{\mathrm{UR}}; \boldsymbol{Z}), \tag{1}$$

subject to a linear budget constraint

$$\mathbf{p}_{\mathrm{R}}\mathbf{Q}_{\mathrm{R}} + \mathbf{p}_{\mathrm{UR}}\mathbf{Q}_{\mathrm{UR}} = \mathrm{Y}, \tag{2}$$

where $\mathbf{Q}_{\mathrm{R}}$ is a bundle of n commodity groups bought recorded in the economy, whereas $\mathbf{Q}_{\mathrm{UR}}$ is a bundle of m groups bought unrecorded. Consumer prices associated with these goods are given by the price vectors $\mathbf{p}_{\mathrm{R}}$ and $\mathbf{p}_{\mathrm{UR}}$. Total private expenditure is denoted as Y, and $\boldsymbol{Z}$ is a vector containing the total number of children, adults and households in the economy. We will think of $m < n$, i.e. only some of the commodity groups bought recorded are exposed to unrecorded purchases, such as alcohol and tobacco. Note that we adopt the Armington assumption found in empirical trade studies and model the goods bought unrecorded as imperfect substitutes for the recorded goods (Armington, 1969). As described by Blonigen and Wilson (1999), product differentiation does not depend on actual physical differences between goods. Physical identical goods may still be differentiated by availability in time, convenience of purchase or inherent unobservable quality.

In our context this implies that a bottle of wine could be bought in Swedish border regions even though the Norwegian price is reduced to the Swedish price. This is simply due to pure convenience and the fact that the decision to travel for shopping depends on a lot more than the price on this particular good. Several other goods are cross-border shopped in Sweden, e.g. different food products. As long as the total price on a bundle of goods is lower in Sweden, the consumer saves money and can go cross-border shopping. Moreover, huge shopping malls, as we observe at the Swedish border, are attractive in itself, offering a wide variety of goods. The same phenomenon applies elsewhere in the world, for instance at the border regions between US and Canada.[8]

From (1) and (2) it follows that we can derive total demand for a given recorded or unrecorded good as

[8] See https://hellosafe.ca/en/newsroom/us-canada-border-shopping#5_things_that_are_worth_buying_in_the_US_for_Canadians: Some goods are cheapest in US, others in Canada and shopping centres have appeared to attract people to go cross-border shopping/duty-free shopping.

$$Q_i = g_i(\mathbf{p}_{\mathrm{R}}, \mathbf{p}_{\mathrm{UR}}, Y, \boldsymbol{Z}), \tag{3}$$

$$i = R, UR,$$

i.e. total demand as a function of prices on all unrecorded and recorded goods, total expenditure and demographic characteristics.

Further, the consumer price on a recorded good is given by

$$p = q(1 + t), \tag{4}$$

where q is the producer price and t, the effective Norwegian indirect tax rate that applies to the good, includes VAT and all excise taxes. From this it follows that the total tax revenue T is defined as

$$T = \mathbf{Q_R q t}. \tag{5}$$

3.2 Specification of preferences

Our empirical model is perfectly consistent with the general consumer theory as outlined above. The preferences can be visualized as a utility tree, as shown in Figure 2. The utility tree is based on non-homothetic weak separability (Aasness and Holtsmark, 1993).[9] As we will return to, these properties are useful when it comes to calibrating the model based on available information.

A translated CES sub-utility function is specified at each node in the utility tree (Blackorby et al., 1978). Figure 2 depicts the complete specification with respect to the branch for Food, beverages, and tobacco (FBTG). The branches for the other main groups, Communication (CO), Housing (HO), and Other goods and services (OGS), consist of several levels, but we confine ourselves to indicating the groups at level two. Within the main group Food, beverages, and tobacco (FBTG), we formally find 31 goods at the lowest level.

Spirits is divided into four commodity groups: bought recorded in Norway (H); bought legally through cross-border shopping (C) and duty-free shopping for use in Norway (T); smuggled into the country or distilled illegally in Norway (S). Duty-free shopping is divided further into duty-free shopping at Norwegian airports (TH) and duty-free shopping elsewhere (TF).

[9] It is possible to show that given our particular functional form we could derive the macro demand functions in (3) from micro demand functions derived from utility maximizing households (Aasness and Holtsmark, 1993).

Duty-free shopping elsewhere consists of duty-free shopping at foreign airports, airplanes and ferries. We proceed similarly for wine, beer, and tobacco, whereas for food and non-alcoholic beverages cross-border shopping (A) is the only channel for unrecorded purchases.

Our utility tree implies that every household can make decisions about the composition of expenditures by first considering changes in utility brought about by changes in consumption of goods within the same branch of the utility tree. To illustrate, when the price on duty-free wine at Norwegian airports raises, the consumer can be thought of as choosing his new composition of expenditure in the following way: She first considers whether to reduce her duty-free shopping at Norwegian airports, and make up for the loss by shopping duty-free elsewhere, e.g. at foreign airports. Second, she considers whether to cut back on duty-free shopping of wine and replace part of her loss in wine consumption by more cross-border shopping and purchases at the local store. Third, she considers whether to drink more beer and spirits instead of wine. The next step she does is to adjust her spending between Food (00), Beverage without alcohol (BO), Beverage with alcohol (BA), and Tobacco (04). Moreover, she can also adjust her spending balance of expenditure on the four main groups at the top level of the utility tree. Finally, she will run down the utility tree checking whether her budget is optimally distributed between the different groups and subgroups.

3.3 Data and calibration

The modeling and calibration procedure is inspired by the idea described by Frisch (1959). Under additive utility, he showed that by knowing the Engel elasticity, the macro budget share of each good, and the own-price elasticity of only one good, we have enough information to derive all own-price and cross-price elasticities. Let θ be a vector of unknown parameters in our utility function. It is possible to show that in our case there exist a function f

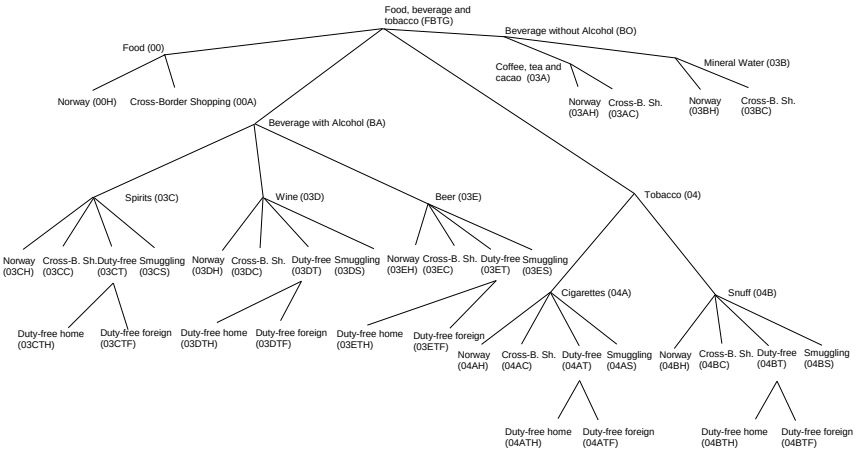
$$\theta = f\left(p_t, Q_t Y_t, Z_t, E_t, P_{1t}, P_{2t}, S_t\right), \tag{6}$$

where the arguments are characteristics of the demand function at one point in time (t). In other words, given our structure of preferences, we can derive the whole demand function by only observing characteristic at time t (Aasness and Holtsmark, 1993).

The first set of variables, p_t, Q_t, Y_t, Z_t, are the prices, aggregate demands, total expenditure, and demographic variables, respectively. We use a slightly extended version of the model updated in 2020 for the budget year 2021.

To derive estimates on both aggregate recorded and unrecorded demand

Figure 2: Utility tree, KONSUM-G



we use national account data and several other sources. The main sources we use consist of i) data from the survey on cross-border trade from Statistics Norway, covering a representative sample and collected by telephone interviewing, ii) data on duty-free shopping collected and compiled by The Norwegian Institute of Public Health, which are partly based on sales figures collected directly from duty-free shops at Norwegian airports (Bergsvik, 2015, 2020). Recorded consumption are taken from the National account data and sales figures published by the state monopoly.[10] The demographic variables consist of the number of adults, children and households in the Norwegian economy, all from Statistics Norway. When we calibrate the model consumption is measured in Norwegian 2021-kroner (NOK), i.e., all prices are normalized to 1 in the base year. However, since we focus on alcohol and

[10]Our consumption estimates must be interpreted as in a normal year. Due to the covid-19 pandemic, these will obviously not match the consumption in 2021. Due to travel restrictions, we observed a dramatic decrease in 2021 for cross-border and duty-free shopping in Norway. However, it is hard to predict what the long-term consequences of the pandemic will be. Nevertheless, we have chosen to believe that cross-border shopping will return to pre-pandemic situation, but have adjusted duty-free shopping slightly down. We believe that the long-term trend growth for international travelling will experience a downward shift.

tobacco consumption, we present results for changes in liter of (pure) alcohol and kilo of tobacco. This is particular relevant in our case, since the price on alcohol and tobacco depends on the place of purchase.

The second set of variables consists of Engel elasticities, E_t, and adult and child elasticities, P_{1t} and P_{2t}.[11] We find such estimates in comprehensive micro econometric studies conducted at Statistics Norway, and we report the Engel elasticities in Table 6. These studies are based on data from the Household Expenditure Survey, carried out by Statistics Norway, and use latent variables to take into account both random and systematic measurement errors, cf. Aasness et al. (1993).[12]

The last variables (S_t) consist of several substitution parameters set on the basis of data from several sources, see Aasness and Holtsmark (1993) for a detailed documentation. Important for our purpose is the branch covering Food, Beverages and Tobacco, and in particular Beverages with alcohol and Tobacco. By exploiting the above mentioned idea from Frisch, the substitution parameters for this part of the tree have been calibrated based on a review of the empirical literature on price elasticities.

In Tables 3 and 5 we give an overview of estimated own-price elasticities for recorded demand in Norway found in several econometric studies (see NOU 2003:17, Table 6.6, 6.7, and 7.1, pp. 52–53, 62). Table 4 presents price elasticities used in Norwegian studies and by the Norwegian Ministry of Finance in tax revenue calculations prior to 2002, i.e. prior to the introduction of the current model. Apart from Skog et al. (1993), all sources indicate that demand for beer is less elastic than demand for wine and spirits, and also suggest that demand for beer is inelastic. Demand for wine and spirits, however, appears to be elastic, wine somewhat more elastic than spirits. For tobacco products, Table 5 seems to suggest that tobacco demand is inelastic. In the governmental report from 2003 (NOU 2003:17), they concluded that a own-price elasticity between -0.4 and -0.5 seemed reasonable and in accordance with the practice at the Ministry of Finance.

When the model is calibrated we can simulate price elasticities as reported in Table 6. We report both aggregated and detailed own-price elasticities (see Appendix B for complete matrices). The aggregated price elasticities are generated by increasing the prices associated with each source eqiproportionally, ck. Hicks aggregation theorem. Starting with the aggregated

[11] The adult and child elasticities describe the change in demand when increasing the number of adult or children.

[12] Regarding unrecorded consumption, we have not much to rely on. However, the Engel elasticities are set equal to the recorded consumption for cross-border shopping, and halve this value for smuggling and tax-free shopping. It is probably reasonable to assume that activities as smuggling and tax-free shopping are less sensitive to income changes.

Table 3: Estimated (uncompensated) own-price elasticities for spirits, wine and beer in Norwegian studies

Source	Data	Spirits	Wine	Beer
Horverak (1977)	1960–1974, two months	–1.2	–1.5 (fortified), –0.7 (ordinary)	-
Horverak (1977)	1960–1970, annual	–1.2	–1.2 (fortified)	-
Strand (1993)	1974–1991, tertiary	–0.9	–1.3	-
Strand (1993)	1960–1991, annual	–1.2	–0.3	-
Econ (1999)	1970–1996, annual	–0.6	–1.1	–0.3
Bentzen et al. (1997)	1960–1994, annual	–0.53/ –0.47)	–0.92/ –1.06)	–0.39
Alver (2004)	1996–2004, monthly	–0.65	–0.54 (fortified)	-0.68
Aasness and Nygård (2014)	simulated, 2007	–1.14	–1.30	-0.83

elasticities we see that the price elasticity for wine is elastic (-1.1), while beer (-0.69) and spirits (-0.85) have inelastic demand. Moreover, tobacco (-0.33) and snuff (-0.78) are both inelastic. Turning to the detailed elasticities and recorded demand, all elasticities becomes higher in absolute value. This is as expected since we then open up for substitution between place of purchase. Spirits then becomes elastistic, and the magnitude of all the price elasticities for alcoholic beverages is within a reasonable range according to the above discussion. Note that those goods having the largest share of unrecorded consumption experience the largest difference between the aggregate and recorded own-price elasticity. For instance, for beer this difference is not so large as for spirits.

Recorded tobacco demand, which mainly consists of cigaretts, has an elasticity of –0.473. This is somewhat higher than the tobacco elasticity used in Aasness and Nygård (2014). However, this was an aggregated price elasticitiy for tobacco including snuff. The elasticity for snuff is given by –1.215. Judging this value is hard, since no empirical work is done on price elasticity for snuff in Norway, at least to our knowledge. However, it seems reasonable that snuff is more price sensitive than other tobacco products as this is consumed relatively more among young adults. This is also reflected in the higher estimated Engel elasticity.

We also report the effective tax rates measured as share of consumer price in Table 6. As we see, the tax shares are high, note in particular the tax on spirits.[13]

[13]These effective tax rates are computed from national account data and contain all indirect taxes.

Table 4: Own-price elasticities used in Norwegian studies

Source	Spirits	Wine	Beer	Alcoholic beverages
Rickertsen (1998)				–0.8
Skog et al. (1993)	–0.9	–1.3	–1.0	
Econ (1999)	–1.0	–1.0	–0.3	
Horverak et al. (2001)	–1.0	–1.1	–0.5	
Norwegian Ministry of Finance, 2002	–1.0	–1.0	–0.5	

Table 5: Estimated (uncompensated) own-price elasticities for tobacco in Norwegian studies

Source	Data	Elasticity
Amundsen (1963)	1952–1959	–0.60
Vegsund (1982)	1964–1980	–0.41
Bergh (1989)	1966–1988	–0.52
Hodne (1978)	1866–1910	–1.17
Wangen and Biørn (2001)	1975–1994	–1.70/–0.83
Nordvik (2020)	1990–2012	–0.39/–0.79
Aasness and Nygård (2014)	simulated, 2007	–0.42
Ministry of Finance, 2002		[–0.4, –0.5]

Table 6: Price elasticities, budget shares and tax rates in base year

	Own-price elasticity (uncompensated)	Engel elasticity	Effective tax rate as share of consumer price
Beer; aggregated	–0.693	0.799	
Beer; recorded	–0.761	0.807	0.594
Beer; cross-border sh.	–1.307	0.807	
Beer; duty-free home	–1.323	0.403	
Beer; duty-free abroad	–1.606	0.403	
Beer; smuggling	–0.680	0.403	
Wine; aggregated	–1.100	1.437	
Wine; recorded	–1.258	1.513	0.556
Wine; cross-border sh.	–1.833	1.513	
Wine; duty-free home	–1.286	0.756	
Wine; duty-free abroad	–1.893	0.756	
Wine; smuggling	–0.949	0.756	
Spirits; aggregated	–0.864	0.932	
Spirits; recorded	–1.077	1.008	0.801
Spirits; cross-border sh.	–1.678	1.008	
Spirits; duty-free home	–1.185	0.504	
Spirits; duty-free abroad	–1.914	0.504	
Spirits; smuggling	–0.870	0.504	
Tobacco; aggregated	–0.326	0.098	
Tobacco; recorded	–0.473	0.101	0.635
Tobacco; cross-border sh.	–1.744	0.101	
Tobacco; duty-free home	–1.190	0.050	
Tobacco; duty-free abr.	–1.968	0.050	
Tobacco; smuggling	–0.918	0.050	
Snuff; aggregated	–0.783	0.383	
Snuff; recorded	–1.215	0.403	0.428
Snuff; cross-border sh.	–1.742	0.403	
Snuff; duty-free home	–0.954	0.202	
Snuff; duty-free abroad	–2.223	0.202	
Snuff; smuggling	–0.945	0.202	

Source: KONSUM-G

Note: Aggregated price elasticity computed by increasing the price on sub-groups in the same proportions.

4 Results

We start by considering a reform scenario that implies abolishing duty-free shopping at Norwegian airports. Alcohol and tobacco sales are still allowed at the airports, but under the same tax regime as for recorded consumption. We simulate the reform by increasing the price on duty-free goods at airports up to the same price and tax level as the current recorded purchases. The estimated change in tax revenue and consumption is in essence a revenue gained method estimate (RGM) and will be compared to the more simple and mechanical revenue forgone method (RFM). The current consumption of alcohol and tobacco bought in duty-free shops in Norwegian airports are summarized in Table 7. In total, the duty-free consumption amounts to about 3.2 billion NOK. The duty-free sales' share of total consumption (recorded and unrecorded) differs substantially between goods. The share is higher for spirits (16%) and snuff (12%), more moderate for cigarettes (6%) and wine (7%) and almost neglectable for beer (1%). The different shares can probably be explained by larger price differentials compared to the tax-inclusive price for spirits and snuff (see Table 2 in Section 2), and the difference in the non-pecuniary cost of carrying the items, that is especially prominent for the alcoholic beverages, incentivizing buying spirits and/or wine instead of beer.

The effect on tax revenue from this reform consists of (at least) five components: First, the increased taxation raises revenue mechanically by the size of the tax rate increase. Second, the increased price on goods at the airports reduces demand for these goods. Third, there will be substitution from goods bought at Norwegian airports to duty-free shops at foreign airports, since these are considered close substitutes. Fourth, since the price of duty-free shopping has increased in general, there will be substitution towards other channels of purchase; registered consumption, cross-border shopping, and smuggling. Lastly, since the reform rises the cost of alcohol and tobacco in general, some substitution will be directed towards other goods. Since

Table 7: Baseline duty-free purchases at Norwegian airports

	Million NOK	Share of total consumption
Spirits	748	16%
Wine	1,014	7%
Beer	127	1%
Cigarettes	528	6%
Snuff	740	12%
Total	3,158	

Source: KONSUM-G

Table 8: Revenue effects using different estimation methods

	Tax revenue (mill. NOK)		
	RFM	RGM	RGM + spillover
Spirits	1 204	641	641
Wine	624	564	564
Beer	134	85	85
Cigarettes	793	483	483
Snuff	548	442	442
Other goods	-	-	-157
Total	3 303	2 215	2 058

Source: KONSUM-G

other goods also are taxed, this substitution will also affect tax revenue. The first effect is mechanical, while effect two through five are behavioral responses that alters the tax base. The latter four are explicitly modelled in our simulations.

In Table 8 the estimated effects on tax revenue from our simulation are compared to the RFM estimate, which is assuming no responses in the tax base when introducing the same tax regime as for the recorded consumption.[14] That yields a forgone revenue of about 3.3 billion NOK. In the latest Norwegian Official Report, 50% of the forgone revenue was assumed to be left as potentially increased tax revenue from the reform (NOU 2022:20, p. 453). This would mean about 1.65 billion NOK in increased tax revenue. Our simulations indicate that this might be a quite conservative estimate. We find that the forgone revenue is reduced by about 38%, when all behavioral responses are considered. Looking only at the goods directly affected, the increased tax revenue estimate is about 2.2 billion NOK, and about 2.1 billion when taking into account that the reform also alters demand for other indirectly taxed goods in the economy (spillover effect). The income effect dominates, making the spillover effect on tax revenue from other goods negative.

The behavioral response to the tax entails that a fraction of the consumption from the (previously) duty-free shops at Norwegian airports, moves to other channels of consumption. These effects are summarized in Table 9. As expected, the most profound effect is the change in purchases at airports. The demand for beer, spirits and tobacco products are reduced by between

[14]The effective tax rates for recorded consumption are 80% for spirits, 54% for wine, 57% for beer, 63% for cigarettes and 43% for snuff, measured as a share of the consumer price. The effective tax rates includes both the specific excises for alcohol and tobacco and VAT.

Table 9: Change in consumption from abolishing duty-free shopping at airports (1,000 liter/kg and %)

	Spirits		Wine		Beer		Cigarettes		Snuff	
	Liter	%	Liter	%	Liter	%	kg	%	kg	%
Airport sales	-1,648	-56%	-998	-16%	-2,194	-56%	-120	-61%	-95	-32%
Duty-free, abroad	1,005	107%	342	15%	1,722	64%	80	154%	8	138%
Recorded channels[a]	261	2%	406	1%	806	0.3%	44	2%	41	3%
Cross-border shopping	41	2%	58	1%	140	0.3%	6	2%	15	2%
Smuggling, home prod. etc.	6	1%	2	0,3%	4	0.2%	1	1%	1	1%
Total consumption	-334	-2%	-190	-0.2%	478	0.2%	10	0.3%	-31	-1%

Source: KONSUM-G

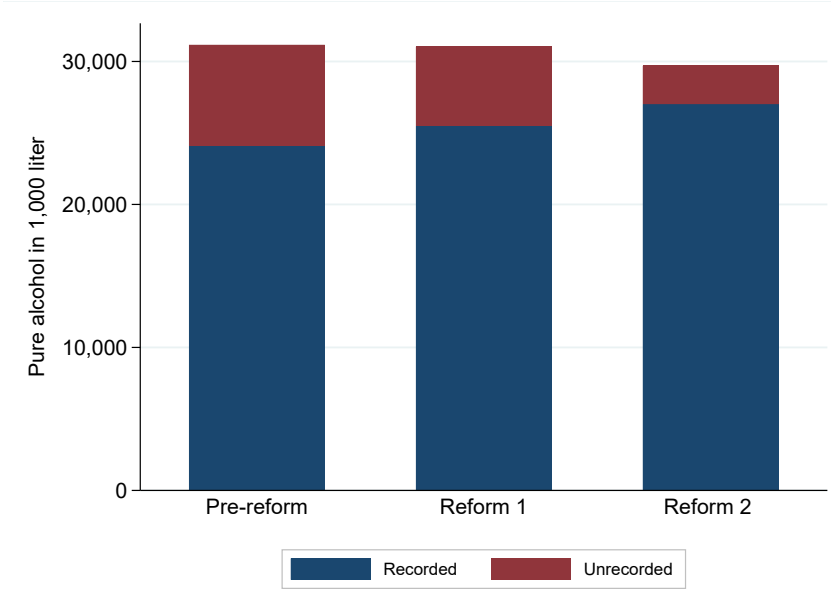
[a]Vinmonopolet, grocery shops etc.

32% and 61%. A more modest fall in demand for wine (16%) is due to the fact that the pre-reform price differential for wine was not very large, ck. Table 2. Since purchasing duty-free elsewhere, e.g. at foreign airports and airplanes, is the closest substitute, we experience a high increase in demand for these goods. Moreover, a slight increase in cross-border shopping is also observed, along with somewhat more being bought at through recorded channels (Vinmonopolet, grocery shops etc.). A slight increase in smuggling must also be expected. When adding up to see the effect on total consumption for each good, we see that total consumption drops for spirits (-2%), wine (-0.2%) and snuff (-1%). Since the reform affects the price structure, substitution takes place between different types of goods as well. Beer and cigarette consumption actually goes up due to such effects (0.2% and 0.3% respectively). Measured in pure alcohol, the total effect is a reduction, driven by the larger reduction in spirits.

We have also simulated a more radical reform scenario, in which both abolish duty-free shopping at airports and remove the personal allowances for Norwegian travelers as well and replace them with simplified declaration.[15] This invokes a price increase on all legal unrecorded purchases, and hence a much larger fall in demand for these purchases. The tax revenue estimate is about 6,5 billion NOK and reduction in total consumption of the five goods are ranging between 3 and 8%. Moreover, also in this reform scenario the RFM estimate is reduced by somewhat more than one third (35%) when behavioral responses are considered. Tables equivalent to Table 7 through 9 for the second reform scenario are available in Appendix A.

[15]Simplified declaration allows travellers to Norway, in addition to the duty-free personal allowence, to declare up to 27 litres of beer or wine, four litres of spirits, 400 cigarettes and 500 grams of tobacco, chewing tobacco or snuff for personal use. Taxes can be payed in a smartphone application. For details, see https://www.toll.no/en/goods/alcohol-and-tobacco/simplified-customs-declaration/

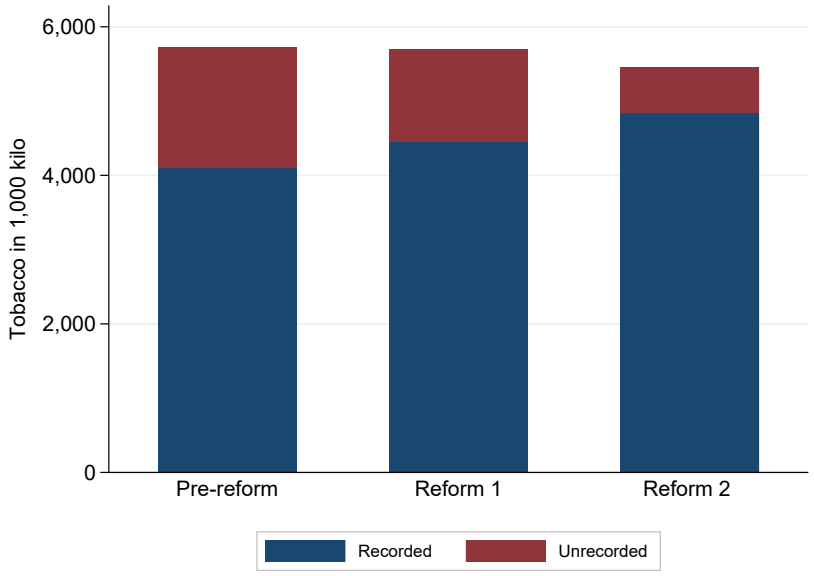
Figure 3: Consumption of pure alcohol, 1,000 liter



Source: KONSUM-G

In Figure 3 and 4 we summarize the effects of the reforms in terms of total consumption of pure alcohol and tobacco. We also show the composition in terms of recorded and unrecorded consumption. We see that the effect of the first reform on consumption of pure alcohol and consumption of tobacco are almost negligible, however, turning to the second reform the total consumption of alcohol measured in liter of pure alcohol and tobacco decreases by around 5%. We see a clear shift away from unrecorded sources for both reforms. In the first reform, unrecorded alcohol consumption measured in liter of pure alcohol drops by 21%, whereas unrecorded tobacco consumption falls by 24%. However, in the second, and more radical reform, unrecorded alcohol consumption measured in liter of pure alcohol and tobacco consumption are more than halved. Recall that unrecorded alcohol consumption stands for more than 20% of total consumption measured in liter of pure alcohol, whereas unrecorded tobacco consumption makes up for about 30% of total tobacco consumption. In our second reform alternative the share of unrecorded consumption is lowered to about 10%.

Figure 4: Consumption of tobacco, 1,000 kilo



Source: KONSUM-G

5 Conclusion

Our study highlights the relevance of using more comprehensive analyses for tracking the behavioral effects when reforms are targeted towards elastic tax bases. Although not directly comparable, estimates from the literature on dynamic scoring finds behavioral (dynamic) effects[16] with widely varying magnitude, ranging between 1% and 60% of static estimates (Bluestone and Bourdeaux, 2019; Barrios et al., 2019; Thoresen et al., 2010). These studies investigate effects of tax changes to major tax bases (income taxes, sales taxes, corporate taxes, property taxes, and social insurance contributions) while our results indicate that behavioral responses to minor tax bases might also be substantial, if the tax base is elastic.

Our main finding is that the reduction on the mechanical forgone revenue from the Norwegian duty-free arrangement might be smaller than previously assumed. While previous reports on the issue assumes not more than 50% of the forgone revenue could be raised, our estimates suggest that it is only reduced by 38%. The result is similar, both for the first reform scenario only affecting the airport sales, and for a more radical reform involving removal of the personal allowances, affecting goods bought at duty-free shops in Norway and abroad, and goods imported through cross-border shopping. While the

[16]These are sometimes referred to as "feedback effects" in the dynamic scoring literature.

Table 10: Externality-reducing effects from reduced alcohol consumption

	Reform 1	Reform 2
Δ Per capita pure liter annual alcohol consumption	-0.03	-0.33
Δ Total deaths	-9	-112
Δ Accidental deaths per 100,000 (men)	-3	-41
Δ Suicides (men)	-1	-15
Δ Homicides	0	-1
Δ Violence convictions	-9	-113
Δ Sick leave, share of total days per worker (men)	-0.02	-0.20

Note. Deaths and violence convictions are measured in absolute numbers.
Sick leave is measured as the percentage point change in the absent rate.

first reform has almost neglectable effects on overall consumption, the latter implies a significant reduction in total alcohol and tobacco consumption. Both reforms significantly reduce the fraction of unrecorded consumption.

The reduced consumption from the two reform scenarios might have some externality-reducing effects on public health and labor market outcomes. We have performed a few simple back-of-the-envelope calculations utilizing parameter studies for how the population-wide consumption of alcohol relates to total deaths, accidental deaths, suicides, murders, violence convictions, and sick leave.[17] The results are summarized in Table 10.

The reforms induce a reduction in total consumption per capita pure liter alcohol of 0.03 and 0.33 respectively. For the first reform, these numbers are associated with a reduction of nine annual alcohol related deaths in total, three of these from accidents and one suicide. Violence convictions fall by nine and the sick leave absenteeism reduced by 0.02 percentage points. For the more radical second reform scenario, more than ten times the reduction in alcohol consumption is estimated, which is associated with tenfold the reductions in deaths and labor market absenteeism compared to the first reform scenario.

As mentioned in Section 2, the existing Norwegian duty-free arrangement is an important source of income for Avinor, the state-owned airport company running all airports with international connections except one. In 2019, about 2.9 billion NOK (corresponding to one fourth of the company's operating revenue) came from sales and rents from the duty-free shops at the airports with international connections Avinor (2019, p. 81). Avinor does not receive subsidies from the government, and only a few of its forty-three airports are profitable. The profit from these airports is used to cover losses at the

[17]The parameter studies are referenced in Bergsvik and Rossow (2016, p. 25)

other airports, to maintain an infrastructure with airports across the country. In absence of the current income from duty-free, the losses would probably have to be covered by a subsidy (Ministry of Finance, 2016, p. 247). Our analysis shows that a moderate duty-free reform would not raise enough tax revenue to fully compensate the loss if all revenue associated with the current duty-free sales disappear in the reform scenario. Taking into consideration the value of alternative use of the space currently rented by the duty-free shops, and the value of the externalities from reduced alcohol consumption, is relevant in a complete cost-benefit analysis of abolishing the current duty-free arrangement. We leave for future research to perform this cost-benefit-analysis.

In this paper we have quantified the effects of hypothetical reforms concerning unrecorded alcohol and tobacco consumption in Norway, all within a comprehensive model framework consistent with standard consumer theory. The empirical model was calibrated by exploiting numerous sources, including information from both micro and macro data. By using this tool, we were able to keep track of numerous consumption effects associated with several goods from both recorded and unrecorded sources.

The model has some limitations worth mentioning. We must stress that by nature, data on unrecorded consumption and the behavioral parameters associated with such consumption are highly uncertain. The model could indeed benefit from better and more reliable consumption data, and more micro-econometric studies with focus on such behavior. Nevertheless, our analyzes reflect the best of knowledge taken from several sources, compiled in a systematic way, within a comprehensive model framework. In terms of this, it will hopefully provide a useful contribution to decision-makers and the discussion of reform effects with behavioral responses in elastic tax bases in general and in the Norwegian duty-free arrangement in particular.

References

Aasness, J., E. Biørn, and T. Skjerpen (1993). Engel functions, panel data, and latent variables. *Econometrica* (61), 1395–1422.

Aasness, J. and B. Holtsmark (1993). Consumer demand in a general equilibrium model for environmental analysis. Discussion paper 105, Statistics Norway, Oslo.

Aasness, J. and O. E. Nygård (2014). Revenue functions and Dupuit curves for indirect taxes with cross-border shopping. *Int Tax Public Finance* (21), 272–297.

Alver, Ø. O. (2004). Om pris og etterspørsel etter alkohol i Norge [Price and demand for alcohol in Norway]. SIRUS report (4), Oslo.

Amundsen, A. (1963). Konsumpriselastisiteter og konsumprisprognoser bygget på nasjonalregnskapet [Price elasticities and forecasts on consumer prices based on the national accounting]. Statistics Norway, Article 7, Oslo.

Arbeidsnotat 2017/10 (2017). Grunnlag for Finansdepartementets beregninger av skatter og avgifter [Method used by the Ministry of Finance when computing tax-revenue]. Ministry of Finance, Oslo.

Armington, P. S. (1969). A theory of demand for products distinguished by place of production. Staff papers- International Monetary Fund 16 (1), 159–178.

Asplund, M., R. Friberg, and F. Wilander (2007). Demand and distance: Evidence on cross-border shopping. *Journal of Public Economics 91*, 141–157.

Avinor (2019). Års- og samfunnsansvarsrapport 2019 [Annual report 2019].

Barrios, S., M. Dolls, A. Maftei, A. Peichl, S. Riscado, J. Varga, and C. Wittneben (2019). Dynamic scoring of tax reforms in the european union. *Journal of Policy Analysis and Management 38*(1), 239–262.

Beatty, T. K., E. R. Larsen, and D. E. Sommervoll (2009). Driven to drink: Sin taxes near a border. *Journal of Health Economics 28*(6), 1175–1184.

Bentzen, J., V. Smith, and N. Nannerup (1997). Alcohol consumption and drunken driving in the scandinavian countries. Working paper (91–1), Aarhus School of Business, Aarhus.

Bergh, M. (1989). Etterspørsel etter tobakk og tilpasningen til EF's indre marked i 1992 [Demand for tobacco and the adaption to EF in 1992]. Master's thesis, University of Oslo.

Bergsvik, D. (2015). Avgiftsfritt salg av alkohol og tobakk ved norske lufthavner [Duty-free sales of alcohol and tobacco at Norwegian Airports]. SIRUS report (6), Oslo.

Bergsvik, D. (2020). Alkoholomsetningen i Norge [Total sales of alcohol in Norway]. We received the underlying data for the web page from Bergsvik on request. Sometimes we refer to these.

Bergsvik, D. and I. Rossow (2016). En vurdering av virkningen av dagens taxfree-ordning. Utredning til Helse- og omsorgsdepartementet [An evaluation of the duty-free arrangement].

Blackorby, C., R. Boyce, and R. R. Russell (1978). Estimation of demand systems generated by the gorman polar form; a generalization of the s-branch utility tree. *Econometrica 46*(2), 345–363.

Blonigen, B. A. and W. W. Wilson (1999). Explaining Armington: What determines substitutability between home and foreign goods? *The Canadian journal of economics 32*(1), 1–21.

Bluestone, P. and C. Bourdeaux (2019, April). Dynamic Revenue Analysis: Experience of the States. Center for State and Local Finance Working Paper Series cslf1911, Andrew Young School of Policy Studies, Georgia State University.

Bratić, V. (2006). Tax expenditures: A theoretical review. *Financial Theory and Practice 30*(2), 113–127.

Christiansen, V. (1994). Cross-border shopping and the optimum commodity tax in a competitive and a monopoly market. *The Scandinavian journal of economics 96*(3), 329–341.

Christiansen, V. (2003, 01). Cross-border Shopping and Tax Structure. *Economic Policy Research Unit (EPRU), University of Copenhagen. Department of Economics, EPRU Working Paper Series*.

Christiansen, V. and S. Smith (2007). Optimal commodity taxation with duty-free shopping. *International tax and public finance 15*(3), 274–296.

Dom, R. and N. McCulloch (2019). What are 'Tax Expenditures' and How Big are Energy-related Tax Expenditures?

Econ (1999). Markedet for alkoholholdige drikker [The Market for alcoholic beverages]. Technical report, Oslo.

Facchini, G. and G. Willmann (1999). The gains from duty free zones. *Journal of international economics 49*(2), 403–412.

Friberg, R., F. Steen, and S. A. Ulsaker (2022, May). Hump-shaped cross-price effects and the extensive margin in cross-border shopping. *American Economic Journal: Microeconomics 14*(2), 408–38.

Frisch, R. (1959). A complete scheme for computing all direct and gross demand elasticities in a model with many sectors. *Econometrica 27*, 177–196.

Gemmell, N. and J. Hasseldine (2014). Taxpayers' behavioural responses and measures of tax compliance 'gaps': A critique and a new measure. *Fiscal Studies 35*(3), 275–296.

Haufler, A. (1996). Tax Coordination with Different Preferences for Public Goods - Conflict or Harmony of Interest? *Int Tax Public Finance 3*, 5–28.

Hodne, F. (1978). New evidence on the history of tobacco consumption in norway 1665-1970. *Economy and history 21*(2), 114–125.

Horverak, Ø. (1977). Etterspørselen etter brennevin og vin i Norge: en analyse av sammenhengen mellom omsatt kvantum og priser på brennevin og vin [Demand for spirits and wine in Norway: an analysis of the relation between quantities and prices on spirits and wine]. SIFA (9), Oslo.

Horverak, Ø., S. B. Nordlund, and I. Rossow (2001). Om sentrale deler av norsk alkoholpolitikk [Central parts of alcohol policy in Norway]. SIRUS report, Oslo.

Johansson, P., T. Pekkarinen, and J. Verho (2014). Cross-border health and productivity effects of alcohol policies. *Journal of Health Economics 36*, 125–136.

Kanbur, R. and M. Keen (1993). Jeux Sans Frontières: Tax Competition and Tax Coordination When Countries Differ in Size. *The American Economic Review 83*(4), 877–892.

Kesseing, S. G. and B. Koldert (2013). Cross-border shopping and the Atkinson–Stiglitz theorem. *Int Tax Public Finance 20*, 618–630.

Kvam, J. R. (2020). [Personal communication, March 17] Re: Presentasjon. [Jan Robert Kvam represents "Tobakkindustriens Felleskontor"].

Lavik, R. and S. Nordlund (2009). Norway at the border of eu – cross-border shopping and its implications. *Nordisk alkohol- & narkotikatidskrift : NAT 26*(2), 205–231.

Ministry of Finance (2016). Skatter, avgifter og toll 2017 (Prop. 1 LS (2016-2017)) [Taxes, fees and customs 2017].

Nielsen, S. B. (2001). A simple model of commodity taxation and cross-border shopping. *The Scandinavian journal of economics 103*(4), 599–623.

Nielsen, S. B. (2002). Cross-border shopping from small to large countries. *Economics letters 77*(3), 309–313.

Nordvik, K. (2020). Alkohol, tobakk og skattepolitikk (Alcohol, tocacco and tax policy). Master's thesis, Norwegian School of Economics, Bergen.

NOU 2003:17 (2003). Særavgifter og grensehandel [Excises and cross-border shopping]. Ministry of Finance, Oslo.

NOU 2007:8 (2007). En vurdering av særavgiftene [An evaluation of the excises]. Ministry of Finance, Oslo.

NOU 2015:15 (2015). Sett pris på miljøet [Environmental Pricing]. Ministry of Finance, Oslo.

NOU 2021:4 (2021). Norge mot 2025 [Norway towards 2025]. Ministry of Finance, Oslo.

NOU 2022:20 (2022). Et helhetlig skattesystem [A holistic tax system]. Ministry of Finance, Oslo.

OECD (2010). *Tax Expenditures in OECD Countries*.

Oslo Economics (2015a). Betydningen av konkurranse om å drive duty-free-handel ved norske flyplasser [The importance of competition in the bidding to become the duty-free operator]. Technical report, Oslo.

Oslo Economics (2015b). Etterspørselsvirkninger av å avvikle duty-free-ordningen [Demand effects from abolishing the duty-free arrangement]. Technical report, Oslo.

Rehm, J., M. Neufeld, R. Room, B. Sornpaisarn, M. Štelemėkas, M. H. Swahn, and D. W. Lachenmeier (2022). The impact of alcohol taxation changes on unrecorded alcohol consumption: A review and recommendations. *International Journal of Drug Policy 99*.

Rickertsen, K. (1998). The demand for food and beverages in Norway. *Agricultural economics 18*(1), 89–100.

Saez, E., J. Slemrod, and S. H. Giertz (2012). The elasticity of taxable income with respect to marginal tax rates: A critical review. *Journal of Economic Literature 50*(1), 3–50.

Samfunnsøkonomisk Analyse (2017). Utredning om avvikling av taxfree ordningen [An evaluation on abolishing the duty-free arrangement]. Technical report, Oslo.

Scharf, K. (1999). Scale economies in cross-border shopping and commodity taxation. *International tax and public finance 6*(1), 89–99.

Skog, O. J., Ø. Horverak, S. Nordlund, and T. Nordstrom (1993). Vurdering av konsekvenser av ulike endringer i omsetningsform og priser for alkohol i Norge [Evaluation of changes in prices and sales pattern for alcohol in Norway]. SIFA 4/93, Oslo.

Stafström, M. (2018). The impact of relaxed traveller allowances: Fixed-effects analyses of the associations between consumer behaviour and alcohol use. *Nordisk Alkohol- og Narkotikatidsskrift 35*(4), 275–287.

Strand, M. (1993). Pris og -inntektselastisiteter for brennevin og vin [Price and income elasticities for spirits and wine]. Master's thesis, University of Oslo.

Thoresen, T., J. Aasness, and Z. Jia (2010). The short-term ratio of self-financing of tax cuts: An estimate for norway's 2006 tax reform. *National Tax Journal 63*(1), 93–120.

United States Department of the Treasury (2023). Tax Expenditures. [Online; accessed 19-February-2023].

Vegsund, O. (1982). Tobakkskonsum og reklameforbud [Tobacco consumption and the prohibition of advertising]. Master's thesis, University of Oslo.

Wang, Y.-Q. (1999). Commodity taxes under fiscal competition: Stackelberg equilibrium and optimality. *The American economic review 89*(4), 974–981.

Wangen, K. and E. Biørn (2001). Individual heterogeneity and price responses in tobacco consumption: a two commodity analysis of unbalanced panel data. Discussion paper 294, Statistics Norway, Oslo.

A Appendix: A more radical reform scenario

Tables 11-13 describes the effects of a more radical reform in which both abolish duty-free shopping at airports (the first reform) and remove the personal allowances for Norwegian travelers as well and replace them with simplified declaration. This affects consumption from forreign airports and cross-border shopping, in addition to consumption from Norwegian airports.

Table 11: Baseline duty-free purchases at Norwegian airports, forreign airports and cross-border shopping

	Airports, Norway		Airports, abroad		Cross-border shopping	
	Million NOK	% of tot. cons.	Million NOK	% of tot. cons.	Million NOK	% of tot. cons.
Spirits	748	16 %	236	5 %	662	10 %
Wine	1 014	7 %	375	3 %	1 156	11 %
Beer	127	1 %	88	1 %	1 292	14 %
Cigarettes	528	6 %	140	2 %	1 176	11 %
Snuff	740	12 %	15	0,2 %	1 349	24 %
Total	3 158		855		5 635	

Source: KONSUM-G

Table 12: Revenue effects using different estimation methods

	Tax revenue (mill. NOK)		
	RFM	RGM	RGM + spillover
Spirits	2 768	1 539	1 539
Wine	1 857	1 207	1 207
Beer	1 490	905	905
Cigarettes	2 471	1 812	1 812
Snuff	1 402	1 040	1 040
Other goods			9
Total	9 988	6 503	6 512

Source: KONSUM-G

Table 13: Change in consumption from abolishing duty-free shopping at airports (1,000 liter/kg and %)

	Spirits		Wine		Beer		Cigarettes		Snuff	
	Liter	%	Liter	%	Liter	%	kg	%	kg	%
Airport sales	-818	-28 %	-208	-3 %	-1 234	-32 %	-74	-38 %	-87	-29 %
Duty-free, abroad	-507	-54 %	-838	-36 %	-362	-13 %	-15	-29 %	1	11 %
Recorded channels[a]	1 097	9 %	3 262	5 %	10 322	4 %	229	9 %	181	11 %
Cross-border shopping	-1 257	-68 %	-5 304	-53 %	-21 401	-48 %	-231	-66 %	-275	-45 %
Smuggling, home prod. etc.	27	5 %	17	2 %	50	2 %	3	5 %	2	5 %
Total consumption	-1 458	-8 %	-3 071	-3 %	-12 625	-4 %	-89	-3 %	-177	-7 %

Source: KONSUM-G

[a]Vinmonopolet, grocery shops etc.

B Appendix: Elasticities in KONSUM-G

Here we report elasticity matrices generated by our demand model. Table 14 presents a complete matrix of aggregated elasticities with respect to all goods exposed to unrecorded consumption, including food and non-alcoholic beverages. Alle other goods in the economy are aggreagated into the group 'Other goods'. The cross-price elasticities reflects the model structure and our utility tree in Figure 2, i.e. close substitutes get a high cross-price elasticities.

Note that the column sums in Table 14 are zero. They are weighted sums of the elasticities which follow from the consumer's budget constraint. Likewise, the row sums are all zero since the demand functions are homogeneous of degree zero in prices and total expenditure. This consistency with consumer theory makes it easy to test wether programming errors were made in the making of the model. Moreover, in Table 15 we report elasticities at a detailed level concerning alcohol and tobacco consumption.

Table 14: Aggregated price elasticities for food, beverages and tobacco

	ej.00	ej.03A	ej.03B	ej.03C	ej.03D	ej.03E	ej.04A	ej.04B	ej.OG	Sum
Food (00)	–0.184	–0.001	0.000	0.001	0.005	0.001	–0.003	0.000	-0.121	0.000
Coffe mv (03A	–0.009	–0.173	0.058	0.001	0.003	0.001	–0.002	0.000	–0.081	0.000
Mineral water (03B)	–0.019	–0.019	–0.278	0.002	0.007	0.002	–0.004	–0.001	–0.182	0.000
Spirits (03C)	–0.040	–0.002	–0.001	–0.864	0.226	0.132	–0.009	-0.002	–0.373	0.000
Wine (03D)	–0.061	–0.003	–0.002	0.117	–1.100	0.203	–0.014	–0.002	–0.575	0.000
Beer (03E)	–0.034	–0.002	–0.001	0.065	0.194	–0.693	–0.008	–0.001	–0.320	0.000
Cigaretts (04A)	–0.004	0.000	0.000	0.000	0.002	0.000	–0.326	0.269	–0.039	0.000
Snuff (04B)	–0.016	–0.001	–0.001	0.001	0.006	0.002	0.562	–0.783	–0.153	0.000
Other goods (OG)	–0.091	–0.003	–0.008	–0.003	–0.003	–0.007	–0.012	–0.005	–0.970	0.000
Sum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

Source: KONSUM-G, 2021

Table 15: Disaggregated price elasticities for alcohol and tobacco products

	ej.03CH	ej.03CC	ej.03CTH	ej.03CTF	ej.03CS	ej.03DH	ej.03DC	ej.03DTH	ej.03DTF	ej.03DS	ej.03EH	ej.03EC	ej.03ETH	ej.03ETF	ej.03ES	ej.04AH	ej.04AC	ej.04ATH	ej.04ATF	ej.04AS	ej.04BH	ej.04BC	ej.04BTH	ej.04BTF	ej.04BS
Spirits; recorded (03CH)	-1.076	0.075	0.042	0.013	0.012	0.212	0.021	0.009	0.003	0.001	0.130	0.012	0.001	0.000	0.000	-0.008	-0.001	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
Spirits; cr.-border sh (03CC)	0.676	-1.678	0.042	0.013	0.012	0.212	0.021	0.009	0.003	0.001	0.130	0.012	0.001	0.000	0.000	-0.008	-0.001	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
Spirits; duty-f. home (03CTH)	0.338	0.037	-1.185	0.336	0.006	0.106	0.010	0.004	0.002	0.000	0.065	0.006	0.000	0.000	0.000	-0.004	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
Spirits; duty-f. abr. (03CTF)	0.338	0.037	1.065	-1.914	0.006	0.106	0.010	0.004	0.002	0.000	0.065	0.006	0.000	0.000	0.000	-0.004	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
Spirits; smuggling. (03CS)	0.338	0.037	0.021	0.007	-0.870	0.106	0.010	0.004	0.002	0.000	0.065	0.006	0.000	0.000	0.000	-0.004	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
Wine; recorded (03DH)	0.103	0.011	0.006	0.002	0.002	-1.259	0.062	0.026	0.010	0.002	0.194	0.018	0.001	0.001	0.000	-0.013	-0.001	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	0.000
Wine; cr.-border sh. (03DC)	0.103	0.011	0.006	0.002	0.002	0.636	-1.833	0.026	0.010	0.002	0.194	0.018	0.001	0.001	0.000	-0.013	-0.001	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	0.000
Wine; duty-f. home (03DTH)	0.051	0.006	0.003	0.001	0.001	0.318	0.031	-1.286	0.357	0.001	0.097	0.009	0.000	0.000	0.000	-0.006	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
Wine; duty-f. abr. (03DTF)	0.051	0.006	0.003	0.001	0.001	0.318	0.031	0.964	-1.893	0.001	0.097	0.009	0.000	0.000	0.000	-0.006	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
Wine; smuggling (03DS)	0.051	0.006	0.003	0.001	0.001	0.318	0.031	0.013	0.005	-0.946	0.097	0.009	0.000	0.000	0.000	-0.006	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
Beer; recorded (03EH)	0.055	0.006	0.003	0.001	0.001	0.170	0.017	0.007	0.003	0.001	-0.761	0.055	0.003	0.002	0.002	-0.007	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
Beer; cr.-border sh. (03EC)	0.055	0.006	0.003	0.001	0.001	0.170	0.017	0.007	0.003	0.001	0.601	-1.307	0.003	0.002	0.002	-0.007	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
Beer; duty-f. home (03ETH)	0.027	0.003	0.002	0.001	0.000	0.085	0.008	0.003	0.001	0.000	0.301	0.028	-1.323	0.644	0.001	-0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Beer; duty-f. abr. (03ETF)	0.027	0.003	0.002	0.001	0.000	0.085	0.008	0.003	0.001	0.000	0.301	0.028	0.927	-1.606	0.001	-0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Beer; smuggling (03ES)	0.027	0.003	0.002	0.001	0.000	0.085	0.008	0.003	0.001	0.000	0.301	0.028	0.001	0.001	-0.680	-0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cigaretts; recorded (04AH)	0.000	0.000	0.000	33$_{0.000}$	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.474	0.101	0.023	0.006	0.010	0.213	0.048	0.013	0.000	0.002
Cig.; cr.-border sh. (04AC)	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.372	-1.744	0.023	0.006	0.010	0.213	0.048	0.013	0.000	0.002
Cigaretts; duty-f. h. (04ATH)	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.686	0.051	-1.190	0.282	0.005	0.107	0.024	0.006	0.000	0.001
Cigaretts; duty-f. abr. (04ATF)	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.686	0.051	1.060	-1.968	0.005	0.107	0.024	0.006	0.000	0.001
Cigaretts; smuggling (04AS)	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.686	0.051	0.011	0.003	-0.918	0.107	0.024	0.006	0.000	0.001
Snuff; recorded (04BH)	0.001	0.000	0.000	0.000	0.000	0.006	0.001	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.537	0.040	0.009	0.002	0.004	-1.069	0.187	0.049	0.001	0.007
Snuff; cr.-border sh. (04BC)	0.001	0.000	0.000	0.000	0.000	0.006	0.001	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.537	0.040	0.009	0.002	0.004	0.827	-1.709	0.049	0.001	0.007
Snuff; duty-f. home (04BTH)	0.001	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.268	0.020	0.004	0.001	0.002	0.414	0.094	-0.949	0.027	0.003
Snuff; duty-f. abr. (04BTF)	0.001	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.268	0.020	0.004	0.001	0.002	0.414	0.094	1.301	-2.223	0.003
Snuff; smuggling (04BS)	0.001	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.268	0.020	0.004	0.001	0.002	0.414	0.094	0.025	0.001	-0.945

Source: KONSUM-G, 2021