Finnish alcohol policy at the crossroads:

The health, safety and economic consequences of alternative systems to manage the retail sale of alcohol

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Executive Summary

Background

The partial Finnish alcohol monopoly, Alko, currently manages the retail sale of 40% of all the alcohol purchased in Finland, while nearly half (46%) is sold in grocery stores and the remainder in bars and restaurants. Over the past few decades, alcohol policy in Finland has seen a series of moves from government to more private ownership of retail alcohol sales, most recently on January 1, 2018 with an increase in the permitted strength of alcohol sold in grocery stores from 4.7% to 5.5% alcohol by volume (ABV). Recent data indicate that the downward trend in Finnish alcohol consumption recorded since 2010 reversed during 2018 with a small increase being observed, despite a simultaneous increase in alcohol taxation.

Objectives

In this report we present empirical evidence and analyses in order to inform public discussions regarding the future of alcohol policy in Finland, with particular attention to the role of the now partial government monopoly on retail sales of alcohol. We present estimates of the main health, social and economic consequences of alcohol consumption in Finland, applying methods developed in recent international studies. We then estimated how policies (e.g. prices, numbers of stores), alcohol consumption and then alcohol caused harms and costs would change under two contrasting scenarios recommended as being useful comparisons by Finnish and other Scandinavian experts, from both government and academia:

Scenario 1: Finland adopts policies similar to those in neighbouring Sweden with Alko responsible for all retail alcohol sales for beverages with more than 3.5% ABV while also having fewer stores and shorter trading hours.
Scenario 2: Finland abolishes Alko and permits the sale of all alcoholic beverages in all grocery stores.

Methods

(i) Estimating the health and social harms of alcohol use

We accessed comprehensive Finnish datasets to identify alcohol caused deaths, hospital admissions and crimes for the most recent year available. In addition to those directly recorded in medical or police records as being 100% alcohol caused, we used established international methods to estimate the likely proportions of other health or crime events that alcohol is known to have partly caused. These methods relied on a number of Finnish datasets including national surveys of alcohol use and studies of alcohol's involvement in violent crimes. In order to estimate lost productivity in the workplace due to alcohol we used Finnish registry data and then applied the Human Capital approach to estimate the impacts of premature deaths caused by alcohol (1-5). This involved a) the estimation of the number of productive years of life lost from premature alcohol caused death and disability up to the age of 65, and b) using surveys to estimate the extent of unemployment due to long-term disability.

(ii) Estimating the economic costs of alcohol use

Estimates of the economic costs of alcohol use were made for hospital admissions, crimes and years of productive life lost. Data were obtained on typical costs of hospital admissions according to main categories of illness or injury, the costs of policing, court time and imprisonment per crime event or person and the average economic value of one year of full-time work. Costs were calculated in terms of euros for the year 2018.

(iii) Estimating the impact of alternative policy scenarios

Key alcohol policies with implications for public health and safety of relevance to the operations of government alcohol monopolies were selected, from comprehensive international reviews of the impacts of policy changes both in Scandinavia and other developed countries. The policy dimensions of outlet density, days and hours of alcohol sale, and mean and minimum prices were selected as having the most impact on consumption and related harms. We used published studies from Finland and other developed countries to estimate the amount of impact each predicted policy change would be expected to have on per capita alcohol consumption, with all other factors remaining unchanged. We also used official estimates of travelers' imports to Finland and other unrecorded alcohol consumption over the years to estimate the size of compensatory effects in unrecorded consumption when there are changes in officially recorded consumption.

Two alternative methods were then employed to assess the impacts of the estimated alcohol consumption changes under each scenario on alcohol-related harms and economic costs. Firstly, we used the International Model of Alcohol Harms and Policies (InterMAHP) (6), an open access alcohol harms estimator and policy scenario modeller, which requires local data on levels and patterns of alcohol consumption to estimate the proportion of observed hospital admissions and deaths in a country that are attributable to alcohol. The second method relied on statistical relationships assessed between per capita alcohol consumption and key outcomes such as deaths registered as alcohol-caused, violent crimes and deaths due to injuries over the period 1995 to 2016 in Finland. This second method employed a time series analysis, with seasonal adjustments, known as Auto Regressive Integrated Moving Average, or ARIMA modelling.

Main Findings

Harms and economic costs from alcohol in 2018

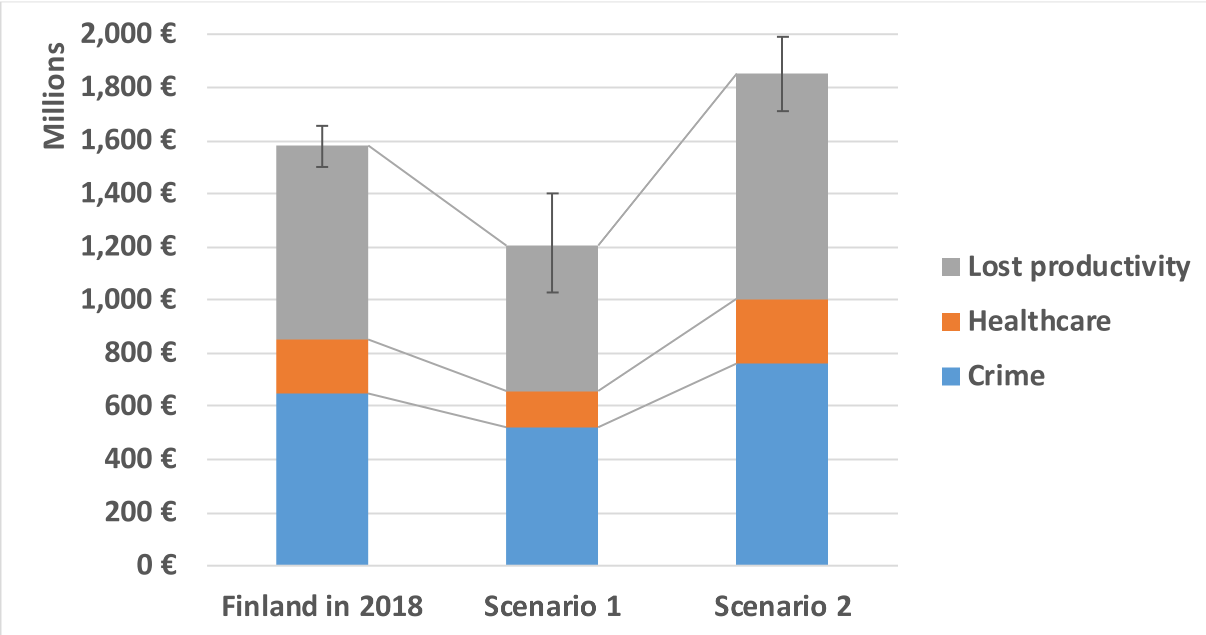
We estimated that, in 2018, alcohol consumption in Finland was responsible for 4 071 deaths, 17 101 productive years of life lost, 46 016 hospital admissions, 2 799 persons unable to work because of a disability and 234 621 crimes reported to police (see Table 1 below). The total economic costs of these outcomes were estimated to be €1.6 billion. This estimate does not include the costs of emergency department presentations, visits to family doctors, day surgery hospital visits or related prescription drugs or the individual quality of life losses from alcohol-caused death and disability. A summary of these economic costs by category is provided in Figure 1 below for Finland in 2018 and also under two alternative policy scenarios.

Table 1: *Summary of estimated impacts on mortality, healthcare, productivity and criminal justice system in Finland, 2018 of different alcohol policy scenarios using InterMAHP and other attributable fraction methods*

Alcohol attributable outcomes	***Finland in 2018***	***Scenario 1*** *Only <3.5% beer in grocery stores*		***Scenario 2*** *All alcohol sold in grocery stores*	
	Estimate *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*
Total per capita consumption	**10.45L***	**-1.65L**	**-15.8%** (-19.7%, -11.8%)	**+0.94L**	**9.0%** (+6.2%, +11.8%)
Deaths	**4 071** (3 402, 4 711)	**-855** (-1 360, -340)	**-21%** (-33.4%, -8.4%)	**+556** (+35, +1 084)	**+13.7%** (+0.9%, +26.6%)
Productive years of life lost	**17 101** (15 769, 18 254)	**-3 901** (-5 021, -2 732)	**-22.8%** (-29.4%, -16.0%)	**+2 283** (+1 268,+3 313)	**+13.4%** (+7.4%, +19.4%)
Hospital admissions	**46 016** (40 548, 51 366)	**-14 659** (-18 972, -10 029)	**-31.9%** (-41.2%, -21.8%)	**+10 035** (+4 757, +15 793)	**+21.8%** (+10.3%, +34.3%)
Long-term disability cases	**2 799** (2 754, 2 842)	**-1 091** (-1 323, -836)	**-39.0%** (-47.3%, -29.9%)	**+802** (+517, +1 146)	**+28.6%** (+18.5%, +40.9%)
Police-reported crimes	**234 621** *(233 748, 235 383)*	**-51 741** *(-89 135, -8 944)*	**-22.1%** *(-38.0%, -3.8%)*	**+32 586** *(+8 259, +53 809)*	**+13.9%** *(+3.5%, +22.9%)*
Economic Costs (Euros, millions)	**€1 582** *(€1 500, €1 655)*	**-€377** *(-€554, -€181)*	**-23.8%** *(-35.0%, -11.4%)*	**+€271** *(+€129, +€409)*	**+17.1%** *(+8.1%, +25.8)*

* Estimated total recorded plus unrecorded consumption based on recorded sales data available in September, 2018 and assuming same unrecorded consumption as in 2017 (2.01L/per person aged 15+)

Figure 1: *Estimated economic costs from alcohol in Finland for 2018 and how these would vary under more restrictive (Scenario 1) or liberal (Scenario 2) policies*



Harms and economic costs with Swedish-style alcohol policies (Scenario 1)
Were Finland to have employed policies more protective of public health and safety such as those in neighbouring Sweden, we estimated that per capita alcohol consumption would decrease by 16%, alcohol attributable deaths and hospitalisations by 21% and 32% respectively while economic costs would be reduced by €377 million. The time series analysis of Finnish data (shown in Results section later in the report) also projected reductions in alcohol-related harms of similar magnitude, specifically Scenario 1 would result in a 39% reduction in deaths directly caused by alcohol, a 12% reduction in suicides, a 9% reduction in injury mortality and a 23% reduction in assaults reported to the police.

Harms and economic costs with all alcohol sold in grocery stores (Scenario 2)
By contrast, it was estimated that the full privatisation of the retail sale of alcohol in Finland would result in substantial increases in the physical availability of alcohol, such as the number of outlets and hours of sale, and reductions in both mean and minimum prices. We estimated that this liberalised policy scenario would have resulted in a 9% increase in total per capita alcohol consumption in 2018, causing an additional 556 deaths, 2 283 productive years of life lost, 10 035 hospital admissions, 802 persons unable to work because of a disability and 32 586 more police-reported crimes, at a total additional cost of €271 million. The ARIMA analysis of observed relationships between alcohol use and harm in Finland since 1995 predicted that abolishing Alko would have resulted in 22% more alcohol-related deaths, 5% more suicides, 4% more injuries and 10% more assaults (shown in Results section).

Limitations and uncertainties

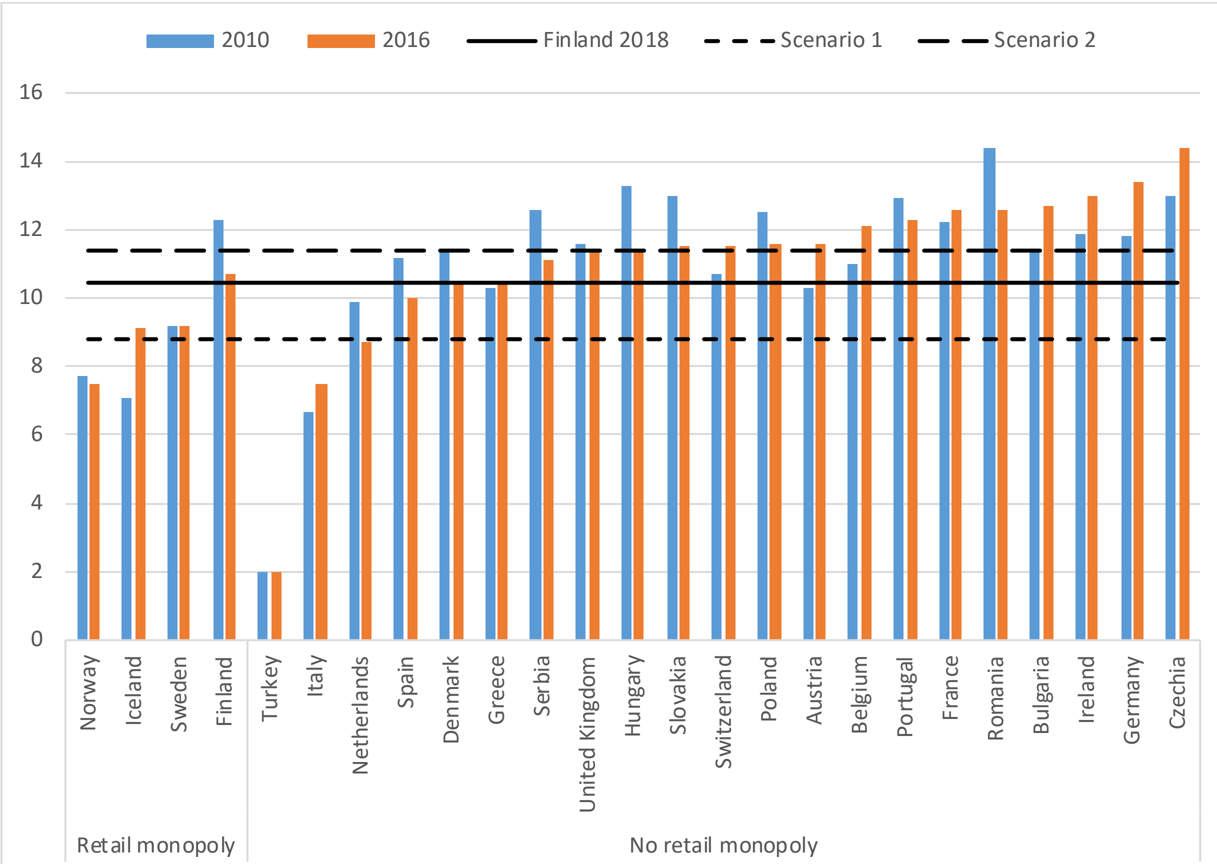
It was necessary to make several key assumptions to create these estimates. We first assumed that there were no other changes to policy, social life or the economy in Finland other than the modelled policy changes. While we based our estimates on large national data sets from surveys, health and police records for a recent year in Finland, it was necessary to assume that some relationships between predicted policy changes, alcohol consumption and related harms would follow similar patterns to those observed on average in other countries and at different points in time.

We have also assumed that the estimated impacts on alcohol consumption of each of the policy changes were additive i.e. we added the effects of pricing changes to those of changes in density and the number of days and hours of trading. Alternative assumptions could have been used e.g. the net effect of each these simultaneous policy changes was multiplicative (i.e. greater than simply additive), or that combining several policy changes leads to a weaker or decaying overall effect than each change would achieve on its own (i.e. it is less than additive). We also note a number of ways in which our estimates may be conservative as we did not attempt to include such effects as less effective restrictions on sales to underage customers in private stores, or the potential impact on sales of an increased level of convenience of access were alcohol to be made available in general grocery stores instead of specialty stores.

We have provided 95% confidence intervals around the exact numbers reported above i.e. upper and lower limits around the estimates within which we have 95% confidence that the true value falls. We have also conducted a series of "sensitivity analyses" which test the impact of differing assumptions such as the strength of the effect of one of the key policies (alcohol prices) or the relationship between the alcohol consumption and important health outcomes like coronary heart disease. These alternative assumptions had mostly minor impacts on our estimates of changes in alcohol consumption and related harms in each policy scenario. Furthermore, they did not change the direction of these estimated changes or any of our main conclusions.

As one validation test of our estimates of changes to per capita alcohol consumption in Scenarios 1 and 2, we compared these against WHO estimates of alcohol consumption among European countries with and without government alcohol monopolies (see Figure 2) (7) . In 2016, Finland had an intermediate level of consumption, similar to Denmark, Greece and Spain. Under Scenario 1 we estimate Finland would have similar consumption to that of Sweden, Iceland and Italy in 2016. Under Scenario 2 we estimate similar consumption to Poland, Slovakia, Hungary, Serbia, Switzerland, the UK and Austria in 2016. Our estimates of per capita alcohol consumption in each scenario are broadly comparable with two other alcohol monopoly countries for Scenario 1 and with many fully privatised countries for Scenario 2.

Figure 2: *Total alcohol consumption (recorded + unrecorded, litres per year) per capita (15+years of age) for 25 European countries compared with Finland with alternative policies*



Conclusions

Our findings are consistent with the general principle that the fewer restrictions placed on an retail alcohol market, the more efficient it becomes at delivering convenient and affordable alcohol to the population. This is done by driving down prices, increasing consumers' ease of access, and efficiency of the retail system; having the collective effect of driving up consumption. While many people in Finland may greatly value more convenient access to affordable alcohol, it is important to also be aware that this will come at the cost of increased alcohol related harms and economic costs.

There has already been extensive liberalisation of alcohol policy in Finland. However, our modelling predicts that complete privatisation of alcohol sales would still result in substantial increases in serious alcohol related health and social harms, as well as in economic costs.

The Finns and their decision makers have to weigh the benefits of better access and lower prices for alcohol against the strong evidence that this will lead to increasing alcohol related harms and economic costs. The two alternatives considered in our report of (i) Finland with similar alcohol policies as in Sweden, and (ii) Finland without an alcohol monopoly, differ by hundreds of deaths and, also, hundreds of millions of euros each year. We suggest that the public debate and decision makers in Finland take this into account when considering the future of alcohol policy in Finland.

Should it be decided by the Finnish people to reduce the harms and economic costs of alcohol use, then the following actions are suggested:

1. Retain the Finnish alcohol monopoly as, once it is disbanded, it will become much harder to influence the alcohol market in a way that will reduce the costs and harms from alcohol.
2. Increase some restrictions on price and availability, for example by adopting some of Sweden’s alcohol policies.
3. Consider introducing a "minimum unit price” (e.g. €1.00 per Finnish standard drink) and/or increasing alcohol taxes.
4. Reverse the trend towards longer hours of trading and greater numbers of outlets that currently sell alcohol e.g. gas stations, kiosks, grocery stores;
5. Continue to monitor levels of alcohol consumption, related harms and economic costs to help inform decision-makers and the wider community as to how best to minimise harms from alcohol use in Finland.

Introduction

The aims of this report are to estimate, firstly, the current impact and costs of alcohol-related harm in Finland and, secondly, how these would likely change under either more government or more private ownership of the retail alcohol market. To estimate the economic costs of alcohol for Finland we have followed international guidelines for such studies (1) and applied methods used in two other formal economic costs of substance use studies from other developed countries (2, 8). We focus in particular on the possible future role of the government alcohol monopoly, Alko, with a view to informing the continuing public debate about its role and potential contributions to protecting public health and safety. Our estimates of alcohol's contribution to health and crime outcomes were based upon the latest available statistical datasets and a large body of international research on how different levels of alcohol consumption are associated with risks of serious disease and injury in developed countries. Wherever possible, we have drawn directly from studies of past Finnish policy experiments to estimate how policy changes impact population levels of alcohol consumption, or when Finnish studies or data were not available, we have based assumptions upon the best available international studies. There are of course uncertainties at each stage in such a modelling study and we have tried to identify these and illustrate how some of the largest uncertainties affect our estimates of policy impact on the outcomes of interest.

Our report follows and extends methods applied in a similar previous study which evaluated the potential impact of privatising Sweden's government alcohol monopoly, Systembolaget (9, 10). That study estimated the impacts of two liberalisation scenarios involving replacing Systembolaget with alcohol sales in either specialty private liquor stores or in all grocery stores. The present report contrasts outcomes were Finland to either (i) have greater public ownership with stricter alcohol controls similar to those currently in place in neighbouring Sweden, or (ii) abolish Alko and permit the sale of all types of alcoholic beverages in all grocery stores.

The study team comprised alcohol policy, public health and health economics researchers with specific experience of research on the effects of privatising government monopolies, of epidemiological research on patterns of drinking and related harm, of economic cost studies and mathematical modelling of alcohol policy impacts.

Before describing our methods and results in detail, we will provide some context, both for Finnish alcohol policy in general and for the role of Alko in particular.

The Finnish alcohol monopoly system

Finland's government alcohol retail monopoly, Alko, was established in 1932 after the prohibition of alcohol was overturned in a national referendum. Alko's present mission is to manage the retail sales of all alcoholic beverages containing alcohol more than 5.5% ABV (alcohol by volume) (4.7 percent till the end of 2017) while minimising the harm caused by alcohol consumption (11). In 2017, Alko operated a network of about 360 stores and 60 internet store pick-up points to serve a population of 5.5 million inhabitants. Around 5 000 other retailers, mostly grocery stores, sell alcoholic beverages containing alcohol less than 5.5% ABV of volume. Alko operates under the control of the Ministry of Social Affairs and Health.

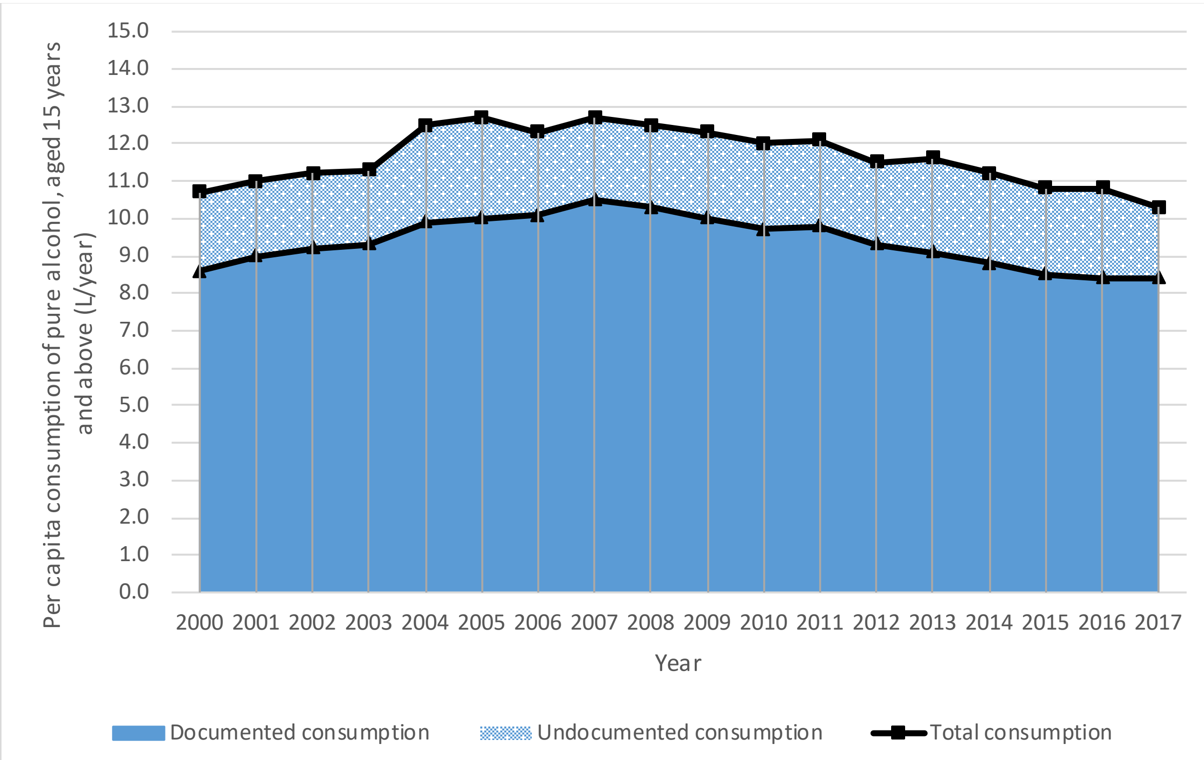
Alko implements a similar range of restrictions to the Norwegian monopoly, whilst neighbouring Sweden has a more comprehensive monopoly than Finland, covering all types of alcoholic beverages containing more than 3.5% ABV. Sweden also has fewer stores per 10 000 residents and shorter trading hours. In Finland, about 40% of all alcoholic beverages were sold through monopoly stores before the liberalisation at the start of 2018, compared with 100% for Sweden for drinks >3.5% ABV. However, unlike in Sweden, Alko doesn't deliver alcoholic beverages to consumers' homes. In all monopoly countries, there are age limits for purchases of alcohol and restrictions on opening hours. In Finland, no alcohol sales are permitted to people under 18 years of age and, further, no sales are permitted to those under 20 years of age of beverages containing more than 22% alcohol by volume (12). From January 2018 onwards, Alko store opening hours were increased to 9 a.m. to 9 p.m. from Monday till Friday, and from 9 a.m. to 6 p.m. on Saturdays. Some smaller stores have shorter opening hours from Monday to Thursday.

Finnish alcohol consumption and related harm

The first two decades of the 21st century saw significant changes in Finnish per capita alcohol consumption. Since the 1930s, a trend of increasing alcohol consumption has dominated the picture, with brief downturns during wars and economic recessions. In the early 2000s, Finland experienced a strong economic boom along with a substantial decrease in alcohol taxes in 2004. This resulted in increased alcohol consumption, which by 2007 was at an all-time high of 12.7 litres per capita for the population over 14 years of age. Since the financial crisis of 2008 and amplified by several smaller alcohol tax increases, consumption has been in decline (13-16) (see Figure 3 below).

The earlier Figure 1 in the executive summary identifies Finland in 2016 as having an intermediate level of total per capita alcohol consumption compared with other European countries when both recorded and unrecorded sources are considered. Finnish per capita alcohol consumption was higher in 2016 than the other Scandinavian alcohol monopoly countries, Norway, Sweden and Iceland.

Figure 3: *Trends in recorded, unrecorded and total alcohol consumption (litres 100% alcohol) in Finland, 2000 to 2017*

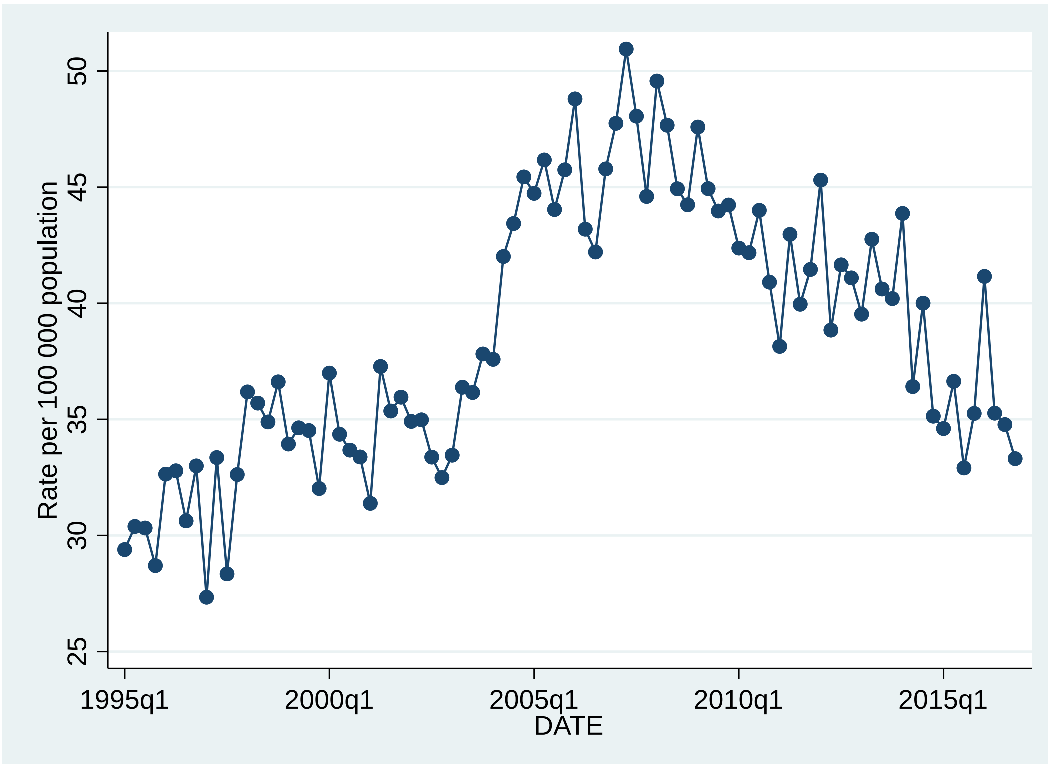


Source: National Institute for Health and Welfare (THL)

These trends are also partly reflected in data from national self-report surveys of alcohol consumption patterns, with increasing trends before the financial crisis and decreases thereafter (13, 17-19) , with an even longer trend of increasing abstinence among young people. Since 2000, there has also been a decrease in the occurrence of heavy episodic drinking, a pattern that has been a strong feature of past Finnish drinking (13, 17, 18).

Drinking among young adults (age 20 to 24 years) has remained stable with around 90% being current drinkers since 2011, while consumption among older people, above 65 years, has increased. According to Statistics Finland, alcohol-related mortality increased in the 2000's until 2007 but has since decreased (see Figure 4). Estimated hospital stays for alcohol-related illnesses steadily decreased between 2007-2011 and have since remained stable (13). These patterns are broadly consistent with the changes in national per capita alcohol consumption described above (13).

Figure 4: *Alcohol mortality (causes of death that are 100% alcohol attributable). Rate per 100 000 population aged 15 years and above, quarterly data*



Source: Statistics Finland

Historical policy changes

In the long history of Alko and Finnish alcohol control policies, one of the most decisive turning points occurred with the reforms of 1969. These extended the sales of "medium strength beer" (alcohol below 4.7% ABV), which were formerly restricted to monopoly stores and licensed restaurants, to grocery stores and cafes. This created thousands of new liquor outlets providing more opportunities to purchase alcohol in cities and also in rural areas that formerly did not have alcohol retail stores.

The 1969 reforms saw a dramatic increase in age 15+ per capita alcohol consumption from 2.88 to 4.12 litres in the first year alone, with strong growth continuing for the next 5 years. Alcohol consumption approximately doubled by the mid-1970s and trebled by the year 2000. The public health and safety outcomes of this dramatic policy experiment were documented in 1975 in the internationally influential book, "Alcohol control policies in a public health perspective" by a Finnish-led international research group (20). This book first introduced what is now known as the "total consumption model" for alcohol policies which supports the idea that an alcohol monopoly can contribute to improved public health outcomes by controlling the population's total consumption of alcohol. Finland's joining of the European Union in 1995 led to some extensive challenges for this model of retailing and controlling the sale and distribution of alcohol. After years of negotiations, it was finally concluded that a retail monopoly was compatible with EU-legislation provided that it did not discriminate against products from other EU countries. However, other aspects of the earlier Alko monopoly concerning the manufacture, distribution and on-premise retail sales (e.g. in restaurants) had to be privatised. Another important change was that the 1995 reforms permitted the introduction of alcoholic beverages produced through fermentation (<4.7%). This introduced cider and long drinks into grocery stores, contributing to an increase in total consumption of about 8% in five years (21). Another significant Finnish alcohol policy change was a major reduction of alcohol taxes in 2004, prompted by Estonia joining the EU and the abolition of import quotas for alcohol between the two countries. This has since been followed by a series of relatively small increases.

Recent policy changes

After a long and sometimes intense political debate, a new Alcohol Act was approved in December 2017 (12, 22). Most of its provisions were enacted in two stages in 2018, on 1 January and then March 1, and contributed to further liberalisation of the alcohol market. Of most public health significance, from 1 January stores outside the Alko monopoly were newly permitted to sell all alcoholic beverages up to a strength of 5.5% ABV. Previously, the limit was 4.7% ABV and only beverages that were based on fermentation could be sold in grocery stores. Significantly, the new law legalized the sale of alcopops, such as spirits-based long drinks, in non-Alko stores. The reform was greeted by many of its proponents as a step in the direction of increasing liberalisation with hopes of further steps to be taken within the next decade or so. Also, commercial interest groups saw many advantages in the new legislation. On the other hand, many health experts expressed concern about the potential for increased consumption and resultant health problems as a consequence of the act.

It was recently reported that alcohol sales only increased by about 1% in 2018 compared with 2017 (23), a figure lower than some commentators had predicted for total effect, but a clear change from the recent declining trends. However, it is not yet possible to make a judgement on the final impact of the policy change on the basis of just one year. In particular, the policy change was accompanied by an increase in the rate of alcohol taxation which may have dampened the immediate effects of increased availability in grocery stores on consumption. It is not possible to isolate and precisely estimate the effects of a policy change observed in just one year without certain knowledge of all the other social and economic trends plus other policy changes. It is possible either that the new policy only had a very limited effect or that it reversed a declining trend despite the dampening effect of an increased alcohol tax.

Previous studies of changes to government alcohol retail monopolies

As discussed above, the partial privatisation of Alko in 1969 was estimated to have resulted in a an increase in per capita alcohol consumption of more than 50%, a change largely driven (86% of the change) by medium-strength beer sales (24).

Medium strength beer with an ABV of between 3.5% and 4.5% was first introduced in Sweden in 1965 and was permitted to be sold in grocery stores up until 1977 when it was withdrawn. A study by Noval and Nilsson (25) showed that the introduction of medium beer contributed to an increase in the total alcohol sales figures by approximately 15% between 1961 and 1977. A later study in Sweden examined the effects of the removal of medium strength beer from grocery stores in 1977 (26). The authors identified a number of positive outcomes resulting from the re-monopolisation, including decreases in suicides, falls and motor vehicle collisions.

The United States Centers for Disease Control and Prevention (CDC) conducted a systematic review of partial privatisations of government alcohol retail monopolies, including events to the end of 2010 (27). This comprehensive review found 17 studies of 12 privatisation events, including the above event in Finland, events in seven U.S. states and in two Canadian provinces. The median increase in per capita sales of privatised beverages was 44.4%, ranging from 0% to 305%. Some of the studies additionally assessed the change in per capita sales of the non-privatised beverages; however, this median 2.2% decrease was not large enough to offset the increase in the privatised portion of alcohol sales. The study concludes that there was strong evidence that partial privatisation events lead to increases in total alcohol consumption.

More recently, a series of three articles studied the partial privatisation of the government alcohol retail monopoly in British Columbia, Canada (28-30). These studies concluded that an increasing proportion of liquor stores in private ownership assessed across 89 local health regions was associated with increased overall per capita alcohol consumption (28) and, further, with increased alcohol-attributable deaths (30) and hospital admissions (29). In the latter study, this relationship held after controlling for changes in alcohol pricing policies.

Several members of the authorship group responsible for this report previously modeled the effect of a full privatisation of Sweden's alcohol retail monopoly, Systembolaget (10), under two scenarios: retail sales of alcohol in specialty private liquor stores or all grocery stores. In the first scenario, it was estimated that disbanding Systembolaget would be associated with a 20.0% increase in per capita consumption, a 41.4% increase in alcohol-attributable (AA) deaths and a 22.2% increase in AA hospital stays (10). In the grocery store scenario, it was estimated that a 31.2% increase in drinking would lead to 76% more AA deaths and 42% more AA hospital stays.

The literature studying alcohol retail monopolies and related policies is clear: the privatisation of government monopolies has almost invariably led to higher per capita alcohol use, and to increased rates of alcohol-attributable harms.

Opportunity created by a new model for estimating alcohol-attributable harms and the impact of alcohol policy changes

The ease with which it is now possible to estimate the impact of changes in a population's alcohol consumption (e.g. as a result of policy changes) has recently been greatly increased by the development of a new open access resource, the International Model of Alcohol Harms and Policies [InterMAHP], a modelling tool developed by members of the research team (6). This was used in combination with an alternative approach based on ARIMA time series modelling which allowed us to compare results obtained from these two methods to help assess their robustness.

InterMAHP builds on developments by Dr Jürgen Rehm and colleagues for estimating alcohol-attributable burden of disease, initially for the World Health Organization's (WHO) Global Burden of Disease studies and now the WHO Global Status Reports on Alcohol and Health (31, 32). We applied new methods developed to estimate the "distribution" of drinking in a population using both population surveys and, typically, estimates of per capita alcohol consumption based on official sales or taxation data. Importantly, research examining patterns and levels of alcohol consumption in surveys from more than 60 countries shows that the proportions of low, medium and heavy drinkers in any population follow a specific type of distribution (known as the 'gamma' distribution). This means the numbers of people drinking at different consumption levels can be accurately predicted when only the total per capita consumption and the number of current drinkers are known (33). InterMAHP also takes account of the number of people reporting they are occasional heavy consumers of alcohol in national surveys of the country in question.

InterMAHP extends these principles with technical advances described in the Methods section of the present report in order to estimate changes in alcohol-attributable harm for a predicted change in the total consumption of alcohol (6). InterMAHP is a new, open access (www.intermahp.cisur.ca) resource, which assists international alcohol research groups in estimating AA harms and alcohol policy impacts. Employing this automated resource has made calculation of these estimates considerably more efficient and less data intensive.

Additionally, we provide an alternative methodological approach to estimate changes in AA mortality and crime by applying ARIMA time series analyses to identify relationships over the decades in Finland between per capita alcohol consumption and these outcomes, as also performed in the earlier Swedish modelling study (34). As modeling techniques involve assumptions and uncertainties, results benefit from comparisons from two disparate, yet related, methodologies.

Aims & Objectives

The study had two aims: (i) estimation of health and crime related harms and economic costs of alcohol for Finland in 2018 and (ii) estimation of how these would change under two alternative policy scenarios: A more restrictive policy scenario assumes similar policies to those in neighbouring Sweden (34), while a less restrictive scenario assumes full privatisation, with the abolition of Alko and sale of all alcoholic beverages in grocery stores. The methods employed to address each of these aims are outlined in detail below. Two alternative approaches were employed to address aim (ii), one applying an attributable fraction approach using the new InterMAHP resource, the other based on time series analysis of several decades of Finnish data on alcohol consumption and related harms (ARIMA). The Results section of this report will address these Aims simultaneously by providing both estimates of the current harms and costs from alcohol use in Finland in 2018 alongside estimated changes in these under different policy scenarios.

Methods

Estimation of the harms and economic costs of alcohol use for Finland, 2018

The economic costs of alcohol use for Finland were assessed across three broad areas: healthcare costs, lost productivity costs and criminal justice costs. Our methods were based on approaches applied in other international substance use cost studies e.g. (2, 35).

Wherever possible, current Finnish data were used to estimate relevant harms from alcohol that might generate costs. For example, many hospital admissions caused by alcohol are clearly identified in official diagnostic records (e.g. alcohol dependence). However, there are also a large number of health conditions and crime events that are only partially attributable to alcohol. As individual cases of partially-attributable events (health or crime) are usually impossible to attribute to a single risk factor, a condition-based epidemiological attributable fraction approach was used to estimate alcohol's overall proportionate contributions to groups of these health and crime outcomes. This approach is widely used in projects which estimate substance use harms, e.g. (2, 6, 31). For example, an association between specific levels of alcohol consumption and colorectal cancer has been established (36), but it is not possible to divide individual cases of colorectal cancer into those which are and are not caused by alcohol. Using the attributable fraction approach allows us to estimate the proportion of cases of colorectal cancer, for example, in the population that can be considered to be caused by alcohol consumption. To do so we combine two kinds of information: (i) published estimates of the risk of developing a condition (in this case, colorectal cancer) associated with various quantities of average alcohol consumption, and (ii) the proportion of drinkers in a population consuming alcohol at those quantities. Using this information, we can estimate the likely proportion of all cases of colorectal cancer that are alcohol-attributable. Multiplying this proportion by the total number of colorectal cancer cases allows us to calculate the number of alcohol-attributable cases of colorectal cancer and the costs associated with treating them.

The approach of estimating unique "attributable fractions" for a range of partly alcohol-caused conditions is widely used in alcohol epidemiology (2, 32). With input of required data from Finnish drinking surveys and statistics, the mathematical estimation of alcohol-attributable fractions (AAFs) was automated by InterMAHP (6). Unique AAFs, by gender and age population subgroups, were estimated for all health conditions for which alcohol is causally associated. The list of these conditions was taken from InterMAHP and informed by several articles and reports from members of its authorship group, including the WHO Global Burden of Disease project (6, 37-39). These fractions were used to help estimate the healthcare and premature mortality costs incurred for Finland in 2018.

Another important methodological choice was to use the human capital approach to estimate the impacts of premature mortality attributable to alcohol on lost productivity. Briefly, this approach places a monetary value on the present value of future earnings between the age of death and an assumed age of retirement to estimate the cost of lost productivity when an individual is removed from the workforce due to premature death. These methods were guided by best practice from the field of health economics and previous international costs of substance use studies (1, 5, 40, 41).

For the criminal justice section of this report, new attributable fractions were calculated, using associations estimated within Finnish data on per capita alcohol consumption and rates of violent crime.

It is important to note that while published best practices were followed in our methods, the scope of the study was restricted and our estimates of the economic costs of substance use in Finland in 2018 are therefore quite conservative. For example, we did not include family doctor visits, day surgeries and pharmaceutical costs in our estimates of healthcare costs. Only direct criminal justice costs and indirect costs of lost productivity were included. We did not account for privately incurred costs (e.g. the cost of purchasing alcohol) or intangible costs (nonmonetary outcomes such as pain and suffering) associated with alcohol use. Previous studies indicate such cost categories can be substantial.

Hospitalisation costs

We estimated the number and the cost of hospitalisations attributable to alcohol use. Hospitalisations were defined as those requiring admission to a hospital bed for at least one night.

Aggregate level inpatient hospitalisation data for Finland in 2016 were obtained via request from the National Institute for Health and Welfare (THL). Hospital stays were grouped into health conditions using the International Statistical Classification of Diseases and Related Health Problems (ICD10) codes, a standard maintained by the WHO (42). Aggregate counts for each alcohol-related health condition, gender and age group were adjusted by population change proportions to reflect 2018 counts (43).

As hospital records representing each stay may be assigned multiple diagnoses, an algorithm was required for assigning admissions to health conditions. For this project, we used the 'primary diagnosis algorithm' recommended and detailed by InterMAHP (6). Briefly, the diagnosis most responsible for the hospital visit is typically called the primary diagnosis. For non-injury alcohol-related conditions, a record is only grouped to that condition if the *primary diagnosis* matches the list provided in Appendix A1. For injuries, we are more concerned with the cause of injury/poisoning (e.g. motor vehicle collision) as opposed to the primary clinical diagnosis (e.g. a broken arm). These *cause of injury/poisoning codes* (called external cause codes) may appear in any diagnosis position on the record and so for injury records, each diagnosis position was searched until an alcohol-related external cause code was found, if applicable. These external cause codes have their own column in Appendix A1.

Then, for every condition, gender and age grouping, AAFs were applied to the counts enumerated by the primary cause algorithm. Detailed AAF methodology is provided later in this chapter and is represented in *Formula 7*. Application of the AAFs to the enumerated counts of Finnish hospitalisations generated our estimates of how many of these were alcohol-attributable.

Next, THL provided the average cost of a hospital stay in Finland, by ICD10 chapter. These costs were applied to the corresponding hospitalisations counts above. Costs were updated to 2018 by applying Finnish Consumer Price Index (CPI) changes from 2016 to 2018. Costs were estimated by applying the provided by-chapter costs of a hospital stay to the count of alcohol-attributable hospitalisations, described in detail below.

Lost productivity costs

We employed a hybrid approach to the estimation of lost productivity costs as recommended by Schroeder (5), reflecting the kinds of data available for analysis. To estimate the impacts of premature mortality we used the Human Capital Approach to estimate future years of lost productivity according to the number of deaths estimated to be attributable for alcohol and the age of these for the year 2018, assuming a retirement age of 65 years. We also estimated the current impact of long-term disability on productivity based on the Finnish national agency that handles national social security programs, including long-term disability benefits, and on the age and sex of people unable to work in a recent year in Finland (44).

Premature mortality

Our primary method of estimating costs associated with lost production due to premature mortality was the Human Capital (HC) approach as this approach is widely used, best reflects our study parameters and is sensitive to age and sex subgroups. For this project, we estimated the cost of lost production due to premature mortality for those aged 0-64 years old, i.e. we assumed an age of retirement of 65. Data were grouped into the following age groups: 0-14 years, 15-24 years, 25-34 years, 35-44 years, 45-54 years, and 55-64 years. For the 0-14 age group, only 100% attributable conditions were enumerated, i.e. we assumed there was not time for chronic conditions such as cancer to appear in this age group – this is a conservative assumption. InterMAHP currently assumes some protective effects for low-level alcohol use in relation to some cardiovascular diseases and type II diabetes. The estimated impacts on premature mortality were calculated net of these assumed positive effects.

The HC approach assumes that production lost due to premature mortality, work absence or disability due to disease is not recoverable. That is, once an individual departs the labour force due to premature mortality their contribution to the overall economy is not replaced. Thus, cost estimates for lost production using this approach are generated by calculating an individual's projected future earning until retirement and summing these costs across all individuals who died due to the condition of interest (in this case alcohol use). The major criticism with the HC approach is the assumption that a person departing the workforce cannot be replaced. While this may be the case in labour markets with full employment, this is not necessarily the case in Finland where a state of registered and involuntary unemployment exists from which some workers can be replaced (45). However, the HC approach also takes account of the fact that a larger workforce will have greater productivity overall across all sectors: countries with a larger population tend to have greater Gross Domestic Product than those with a small population, all else being equal.

Alcohol-related mortality counts, adjusted for workforce participation, were taken from Statistics Finland (46, 47). Attributable fractions were then applied to the enumerated counts in the same manner as for the hospitalisation costs, as described above. Potential years of productive life lost (PYPLLs) were calculated using the following formula, using previously described methods (48). For age group 0-14 years, we assume 50 years of future lost production.

$$\mathbf{PYPLL_{AA}} = \mathbf{Average\ years\ lost_{AA}} * \mathbf{Mortality\ count_{AA}} * \mathbf{Employment\ rate} \qquad (1)$$

The terms in this equation are defined as follows:

Average years lost$_{AA}$, assuming age of retirement of 65 years, average years of lost production attributable to alcohol for each age group were calculated by simply subtracting the estimated age of death from 65 years (based on Finnish mortality data after applying AAFs), and assuming 50 years of lost productivity arising from cases of mortality among those in age group 0-14 years,

Mortality counts$_{AA}$ were the total numbers of fully and partially alcohol-attributable mortality occurring prior to 65 years of age,

Employment rate is the proportion of the population employed, excluding unemployed jobseekers or undergoing military or non-military service (49).

Lost productivity costs due to alcohol-attributable premature mortality were calculated as the product of total years lost and yearly-lost wages, after applying a discount rate of 2% for future earnings allocated to the current year (i.e., the current worth of a future earning stream is calculated by applying a discount equal to an assumed rate of return forgone) using the present value of an ordinary annuity formula (4, 50), described below.

$$\begin{aligned}\textbf{Lost productivity costs}_{\textbf{AA mort}} &= \textbf{Mortality count}_{\textbf{AA}} \\ &* \left(\frac{\textbf{Yearly wage}}{\textbf{0.02}} * \left[\textbf{1} - \frac{\textbf{1}}{(\textbf{1}+\textbf{0.02})^{\textbf{Average years lost}_{\textbf{AA}}}}\right]\right)\end{aligned} \tag{2}$$

The terms in this equation are defined as follows:

Yearly wage is yearly wage by gender, taken from Statistics Finland (51), and

Average years lost$_{AA}$ is as above,

Mortality counts$_{AA}$ is as above.

Sensitivity analyses were conducted assuming either 0% or 3% discount rates, reflecting alternative assumptions in both the Finnish and international literature (50, 52).

Long-term disability (LTD)

Previous attempts to quantify disability pensions granted for alcohol-related diseases in Finland have been limited to the following alcohol-related diseases: neuropsychiatric conditions caused by alcohol (ICD10 code F10), accidental poisoning caused by alcohol (ICD10 code T51), chronic liver diseases and liver cirrhosis (ICD10 code K70), diseases of the pancreatitis (ICD10 code K86), and other alcohol-related diseases (ICD10 codes Z50, Z71-72) (13). For our analysis, we have relied on a comprehensive list of alcohol-related conditions (see Appendix A1) and attributable fraction methodology to account for wholly and partially alcohol-attributable conditions leading to disability and estimated the proportion attributable to alcohol. As such, our estimates of the alcohol-attributable LTD case counts will not be comparable to prior estimates (13). Additionally, most other costs of substance use studies e.g. (2, 48) use the HC approach to estimate the costs associated with lost production due to LTD as well as from premature mortality. Following CSUCH(2) we used data on the prevalence of LTD in the year of interest and estimated the proportion of this that can be assumed to be attributable to substance use.

Estimates of 2017 LTD pensions by major ICD10 chapter grouping, were taken from Kansaneläkelaitos (Kela), the Finnish national agency that handles LTD benefits (44). These data were population-adjusted to represent 2018 and the employment rate was applied to produce an estimate of individuals living with LTD that would have been in the workforce were it not for their disablement (43, 49).

As the LTD count represents all-cause disability, these must be adjusted in order to represent only those with a LTD due to alcohol. We calculated the proportion of all hospitalisations, themselves calculated using InterMAHP-derived AFs, that were attributable to alcohol consumption by age group, sex, and major ICD10 groupings. As such, these proportions of hospitalisation cases attributable to alcohol are not AFs, *per se*, but AFs are intrinsic to their calculation. The total number of hospitalisations by major ICD10 chapter grouping were received via a data request from THL. These alcohol-attributable proportions were then applied to the total counts of lost productivity due to LTD, by ICD10 grouping. Costs of lost productivity due to alcohol-attributable LTD are then estimated by applying the yearly wage to AA LTD counts.

$$\begin{aligned}\mathbf{Lost\ Productivity\ cost}_{\mathbf{AA\ LTD}} \\ = ([\mathbf{LTD}_{\mathbf{Total}} * \mathbf{Employment\ rate}] * \mathbf{AP}_{\mathbf{AA}}) * \mathbf{Yearly\ wage}\end{aligned} \tag{3}$$

The terms in this equation are defined as follows:

Lost Productivity cost$_{\mathbf{AA\ LTD}}$ is the cost of lost productivity as a result of alcohol-attributable LTD,

LTD$_{\mathbf{Total}}$ is the total (all-cause) count of disability pensioners, obtained from Kela (44),

AP$_{\mathbf{AA}}$ is the alcohol-attributable proportion estimated for all hospitalisations calculated as described earlier i.e. it is assumed that the proportion of hospitalisations estimated to be attributable to alcohol is applicable to cases of disability.

Crime Costs

As with alcohol-related health conditions, certain crime events are considered fully alcohol-attributable (drunken driving, alcohol offences), and are easily accounted for. For other crime events alcohol may be a contributing causal factor. Causal frameworks for alcohol attribution in crime events are described by Goldstein (53) and Pernanen who propose that crimes are committed due to the psychopharmacological effects of short- or long-term alcohol use that inhibit impulse control (intoxication factor) in addition to a small proportion of crimes committed in order to economically support costly substance use (economic compulsive factor). For these “partially alcohol-attributable” crimes, we have employed an epidemiological attributable fraction methodology.

Criminal justice spending, either partially or fully attributable to alcohol, includes the costs associated with the following criminal justice functions:

- Policing of crimes (crime incidents)
- Courts (charges)
- Corrections (admissions to sentenced custody)

Count data of crime incidents, charges, and sentences for the year 2016 were provided by Statistics Finland from their Crimes and their Clearance 1980-2017 dataset. Offences were grouped into homicides, other violent crimes, non-violent crimes, and alcohol-defined crimes. National expenditures for police services, law courts, and prisons were taken from Statistics Finland's General Government Expenditures by function dataset (54).

During 2003-2006, Granath, et al. (55) report that, on average, 80.0% of homicides in Finland were committed by perpetrators under the influence of alcohol. However, there were insufficient Finnish data available to calculate crime AFs and we look to studies conducted in other developed countries. In a Canadian study, Pernanen, et al. (56) report that 81.1% of prison inmates who reported committing a crime while under the influence of alcohol also stated that they would not have committed their offence had they not been using alcohol. A two-factor adjustment (0.80*0.811=0.649) was therefore applied to reported rates of homicide in Finland in order estimate the proportion of Finnish homicides that would not have occurred had the perpetrator not been under the influence of alcohol.

For non-fatal violent crimes, the alcohol AF was taken from the ARIMA modelling exercise, described in detail below. In brief, the model examines the relationship between police reported assaults and per capita alcohol consumption, deriving an alcohol AF as described by Norström and Ramstedt (57). This assault alcohol AF was assumed as our AF for non-fatal violent crimes.

The Canadian Substance Use Costs and Harms study (2) conducted an extensive and comprehensive analysis of alcohol's causal contribution to crime. A much smaller violent crime alcohol attributable fraction of 0.199 and a non-violent alcohol AF of 0.080 was calculated based on a large survey conducted over several years of new prison inmates in Canada. The survey enquired about substance use at the time and offence was committed and also whether the inmate considered the crime would have occurred had they not been using that substance. In the absence of specific Finnish data, we applied the ratio for violent to non-violent crime from this Canadian study and applied it to the Finnish assault alcohol AF described above to arrive at our assumed Finnish *non-violent* crimes alcohol AF (i.e. 0.608*(0.080/0.199)=0.244). An alcohol AF of 1.0 was applied to alcohol-defined crimes. Final alcohol AFs employed are presented in Table 2 below.

A sensitivity analysis was also conducted employing the more conservative assumption that, as in the Canadian study, only 8% of nonviolent crimes could be attributable to alcohol (3).

Table 2. *Finnish crime alcohol AFs by crime group*

Crime group	Alcohol AF
Homicide	0.6488
Other violent crimes	0.6080
Non-violent crimes	0.2440
Alcohol-specific crimes	1.000

To estimate numbers of crimes processed variously by police, the courts and prison services, the alcohol AFs presented in Table 2 were applied to total crime counts. The UK Home Office (58) reported that, on average, the cost of violent crimes was 3.58 times that of non-violent crimes: this factor was applied to Finland in the absence of local estimates. We then estimated the total cost of alcohol-attributable crime in Finland using equation 4 below:

$$\mathbf{Total\ expenditures_{all\ crimes}} = (\mathbf{Unit\ cost_{NV}} * \mathbf{Prevalence_{NV}}) + ([\mathbf{3.58} * \mathbf{Unit\ cost_{NV}}] * \mathbf{Prevalence_{V}}) \quad (4)$$

The terms used in this formula are defined as follows:

Total expenditures$_{\text{all crimes}}$ is the national expenditure on different criminal justice services (police, courts, prisons),

Unit cost$_{\text{NV}}$ is the cost to the criminal justice system of one non-violent crime event (separately for police, court, prison services),

Prevalence$_{\text{NV}}$ is the total prevalence of non-violent crimes (separately for police, court, prison services),

Prevalence$_{\text{V}}$ is the total prevalence of violent crimes (separately for police, court, prison services).

Solving for the unknown variable, the unit cost of non-violent crimes in Finland was then calculated for each crime category as follows (using the same terms as defined above):

$$\mathbf{Unit\ cost_{NV}} = \frac{\mathbf{Total\ expenditures_{all\ crimes}}}{(\mathbf{Prevalence_{NV}}) + (\mathbf{3.58} * \mathbf{Prevalence_{V}})} \quad (5)$$

Alcohol attributable homicide and other violent crimes were grouped as violent crimes while all others were defined as non-violent crimes. Alcohol-attributable crime costs were then calculated, for each category of crime costs, using the following formula:

$$\mathbf{Crime\ cost_{AA}} = (\mathbf{Unit\ cost_{NV}} * \mathbf{Prevalence_{AA\ NV}}) + ([\mathbf{3.58} * \mathbf{Unit\ cost_{NV}}] * \mathbf{Prevalence_{AA\ V}}) \tag{6}$$

The terms used in this formula are defined as follows for each category of crime costs:

Crime cost$_{AA}$ is the cost of alcohol-attributable crimes,

Prevalence$_{AA\ NV}$ is the count of alcohol-attributable non-violent crimes,

Prevalence$_{AA\ V}$ is the count of alcohol-attributable violent crimes.

Modelling the impacts of alcohol policy changes in Finland on alcohol attributable harms and costs

Overview

We estimated alcohol attributable harms and economic costs in each of the following scenarios:

The Baseline Scenario: Finland in 2018, employing comprehensive national data for the most recent available year, adjusted on the basis of changes in population, alcohol consumption and inflation to 2018 values;

Scenario 1: Finland in 2018, as above but with more government controls on the retail sale of alcohol, similar to those currently operating in Sweden;

Scenario 2: Finland in 2018, as above but with Alko abolished and all types of alcohol available for sale in grocery stores.

Comprehensive and systematic reviews of the published literature (59-61) consistently identify the following policy parameters as being the most influential on rates of alcohol consumption and related harm:

1. The density of liquor outlets (30, 62).
2. The days and hours of trading (63).
3. The overall price elasticity of alcohol (64).
4. The "floor" or minimum price of alcohol (65, 66).

We start from the assumption that a government alcohol monopoly such as Alko will only be effective as a means of reducing alcohol-related harm to the extent that it implements effective policies in each of these domains. As described below, we proceeded through five specific steps to model how these policies would change and, in turn, impact consumption and harm under the "base case" of Finland in 2018 versus alternative scenarios of with either greater (Scenario 1) or fewer (Scenario 2) alcohol controls:

Step 1: estimate the extent of the changes in each of the above policy domains under each scenario for Finland in 2018;
Step 2: estimate the impacts of each of these policy changes on per capita alcohol consumption in Finland in 2018;
Step 3: estimate the total impact of all of these policy changes combined on per capita alcohol consumption taking account of likely countervailing effects on unrecorded consumption;
Step 4: estimate degree of uncertainty around these estimated impacts on total consumption of alcohol;
Step 5: using two alternative methods (ARIMA and InterMAHP), estimate the impact of the change in alcohol consumption and alcohol attributable harms and costs in each scenario.

The methods employed for each of these steps are now discussed in detail below.

Step 1: The extent to which key alcohol policies would change under alternative scenarios

We employed comparisons with privatisation experiences in Scandinavia and North America informed by the advice of Finnish experts from government and academia, to estimate the extent to which outlet density, days and hours of trading, and alcohol prices would change under each scenario. A summary of the estimated policy changes under each scenario is provided in Table 3 with breakdowns according to the situation for beer and pre-mixed drinks (or "long drinks") currently sold in grocery stores (i.e. with a strength up to 5.5% ABV) or all other beverages currently sold only in Alko stores.

Table 3: *The estimated changes in key policy levers in two privatisation scenarios*

Policy Lever	**Baseline** 2018 alcohol policy	**Scenario 1** Only <3.5% beer in grocery stores	**Scenario 2** All alcohol sold in grocery stores
Beer, Cider and Long Drinks >3.5% to ≤5.5%			
Store density	5,165 stores	251 stores*	4,808 stores
Sunday trading	Yes	No	Yes
Mon-Sat hours	72 hours/week	50 hours/week	72 hours/week
Mean prices	No change	+6.46%	No change
Minimum prices	No change	+28.09%	No change
Beer, Cider and Long Drinks >5.5% plus Wine and Spirits			
Store density	357 stores	251 stores*	4,808
Sunday trading	No	No	Yes
Mon-Sat	69 hours/week	50 hours/week	72 hours per week
Mean prices	No change	No change	-6.07%
Minimum prices	No change	No change	-21.93%

*The estimated number of stores assuming the same per capita density of government liquor stores as in Sweden

While there is also evidence for private liquor outlets being less strict in their checking of customer age-IDs and level of intoxication than are government-owned stores (67), we were unable to find an empirical basis upon which to estimate the effects on population consumption and therefore, conservatively, excluded this factor from the analysis. The studies used to inform these estimates were drawn from the systematic reviews identified below in Step 2 as well as the team's knowledge of research in alcohol monopoly countries. In particular, we drew heavily on a systematic review of the impacts of privatisation events on alcohol sales to identify relevant studies (68) and recent studies of the impacts of opening increasing numbers of private liquor stores alongside government stores in the Canadian province of British Columbia (28, 30). The existence of the two kinds of stores operating alongside each other is almost unique and allows direct comparison on issues such as pricing and trading hours.

a) <u>Population density of liquor stores:</u> For the Baseline Scenario we used the estimated 4,808 grocery stores in Finland and 357 Alko stores (the current numbers as of September, 2018) for beers, ciders and long drinks with a strength up to 5.5% ABV and only the Alko stores for all other beverages. In the more restrictive Scenario 1 there would only be 251 Alko stores for all types of alcohol, assuming the same per capita density of government liquor stores as in Sweden. Under Scenario 2 alcohol would only be sold in Finland's 4,808 grocery stores and there would be no Alko stores for any type of alcoholic beverage. Given the substantial size of the estimated changes in output density and likely impacts on per capita consumption, two sensitivity analyses were also conducted assuming either a 10% larger or 10% smaller increase in density. It is possible that many more outlets than grocery stores would stock wine and spirits for off premise retail sale if it became legal to do so e.g. gas stations, kiosks, bars and restaurants. It is also possible but not all grocery stores would elect to take advantage of this new opportunity.

b) <u>Days of sale</u>: The Baseline Scenario would have the current arrangements for days of sale i.e. Sunday sales only for beverages up to 5.5% ABV and six days per week for all other beverages. In the more restrictive Scenario 1 there would be no Sunday sales for any beverage. Under Scenario 2 there would be trading for all seven days of the week.

c) <u>Additional operating hours</u>: Currently, Alko operates between 09.00-21.00h Monday to Friday, and 0900-1800h on Saturdays i.e. a total of 69 hours per week; alcohol sales in grocery stores are usually available in most locations between 09.00 and 21.00h seven days a week i.e. a total of 84 hours per week. In Scenario 1, we assume the same opening hours as Sweden i.e. 9 hours per day Monday to Friday and five hours on a Saturday, or 50 hours per week.

d) <u>Alcohol prices</u>: We analysed retail price data from grocery store websites to make precise comparisons for a range of directly comparable products (i.e. same brand, container size and strength, see: https://www.pty.fi/julkaisut/tilastot/) available for sale in both Alko stores and either S or K grocery stores, two major chains accounting for more than 80% of grocery store sales. These comparisons could only be made for beer, cider and refreshment drinks with an alcohol content of no greater than 5.5% ABV. We pooled the estimates across all beverage types available and, after weighting for sales volumes, calculated an overall price differential (~6% higher in Alko) that was then assumed to also apply for wine and spirits. In the case of minimum prices, which were also incorporated in our models since heavy drinkers and young drinkers may be more likely to consume very inexpensive brands, we identified the five cheapest products sold in either of the grocery stores and compare them with the five cheapest products sold in Alko in the same beverage category. Once more, we calculated an overall price differential across all comparable products and assumed that this also apply for wine and spirits were they also to be available for sale in grocery stores. There was a substantial difference (~20% higher in Alko) in the average minimum price, after weighting by sales volumes.

Step 2: The independent effect of each policy lever on recorded per capita alcohol consumption

Comprehensive systematic reviews and, where possible, meta-analyses, were used to estimate the effect on per capita alcohol consumption of the above changes in: (1) alcohol outlet density, (2) days and hours of alcohol sale, (3) and price. These are reported in full elsewhere while being briefly summarised here (63). Quality criteria were applied to select studies with controlled before and after intervention analyses.

Density of liquor outlets

A published systematic review identified four relevant articles examining the relationship between alcohol outlet density and per capita consumption, three of which were population-level studies (28, 69, 70), the other individual-level (71). Different measures of outlet density ruled out a meta-analysis. The scale of changes in density estimated to occur under the two scenarios (-34% and over 1000% respectively) were significantly larger than those reported in two of the identified studies. We reanalysed data from the other identified study, a longitudinal panel study in part examining the effects of changes in private liquor store density on alcohol-attributable hospital admissions in a province in Canada (72), and found evidence that the effects on alcohol-attributable hospital admissions of increasing outlet density on alcohol consumption obeyed a decay function such that smaller proportional effects were seen at higher levels of outlet density that were equivalent to what was predicted for Alko. This finding was used to estimate consumption impacts of the different increases in outlet density for the two scenarios.

Days and hours of sale

A published systematic review examining the relationship between days or hours of sale and population alcohol consumption identified seven studies suitable to inform our scenarios, six of which studied days of sale (73-78) and one of which studied hours of sale (79). Across-study results were consistent and a meta-analysis indicated that an additional day of sale was associated with a 3.4% increase in total per capita alcohol consumption. Estimates were also made for the effect on per capita consumption of changes in the total trading hours in a typical week as summarised in Table 3 for each scenario, taking account of whether a beverage was sold in grocery stores or just through Alko (e.g. in Scenario 1: -34 hours for beverages up to 5.5% and -19 hours for all other beverages). These were based on the effect size estimated for the effect of the addition of a whole extra day of trading assuming, in the absence of other evidence, a decay function in effect size similar to that for outlet density.

Mean and Minimum Prices

We took estimates of the price elasticity of demand for each beverage type (beer, wine and spirits) of -0.39, -0.95 and -0.46 respectively from a recent Finnish study and used these to calculate the impact of the change in mean price on consumption (80). We assumed the same price elasticity for long drinks ("alcopops") as for beer as no directly equivalent estimate was available. These elasticities were beverage-specific estimates reported in this study and are well within the ranges overall of estimates from three previous studies of price elasticity in Finland (81-83) and also comparable to those reported in an international review (64). A sensitivity analysis was also conducted using an alternative estimate from this same source that took account of cross-elasticities estimated for Finnish off-premise alcohol sales. This latter estimate (-0.17) was not used in the Base Case because it was substantially different from previous estimates of Finnish alcohol price elasticity (81-83) and also from the standard international estimate (64). A sensitivity analysis was also conducted using the standard international estimate of -0.44 (64).

As no published Finnish minimum price elasticities exist, we applied an overall price elasticity for changes in the minimum available price of alcohol, calculated for British Columbia, Canada (84) of -0.34.

Step 3: The collective impact of all policy levers on total per capita alcohol consumption

We combined these independent effect estimates for each policy domain assuming a simple additive effect applied to the baseline estimate. Finnish data on monthly travellers' imports of alcohol were used to estimate substitution between recorded and unrecorded consumption, resulting in an estimated elasticity of unrecorded demand of -0.97 i.e. a 10% increase in recorded consumption will result in a 9.7% decrease in unrecorded sales. Because unrecorded consumption is a much smaller proportion of total consumption this only made a small compensatory difference to any change in recorded consumption.

Step 4: Estimating the uncertainty around modelled changes in per capita consumption

To estimate uncertainty around each parameter and its impact on per capita consumption (e.g. mean price), we collected standard errors or confidence intervals around each parameter from the original published sources. We used a Probabilistic Sensitivity Analysis (PSA) approach, taking 10 000 random draws from the probability distribution around each parameter to estimate the mean overall effects on per capita consumption, as well as 95% confidence intervals around this value for each scenario. PSA is a commonly used approach in analysis of uncertainty in many other branches of research (85).

Step 5: Impacts on alcohol-related harms under each scenario

Two alternative analytic approaches were applied to the estimation of the impacts of changes in per capita consumption on alcohol attributable harms. Method A applies assumptions derived from the international epidemiological literature regarding risk relationships between consumption and harm for many disease and injury outcomes using InterMAHP, introduced above and described in detail below. Method B bases estimates on observed relationships over many years in Finland between level of alcohol consumption and alcohol-related harm. Each method has strengths and weaknesses. The purpose was to investigate how sensitive the estimates would be to different analytic approaches. Both approaches are strongly built on detailed analyses of past and present experiences, both in Finland and in other developed countries, a necessary feature for any serious effort to forecast responses to a specific policy change.

Method A: The International Model of Alcohol Harms and Policies

InterMAHP employs a modern single distribution (by population subgroup) approach to modelling the impact of changes in consumption on alcohol-attributable deaths and morbidities. This methodology is described comprehensively by the InterMAHP (6). Briefly, the distribution of average daily alcohol consumption (i.e. how many people drink different average amounts of alcohol per day) is estimated for the population subgroups defined below using a single parameter Gamma distribution, which depends solely on average consumption in the subgroup. This method was originally detailed in two articles (33, 86) and is based on the analysis of surveys of alcohol use patterns from more than 60 countries. As the shape of the distribution in each subgroup depends only on average consumption, the application of an estimated percent change in consumption, as we have calculated for each policy scenario, allows the mathematical specification of the *modified* distributions that would occur under each of these policy scenarios. These modified distributions are then carried through to the AAF estimations by InterMAHP, in order to arrive at the modified estimates of alcohol-caused harms. An adjustment is also applied for binge drinking prevalence, which assumes an increase (decrease) in the number of binge drinkers when average consumption increases (decreases) (6). This is predicted by foundational theories in alcohol research, such as Single Distribution Theory (87), the Collectivity of Drinking Cultures (88) and, later, the Gamma distribution method (33).

Deaths and hospital stays for 43 alcohol-related conditions, including wholly and partially alcohol-attributable conditions, (see Table A1 in the Appendices) were enumerated for each of ten population subgroups.

The ten population subgroups were defined by gender (male, female) and age groups of 0 to 14 years, 15 to 24 years, 25 to 34, 35 to 64 and 65 and over. InterMAHP methodologies are based on those designed for the WHO Global Status Reports on Alcohol and Health (31, 32), as described in more detail below. Note that although InterMAHP estimated AAFs in only these ten age groups, the number of potential years of productive life lost were estimated in more granular ten year age groups.

<u>Estimating the distribution of alcohol consumption</u>: InterMAHP automates the calculation of a Gamma distribution-based continuous prevalence of average daily alcohol consumption in the Finnish drinking population given the following pieces of information:

i) Prevalence of current drinkers, binge drinkers, former drinkers and lifetime abstainers
ii) Per capita consumption for the population 15+
iii) A measure of the volume of consumption by population subgroup. This provides relative consumption levels for each gender-age group and allows the total quantity of alcohol to be apportioned into each subgroup.

Per capita consumption for the Finnish population 15+ for 2016 was taken from Valvira (23) in order to match the latest available survey data. This was then adjusted to 2018 based on observed consumption changes in the first eight months of 2018 as compared to the same months for 2016, resulting in an estimated total recorded plus unrecorded consumption of 10.45L ethanol per person aged 15+ for 2018.

Prevalence information and a measure of relative consumption were received via special request from Finland’s National Institute for Health and Welfare - Alcohol, Drugs and Addictions Unit and were taken from the 2016 Finnish Drinking Habits Survey. In InterMAHP, current drinkers are defined as those who have consumed at least one standard drink of alcohol in the past year. Binge drinkers are those who have consumed 60g or more of alcohol on 12 or more occasions in the past year, i.e. one or more times per month. Lifetime abstainers were defined as those who have consumed <1 standard drinks in their lifetime. Former drinkers are neither current drinkers nor lifetime abstainers.

When estimating the distribution of alcohol consumption in each population we assumed a maximum level of consumption of 250g ethanol per day corresponding to the mean levels of consumption observed in street-involved groups of dependent drinkers observed in Canada (89). The standard WHO approach is to use a cut-off of 150g. Sensitivity analyses comparing the two assumptions showed there were only small differences in final estimates of alcohol attributable conditions. We selected 250g as reflecting evidence for the most appropriate upper level of alcohol consumption to assume in the Finnish population.

Calculating alcohol attributable fractions: Using the information above, we were then able to calculate alcohol attributable fractions (AAFs) for each condition, by subgroup. An AAF is the proportion of each condition that would theoretically have not occurred in the absence of an exposure (in this case, the consumption of alcohol). It compares the observed prevalence distribution of consumption with an alternate state wherein everyone in the population is at the theoretical minimum risk; with respect to alcohol use, this is a lifetime abstainer (90).

InterMAHP automated the calculation of AAFs for this project. InterMAHP uses the modern AAF formulation [(6, 9), modified from (33)]:

$$\mathbf{AAF} = \frac{\mathbf{P_f[RR_f - 1] + \int_0^{250} P(x)[RR(x) - 1]\,dx}}{\mathbf{1 + P_f[RR_f - 1] + \int_0^{250} P(x)[RR(x) - 1]\,dx}} \tag{7}$$

where $\mathrm{P_f}$ is the prevalence of former drinkers, $\mathrm{RR_f}$ is the relative risk of former drinkers, $\mathrm{P(x)}$ is the prevalence of drinkers at daily consumption level *x*, $\mathrm{RR(x)}$ is the condition-specific relative risk at daily consumption level *x* and 250g is an assumed maximum daily consumption level.

Estimating changes in the prevalence of "binge" drinking: Special AAFs were calculated for injuries, ischaemic stroke and ischaemic heart disease that took account of the prevalence of "binge drinking" (drinking to impairment, typically defined as consuming 60 grams or more of ethanol) as measured by survey (see above). Studies show that engaging in binge drinking behaviour may remove the protective effects of moderate alcohol consumption on ischemic conditions and is a risk factor for injuries causally related to alcohol use (91-96).

As binge drinking prevalence is an important component of calculating the AAFs for these conditions, we estimated the change in this prevalence as a function of change in per capita consumption. This relative change was then applied to the baseline prevalence of binge drinking to arrive at a modified binge prevalence for each scenario. Estimates of binge drinking prevalence were taken from the Finnish Drinking Habits survey with a definition of a "binge drinker" as someone who reports one or more occasions of consuming 5+ (60g+ pure alcohol) drinks per month.

<u>Calculating the number of alcohol attributable deaths and hospital stays</u>**:** As the calculated AAFs are the estimated proportions of cases within each condition that occur because of alcohol consumption, the number of alcohol attributable (AA) deaths and hospital stays are calculated for each condition and population subgroup by applying the formula:

$$\mathbf{AA\ Hospitalizations} = (\mathbf{Total\ Hospitalizations}) * \mathbf{AAF} \tag{8}$$

$$\mathbf{AA\ Deaths} = (\mathbf{Total\ Deaths}) * \mathbf{AAF} \tag{9}$$

The number of alcohol attributable hospital stays and deaths were calculated for each subgroup; however, note that the majority of results in this document were aggregated to larger groupings.

<u>Estimating changes in wholly alcohol attributable conditions:</u> Several conditions contained in this report are completely attributable to alcohol (i.e. their alcohol attributable fractions are identically 1.00). We call these conditions "wholly attributable" and assign an AAF of 1.00 because these conditions do not occur in the absence of alcohol. The full list of wholly attributable conditions can be obtained as the subset of conditions from Table A1 in the appendices including all conditions with 'alcohol', 'alcohol-induced', or 'alcoholic' in the condition name. Because the methodology for estimating the change in deaths and hospital stays due to a partially attributable condition relies on a relative risk function for each condition which does not exist for wholly attributable conditions, it was necessary to employ a unique method to calculate the estimated harms due to wholly attributable conditions under different consumption scenarios.

For each population subgroup and each wholly attributable condition, an absolute risk function was calibrated using the prevalence distribution of alcohol consumption and morbidity/mortality incidence. This produced an estimated absolute risk curve as a function of average daily alcohol consumption. This absolute risk is analogous to the relative risk functions, denoted $RR(x)$ above, used in the computation of alcohol attributable fractions for partially-attributable conditions. Using this absolute risk function it was possible to compute expected incidence under the prospective per capita consumptions in scenarios 1 and 2. This method is detailed comprehensively elsewhere (97), has been used in previous policy modeling public reports (9, 98), and is automated in InterMAHP.

Changes in deaths and hospital stays under Scenario 1 and Scenario 2: To estimate the health impact of Scenario 1 and Scenario 2, the respective calculated percent changes in per capita alcohol consumption were applied to consumption in each subgroup. It was assumed that this increased alcohol would be consumed by the same number of drinkers (i.e. in the short term, the prevalence of abstainers and former drinkers would not change). Different distributions of current drinkers were then calculated using these updated per capita consumption figures for each scenario.

These updated distributions of consumption were applied to the AAF formula above and updated AAFs were calculated for each condition, population subgroup and scenario. An adjustment was calculated to modify the number of hospital stays (or deaths) due to this increased consumption, based on the identity:

$$\mathbf{H_1} = \mathbf{H_0} + \mathbf{H_1 AAF_1} - \mathbf{H_0 AAF_0} \tag{11}$$

where H_1 is the number of hospital stays for a condition under Scenario 1, H_0 is the number of hospital stays observed in 2016 and adjusted upwards by population change to 2018 (base case) (43), and AAF_1 and AAF_0 are the alcohol attributable fractions calculated under Scenario 1 and the base case, respectively.

The formula was rearranged in order to provide a functional form for the number of alcohol attributable hospital stays under Scenario 1 (AAH_1):

$$\mathbf{AAH_1} = \mathbf{H_1} \times \mathbf{AAF_1} = \frac{\mathbf{H_0(1 - AAF_0)AAF_1}}{\mathbf{1 - AAF_1}} \tag{12}$$

Statistical analysis**:** The open access alcohol harms estimator InterMAHP v2.0 (6), written in R 3.5.1 (99), was used to perform the data analysis to calculate alcohol attributable fractions. The statistical package SAS 9.3 (100) was used to calculate the number of deaths and hospital stays that are attributable to alcohol consumption by applying the estimates of AAFs for each condition.

Method B: ARIMA modelling of Finnish consumption and harm data

We analysed a broad range of harm indicators in order to obtain an encompassing assessment of the detrimental impact of population drinking. The following indicators were thus included:

Alcohol mortality is a composite indicator including causes of death that are wholly attributable to alcohol (e.g. alcoholic cirrhosis mortality). This measure is thus an indicator of the harmful physical effects of chronic heavy consumption and its relation to population drinking has been documented in previous research (57).

Injury mortality was included as an indicator of episodic intoxication drinking (101).

Suicide can be regarded as an extreme expression of self-destructive behaviours and its link to population drinking is well documented (for a review, see (102)).

Assaults represent an important indicator of harm from others' drinking, and is particularly related to episodic intoxication drinking (103).

Age-specific (5-year groups) mortality data for men and women, as well as assault rates were obtained from Statistics Finland. The mortality data were on a quarterly basis, while data for assaults only existed on an annual basis. (Table A2 in the Appendices shows the ICD-codes of the mortality indicators). We constructed age-standardized mortality rates for the whole population 15 years and above. Data on quarterly and annual alcohol sales, expressed in litres of 100% alcohol per capita 15 years and above, were obtained by a special request to National Institute for Health and Welfare. The mortality data spanned the period 1995:1-2016:4, the assault data covered the period 1990-2016.

Previous research suggests that the relation between per capita consumption and chronic harm rates (mostly cirrhosis mortality has been focused upon) is likely to include a lag-structure, i.e. a large part of the alcohol effect is distributed over a longer period of time (13, 104, 105). To accommodate this in the modelling of alcohol mortality, we adopted a strategy applied in previous studies, namely to use a weighted alcohol series where the lag-weights decline geometrically with the passage of time. On the basis of previous results (93, 94), we chose a lag-parameter implying a fairly slow response in mortality to changes in consumption (lag-parameter equal to 0.8); reasonable modifications within the range 0.7-0.9 had little effect on the estimated alcohol effect. The lag-scheme was truncated at lag 24.

Possible effects of the introduction of the revised International Classification of Diseases (ICD-10) in 1996 were captured by a dummy variable, taking the value 0 prior to 1996Q1, and 1 otherwise. If there were consistent differences to how relevant health conditions were coded before and after this key change in medical records, this variable will control for these.

The mortality data were analyzed by applying the technique of SARIMA-modelling (seasonal autoregressive integrated moving average model) (106) . Non-stationarity in the form of time trends was removed by regular or seasonal differencing. The noise (error) term, which includes explanatory variables not considered in the model, is allowed to have a temporal structure that is modelled and estimated in terms of regular and seasonal autoregressive or moving average parameters. A SARIMA-model is specified as: (p, d, q) (P, D, Q, M), where the first bracket represents the model's non-seasonal (regular) part, and the second bracket specifies the seasonal part. The order of the autoregressive parameter in the model's non-seasonal part is indicated by p, while d indicates the order of regular differencing, and q is the order of the moving-average parameter. An ARIMA-model (which is applied to annual data, in our case assaults) is specified as: (p, d, q), where p indicates the order of the autoregressive parameter, d indicates the order of differencing, and q is the order of the moving-average parameter. The symbols in the second bracket have the corresponding seasonal significance, while M is the number of periods per season. The model residuals should not differ from "white noise" i.e. random fluctuations in the data. This was tested using the Box-Ljung Q statistics. As the level of consumption in a quarterly series is one-fourth of that in annual series, in a semi-log model the impact estimate is four-fold compared to what it would be using annual data. In order to make the estimates comparable to those obtained from annual series, they were divided by four. All statistical analyses were performed with Stata V.15 (StataCorp, College Station, Texas, USA).

Estimates for the year 2018, and under the assumptions in each scenario, were calculated by adjusting 2016 counts for populations growth and adjusting for changes in alcohol consumption using the ARIMA modelled beta estimates (i.e., the estimated percent change in indicator per liter change in alcohol consumption).

Results

We will present the findings from these various analyses in a way that addresses both Aim 1 and Aim 2 simultaneously i.e. we will report estimates of harm and economic costs of alcohol for Finland in 2018 alongside estimates of how these change under different policy scenarios. We start with the final outcomes from the first three steps in the methods for modelling these changes, namely estimated impacts on per capita alcohol consumption under each policy scenario and estimates of uncertainty around these.

Effects of changes in alcohol policies on per capita alcohol consumption

The estimated changes in per capita alcohol consumption under the re-monopolization and the privatisation scenarios are shown in Table 4, both for each policy lever separately (i.e. for outlet density, days and hours of sale, mean and minimum prices) and also in combination. Finally, the impact of cross-border effects is shown and the resultant estimates of total impacts on per capita consumption of all policy changes in combination. The degree of statistical uncertainty around each of these estimates, again separately and jointly is also provided in Table 4 by showing 95% confidence intervals (CI) around each estimate.

Other sources of uncertainty involved a) the choice of policy levers assumed to be affected by the alternative scenarios (i.e. pricing, output density et cetera) and b) the choice of studies and datasets upon which to base the estimates used. The effects of some important uncertainties are explored in sensitivity analyses, reported in later sections.

Alcohol attributable mortality in Finland and impacts of alcohol policy changes estimated with InterMAHP (Method A)

It was estimated in the base case that alcohol would be responsible for 4 071 deaths in Finland in 2018 (95% CI: 3 402, 4 711) based on observed sales data up to September 2018 (under present policies) and mortality data from 2016 adjusted for population growth (see Table 5) (43). Cardiovascular diseases were the largest contributor to alcohol attributable deaths (1 409) followed by diseases of the digestive system such as liver disease (959), cancers (556) and unintentional injuries (528). It is important to stress that alcohol attributable deaths include both those that are 100% alcohol attributable (estimated to be 1 759 in 2018, see Table 10) and many more partially attributable deaths. For example, about 55% of liver cirrhosis deaths are typically attributable to alcohol so this is a partially attributable condition.

Table 4: *Estimated changes in per capita alcohol consumption (PCAC) in Finland under alternative alcohol policy scenarios based on policy-related variables known to affect consumption*

Policy Lever	**Scenario 1** Only <3.5% beer in grocery stores	**Scenario 2** All alcohol sold in grocery stores
Beer, Cider and Long Drinks >3.5% to ≤5.5% (currently in grocery stores)		
Store density	**-14.37%** (-15.87%, -12.83%)	**-0.17%** (-0.27%, -0.10%)
Sunday trading	**-2.12%** (-4.23, +0.03)	**0%**
Mon-Sat hours	**-5.91%** (-9.67%, -3.15%)	**0%**
Mean prices	**-3.51%** (-6.07%, -0.82%)	**0%**
Minimum prices	**-8.70%** (-14.4%, -2.24%)	**0%**
Sub-Total	***-34.73%*** (-43.76%, -24.96%)	***-0.17%*** (-0.27%, -0.1%)
Beer, Cider and Long Drinks >5.5% plus Wine and Spirits (currently in Alko stores)		
Store density	**-2.06%** (-2.58%, -1.55%)	**+16.03%** (+14.07%, +18%)
Sunday trading	**0%**	**+2.13%** (+0%, +4.31%)
Mon-Sat	**-5.49%** (-8.05%, -3.14%)	**+1.13%** (+0.9%, +1.37%)
Mean prices	**0%**	**+3.76%** (-1.95%, +9.69%)
Minimum prices	**0%**	**+7.17%** (+3.2%, +11.12%)
Sub-Total	***-7.53%*** (-10.17%, -5.11%)	***+30.28%*** (+20.82%, +39.88%)
Weighted Totals*	***-22.94%*** (-28.62%, -17.1%)	***+13.02%*** (+8.93%, +17.17%)
Cross-Border effects	**+7.15%** (+5.33%, +8.93%)	**-4.06%** (-5.35%, -2.79%)
Final PCAC Change	**-15.78%** (-19.7%, -11.77%)	**+8.96%** (+6.15%, +11.82%)

*Each subtotal estimate was weighted by the proportion of off premise sales for each type of beverage and each type of outlet (Alko vs grocery stores) recorded in the first eight months of 2018 (provided by Valvira).

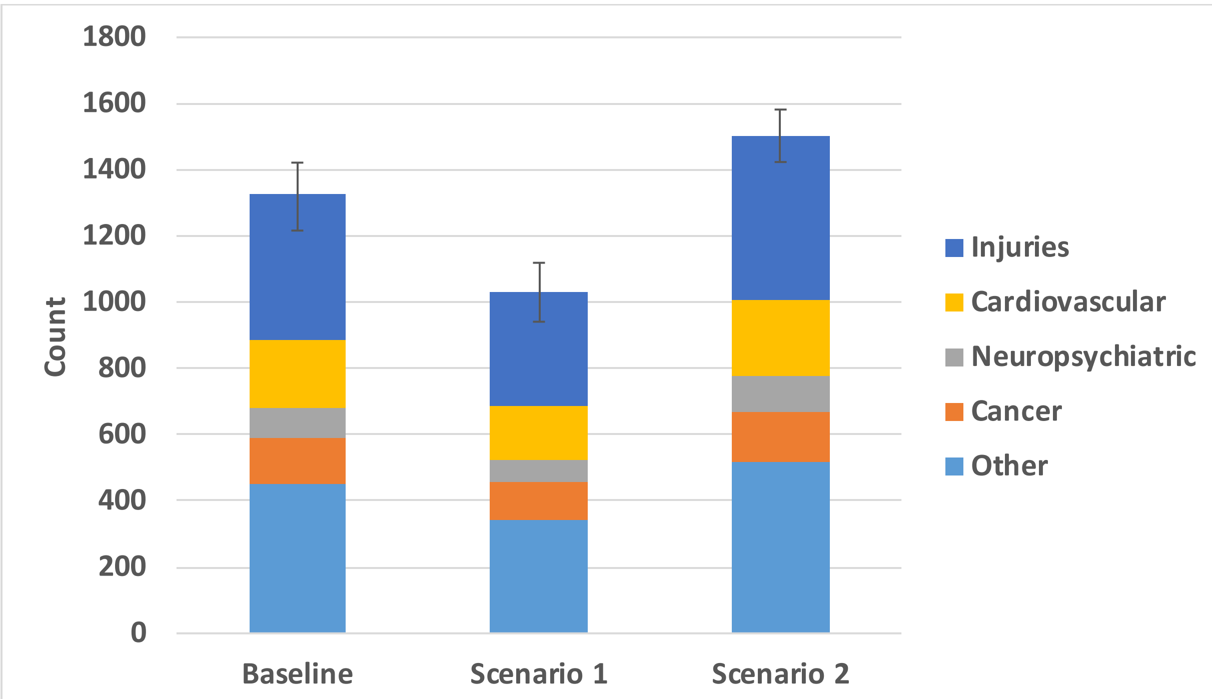
As seen in Table 5, it is further estimated that were more effective alcohol policies in place like those in Sweden (Scenario 1), there would have been 21% or 855 fewer lives lost from alcohol in 2018. By contrast, had all types of alcohol been available for sale in grocery stores in 2018 (Scenario 2), it is estimated there would have been 14% or 556 additional alcohol attributable deaths.

Table 5: *Alcohol-attributable deaths among Finnish people in 2018, and estimated impacts of alternative alcohol policy scenarios using InterMAHP*

Condition Category	**Finland in 2018**	**Scenario 1** Only <3.5% beer in grocery stores		**Scenario 2** All alcohol sold in grocery stores	
	Estimate *(95% CI)*	**Absolute Change** *(95% CI)*	**Percent Change** *(95% CI)*	**Absolute Change** *(95% CI)*	**Percent Change** *(95% CI)*
Communicable diseases	**31** *(25, 37)*	**-6** *(-7, -4)*	**-19.4%** *(-22.6%, -12.9%)*	**+3** *(+2, +5)*	**+9.7%** *(+6.5%, +16.1%)*
Cancer	**556** *(475, 633)*	**-71** *(-119, -24)*	**-12.8%** *(-21.4%, -4.3%)*	**+43** *(-3, +90)*	**+7.7%** *(-0.5%, +16.2%)*
Type 2 diabetes	**-18** *(-23, -14)*	**+0** *(-3, +4)*		**-1** *(-4, +3)*	
Neuropsychiatric conditions	**326** *(322, 331)*	**-119** *(-143, -92)*	**-36.5%** *(-43.9%, -28.2%)*	**+89** *(+59, +123)*	**+27.3%** *(+18.1%, +37.7%)*
Cardiovascular conditions	**1 409** *(973, 1 844)*	**-238** *(-551, +76)*	**-16.9%** *(-39.1%, +5.4%)*	**+161** *(-160, +482)*	**+11.4%** *(-11.4%, +34.2%)*
Digestive conditions	**959** *(880, 1 016)*	**-224** *(-283, -162)*	**-23.4%** *(-29.5%, -16.9%)*	**+139** *(+85, +194)*	**+14.5%** *(+8.9%, +20.2%)*
Transportation	**60** *(54, 66)*	**-14** *(-18, -10)*	**-23.3%** *(-30.0%, -16.7%)*	**+8** *(+4, +12)*	**+13.3%** *(+6.7%, +20%)*
Injuries (unintentional)	**528** *(497, 558)*	**-126** *(-161, -89)*	**-23.9%** *(-30.5%, -16.9%)*	**+77** *(+38, +118)*	**+14.6%** *(+7.2%, +22.3%)*
Injuries (intentional)	**220** *(199, 240)*	**-58** *(-75, -39)*	**-26.4%** *(-34.1%, -17.7%)*	**+35** *(+14, +57)*	**+15.9%** *(+6.4%, +25.9%)*
Total	**4 071** (3 402, 4 711)	**-855** (-1 360, -340)	**-21.0%** (-33.4%, -8.4%)	**+556** (+35, +1 084)	**+13.7%** (+0.9%, +26.6%)

The numbers of different types of attributable deaths estimated under each policy scenario are illustrated in Figure 5 below. It can be seen that injuries make the largest contribution to the overall numbers, cardiovascular conditions and cancers are also substantial and there are a range of "other" alcohol attributable diseases (e.g. liver cirrhosis).

Figure 5: *Estimated numbers of alcohol attributable deaths in Finland for the year 2018 under each scenario and by broad diagnostic category*



As shown in Table A3 (appendices), there were 1 326 (95% CI: 1 216, 1 422) alcohol attributable deaths involving people aged up to 64 years of age in 2018. Table 6 shows the impact of these deaths on productive years of life lost along with the estimated economic costs of these. In total, it was estimated there were 17 101 (95% CI: 15 769, 18 254) future productive years of life lost due to alcohol attributable deaths in Finland in 2018, valued at €616 million. Under Scenario 1 assumptions, a reduction of 22.8% (-29.4%, -16.0%) is predicted in the number of productive years of life lost due to alcohol at a cost saving of €140 million. In contrast, an increase of 13.4% (95% CI: 7.4%, 19.4%) in the number of productive years of life lost due to alcohol at an extra cost of €82 million were predicted under more liberalised Scenario 2. The estimated economic costs and changes in these estimates under different policy scenarios for each condition category are summarised in Tables A4 and A5 in the appendices.

Table 6: *Estimated productive years of life lost, and their costs, in Finland in 2018 due to alcohol attributable premature mortality and estimated impacts of alcohol policy scenarios using InterMAHP*

Condition Category	***Finland in 2018***	***Scenario 1*** *Only <3.5% beer in grocery stores*		***Scenario 2*** *All alcohol sold in grocery stores*	
	Estimate *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*
Communicable diseases	**78** *(63, 92)*	**-14** *(-18, -9)*	**-17.5%** *(-22.8%, -12.1%)*	**+8** *(+4, +12)*	**+10.2%** *(+5.6%, +14.9%)*
Cancer	**1 189** *(1 023, 1 314)*	**-189** *(-264, -112)*	**-15.9%** *(-22.2%, -9.4%)*	**+111** *(+41, +181)*	**+9.3%** *(+3.5%, +15.3%)*
Type 2 diabetes	**-8** *(-10, -5)*	**0** *(-2, +1)*	**-2.9%** *(-21.4%, +15.8%)*	**0** *(-1, +2)*	**+1.7%** *(-17.2%, +20.5%)*
Neuropsychiatric conditions	**996** *(961, 1 026)*	**-313** *(-386, -236)*	**-31.5%** *(-38.7%, -23.7%)*	**+197** *(+131, +266)*	**+19.8%** *(+13.2%, +26.7%)*
Cardiovascular conditions	**2 030** *(1 748, 2 307)*	**-377** *(-522, -229)*	**-18.6%** *(-25.7%, -11.3%)*	**+226** *(+90, +364)*	**+11.1%** *(+4.5%, +17.9%)*
Digestive conditions	**5 163** *(4 825, 5 379)*	**-1 242** *(-1 551, -919)*	**-24.1%** *(-30.0%, -17.8%)*	**+745** *(+490, +1 003)*	**+14.4%** *(+9.5%, +19.4%)*
Transportation	**718** *(654, 778)*	**-168** *(-218, -115)*	**-23.3%** *(-30.3%, -16.1%)*	**+95** *(+47, +143)*	**+13.2%** *(+6.6%, +19.9%)*
Injuries (unintentional)	**4 134** *(3 937, 4 319)*	**-894** *(-1 146, -633)*	**-21.6%** *(-27.7%, -15.3%)*	**+497** *(+279, +717)*	**+12.0%** *(+6.8%, +22.3%)*
Injuries (intentional)	**2 801** *(2 569, 3 017)*	**-705** *(-915, -481)*	**-25.1%** *(-32.6%, -17.2%)*	**+404** *(+186, +625)*	**+14.4%** *(+6.6%, +22.3%)*
Total	**17 101** (15 769, 18 254)	**-3 901** (-5 021, -2 732)	**-22.8%** (-29.4%, -16.0%)	**+2 283** (+1 268,+3 313)	**+13.4%** (+7.4%, +19.4%)
Total costs in (Euros, millions)	***€616*** *(568, 657)*	***-€140*** *(-180, -98)*	***-22.7%*** *(-29.2%,15.9%)*	***+€82m*** *(+46, +118)*	***+13.2%*** *(+7.4%, +19.1%)*

Alcohol attributable hospitalisations in Finland and impacts of alcohol policy changes

It was estimated that alcohol was responsible for 46 016 hospitalisations in Finland in 2018 (95% CI: 40 548, 51 366) (see Table 7). Neuropsychiatric conditions were the largest contributor to alcohol attributable hospitalisations (18 612) followed by unintentional injuries (13 332), diseases of the digestive system (5 191) and communicable diseases (4 168).

These alcohol-caused hospitalizations were estimated to cost the people of Finland €201 million in 2018. If the more health-protective policies identified in Scenario 1 were employed, it was estimated that this cost would be reduced by 32.0% or €64 million; however, if the more liberal Scenario 2 was employed, there would be an estimated €43 million (+22.6%) increase in the cost burden. The estimated economic costs and changes in these estimates under different policy scenarios for each condition category are summarised in Table A4 in the appendices.

Table 7: *Alcohol-attributable hospitalisations of Finnish people in 2018, economic costs and estimated impacts of alternative alcohol policy scenarios using InterMAHP*

Condition Category	***Finland in 2018***	***Scenario 1*** *Only <3.5% beer in grocery stores*		***Scenario 2*** *All alcohol sold in grocery stores*	
	Estimate *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*
Communicable diseases	**4 168** *(3 367, 4 975)*	**-706** *(-944, -457)*	**-16.9%** *(-22.6%, -11.0%)*	**+426** *(+186, +678)*	**+10.2%** *(+4.5%, +16.3%)*
Cancer	**3 413** *(2 900, 3 909)*	**-501** *(-763, -237)*	**-14.7%** *(-22.4%, -6.9%)*	**+305** *(+47, +564)*	**+8.9%** *(+1.4%, +16.5%)*
Type 2 diabetes	**-181** *(-228, -134)*	**+5** *(-28, +38)*		**-3** *(-38, +31)*	
Neuropsychiatric conditions	**18 612** *(18 338, 18 871)*	**-7 239** *(-8 753, -5 570)*	**-38.9%** *(-47.0%, -29.9%)*	**+5 325** *(+3 476, +7 571)*	**+28.6%** *(+18.7%, +40.7%)*
Cardiovascular conditions	**-402** *(-2 024, 1 223)*	**-1 197** *(-1 968, -422)*		**+798** *(-40, +1 635)*	
Digestive conditions	**5 191** *(4 767, 5 566)*	**-837** *(-1 137, -535)*	**-16.1%** *(-21.9%, -10.3%)*	**+493** *(+237, +747)*	**+9.5%** *(+4.6%, +14.4%)*
Transportation	**676** *(612, 737)*	**-168** *(-218, -115)*	**-24.9%** *(-32.2%, -17.0%)*	**+97** *(+46, +150)*	**+14.3%** *(+6.8%, +22.2%)*
Injuries (unintentional)	**13 332** *(11 723, 14 906)*	**-3 688** *(-4 736, -2 510)*	**-27.7%** *(-35.5%, -18.8%)*	**+2 399** *(+765, +4 101)*	**+18.0%** *(+5.7%, +30.8%)*
Injuries (intentional)	**1 207** *(1 093, 1 314)*	**-328** *(-424, -223)*	**-27.2%** *(-35.1%, -18.5%)*	**+196** *(+79, +315)*	**+16.2%** *(+6.5%, +26.1%)*
Total	**46 016** (40 548, 51 366)	**-14 659** (-18 972, -10 029)	**-31.9%** (-41.2%, -21.8%)	**+10 035** (+4 757, +15 793)	**+21.8%** (+10.3%, +34.3%)
Total Costs (Euros, millions)	***€201*** *(€171, €229)*	***-€64*** *(-€85, -€42)*	***-32.0%*** *(-42.2%, -21.1%)*	***+€43*** *(+€18, +€70)*	***+21.6%*** *(+9.1%, +34.9%)*

Estimated changes in alcohol related harms for Finland based on ARIMA modelling methods (Method B)

The observed trends in recorded alcohol consumption (Figure A1) and selected indicators with significant positive relationships to consumption are shown in the appendices (Figures A2 to A3). Table 8 shows the results of the ARIMA-modelling estimating relationships between recorded consumption and the identified indicators. All estimates have the expected positive sign, and are all strongly statistically significant. The diagnostic test for residual autocorrelation (Q) is satisfactory for all models. In the penultimate column, the effect estimates are presented in a more intelligible form (% per litre), i.e. the expected percentage increase in the outcome given a one litre increase in per capita sales. Thus, a one-litre increase in annual per capita sales is associated with a 20.4% increase in alcohol mortality, including the lagged effect. The corresponding figure for suicide mortality is 6%, 4.8% for injury mortality and 11.7% for assaults.

Table 8: *Estimated effects on harms from changes in per capita pure alcohol sales based on ARIMA modelling methods†*

	EST	SE	P	Q*	p(Q)	% per litre	Model
Alcohol mortality	+0.186	0.042	<0.001	1.668	0.797	+20.4	(2,0,0)(2,1,0,4)
Suicide mortality	+0.058	0.009	<0.001	6.926	0.140	+6.0	(0,0,0)(0,1,1,4)
Injury mortality	+0.047	0.009	<0.001	1.031	0.905	+4.8	(0,1,1)(0,0,1,4)
Assaults	+0.111	0.045	0.012	4.974	0.419	+11.7	(0,1,1)

* Box-Ljung test for residual autocorrelation (lag 4).† Estimates based on seasonally-adjusted ARIMA models of quarterly data, 1990-2016 for assaults and 1995-2016 for other indicators. Semi-log models. A positive number indicates an increase.

Finally, Table 9 provides estimates for 2018 of per capita consumption, alcohol-related deaths, suicides, assaults, plus changes in these estimated for each policy scenario from the ARIMA method. They will be contrasted with some of the findings from InterMAHP later.

Table 9: *ARIMA estimated impacts of alcohol on outcomes related to alcohol use in Finland, 2018 under different alcohol policy scenarios (Method B)*

Outcome	***Finland in 2018***	***Scenario 1*** *Only <3.5% beer in grocery stores*		***Scenario 2*** *All alcohol sold in grocery stores*	
	Estimate	**Absolute Change** *(95% CI)*	**Percent Change** *(95% CI)*	**Absolute Change** *(95% CI)*	**Percent Change** *(95% CI)*
Recorded 15+ per capita consumption	**8.44***	**-1.94L** (-2.42, -1.44)	**-22.9%** (-28.6%, -17.1%)	**+1.10L** (+0.75, +1.45)	**13.0%** (+ 8.9%, +17.2%)
Alcohol mortality†	**1 759**	**-695** (-867, -518)	**-39.5%** (-49.3%, -29.4%)	**+394** (+271, +521)	**+22.4%** (+15.4%, +29.6%)
Suicide mortality‡	**796**	**-92** (-116, -69)	**-11.6%** (-14.6%, -8.7%)	**+52** (+36, +69)	**+6.5%** (+4.5%, +8.7%)
Injury mortality‡	**2 267**	**-211** (-263, -157)	**-9.3%** (-11.6%, -6.9%)	**+120** (+82, + 158)	**+5.3%** (+3.6%, +7.0%)
Assaults‡	***34 224***	***-7 753*** (-9 672, -5 779)	***-22.7%*** (-28.3%, -16.9%)	***+4 400*** (+3 018, +5 806)	***+12.9%*** (+8.8%, +17.0%)

* Estimated **recorded** per capita alcohol consumption based for first 8 months of 2018 compared with same months for 2016, as reported earlier in Table 4. † Composite indicator including causes of death that are wholly attributable to alcohol. ‡ Total counts of these deaths or crime incidents (and percent changes in these from 2018 baseline) in the population.

A comparison of Method A and Method B estimates of alcohol attributable mortality

As the InterMAHP-based estimates of alcohol attributable mortality included both 100% and partially alcohol attributable causes of death (n=4 168) and the ARIMA method relied on only those identified as 100% alcohol attributable (estimated at to be 1 759 in 2018), they are not directly comparable in their entirety. This difference applies to both injuries and chronic diseases related to alcohol use. A reasonably close comparison was possible, however, by selecting only the 100% alcohol attributable conditions identified by the InterMAHP criteria and adding to these cases of liver cirrhosis deaths estimated as attributable to alcohol. In the ARIMA data series, cases of 100% alcohol attributable deaths already included alcoholic liver cirrhosis. The comparisons shown in Table 10 suggest the InterMAHP-based estimates are more conservative than the ARIMA estimates based on the observed relationship between alcohol consumption and harm outcomes in Finland over recent decades. The ARIMA method generated both slightly higher estimates of 100% alcohol caused deaths (1 759 versus 1 571) and also of the extent of changes in these under each scenario (e.g. +22.4% versus +17.4% in Scenario 2).

Table 10: *ARIMA versus InterMAHP-based estimates of 100% alcohol-attributable mortality*

100% Alcohol Attributable mortality	***Finland in 2018***	***Scenario 1*** *Only <3.5% beer in grocery store*		***Scenario 2*** *All alcohol in grocery stores*	
	Estimate (95% CI)	**Change** (95% CI)	**Percent Change** (95% CI)	**Change** (95% CI)	**Percent Change** (95% CI)
InterMAHP (Method A)	**1571**	**-417** *(-517,-311)*	**-26.55%** *(-32.91%, -19.78%)*	**+274** *(+176, +377)*	**+17.4%** *(+11.23%, +23.99%)*
ARIMA (Method B)	**1 759**	**-695** *(-867, -518)*	**-39.5%** *(-49.3%, -29.4%)*	**+394** *(+271, +521)*	**+22.4%** *(+15.4%, +29.6%)*

A similar difference between the estimates derived from these two alternative methods applies to the estimated changes in alcohol-caused deaths from injuries. In both scenarios, the estimated change in these is larger for the ARIMA-based approach. For example, in Scenario 1 the InterMAHP approach arrives at an estimated reduction of 198 deaths across all injury categories (see Table 5, combining the three injury categories) estimated compared with 303 for the ARIMA method (see Table 9, combining suicide and all other injuries).

Impact of alcohol consumption on lost productivity due to long-term disability in Finland

It was estimated that 2 799 (95% CI: 2 754, 2 841) individuals aged 15-64 years would have been removed from the workforce during 2018 due to alcohol-attributable long-term disability (LTD) at a cost of €116 million (95% CI: €114, €118 million) (see Table 11). These cases of LTD represent those that were prevented from working in 2018 due to disablement in prior years plus a smaller proportion whose disablement occurred during, 2018.

Under the alternative scenario of Finland having the same alcohol policies as Sweden, it was estimated that 1 091 (95% CI: -1 323, -836) cases of LTD would be prevented in 2018, a 39.0% (95% CI: -47.3%, -29.9%) decrease compared to the baseline estimate. The cost saving under this scenario would be €45 million. Under the more liberalised scenario of alcohol sold in grocery stores, it was estimated that there would be an extra 802 LTD cases (95% CI: +517, +1 146) representing a 28.6% increase and at an extra cost of €33 million. A more detailed breakdown of these cost estimates for LTD by broad health condition is shown in Table A5 in the Appendix.

Alcohol attributable crime in Finland in 2018 and impacts of alternative policy scenarios

It was estimated that alcohol consumption caused 60.8% of violent crimes (95% CI: 55.3%, 66.6%) and 27.9% of non-violent crimes in Finland in 2018 (95% CI: 25.4%, 30.6%). Across the whole criminal justice system, this resulted in approximately 235 000 crimes reported to the police, 27 000 court cases and 10 000 imprisoned individuals at a total cost of €649 million (95% CI: €646 million; €651 million, see Tables 12 and 13) or 23.9% (95% CI: 21.7%, 26.2%), of criminal justice system costs. Most of these costs were due to non-violent offences, including those 100% attributed to alcohol use (e.g. for alcohol impaired driving) (61.3%, 95% CI: 61.1%, 61.5%).

Under the alternative alcohol policies in Scenario 1, it was estimated that cases of alcohol attributable crime dealt with in the criminal justice system would decrease by 22.1% (95% CI: -38.0%, -3.8%), representing a cost saving of €123 million (95% CI: €-234, €-6 million). By contrast, under the more liberal policies of Scenario 2, an increase in cases of alcohol attributable crime was predicted of 13.9% (95% CI: 3.5%, 22.9%), resulting in a 17.3% in economic costs of crimes (95% CI: 6.7%, 26.7%).

Table 11: *Alcohol-attributable cases of long-term disability among productive individuals aged 15 to 64 years in 2018 and under alternative policy scenarios*

Condition Category	***Finland in 2018***	***Scenario 1*** *Only <3.5% beer in grocery stores*		***Scenario 2*** *All alcohol sold in grocery stores*	
	Estimate *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*
Communicable diseases	**0** *(-)*	**0** *(-)*	**-** *(-)*	**0** *(-)*	**-** *(-)*
Cancer	**10** *(8, 11)*	**-1** *(-2, -1)*	**-14.7%** *(-22.4%, -6.9%)*	**+1** *(0, +2)*	**+8.9%** *(+1.4%, +16.5%)*
Type 2 diabetes	**-6** *(-8, -5)*	**0** *(-1, +1)*	**+2.9%** *(-15.4%, +21.1%)*	**0** *(-1, +1)*	**-1.4%** *(-20.6%, +17.4%)*
Neuropsychiatric conditions	**2 508** *(-)*	**-1 025** *(-1 235, -793)*	**-40.9%** *(-49.3%, -31.6%)*	**+761** *(+500, +1 080)*	**+30.3%** *(+19.9%, +43.1%)*
Diseases of the nervous system	**162** *(136, 186)*	**-31** *(-41, -22)*	**-19.4%** *(-25.1%, -13.3%)*	**+19** *(+10, +28)*	**+11.7%** *(+6.3%, +17.3%)*
Cardiovascular conditions	**0** *(-2, +1)*	**-1** *(-2, 0)*	**-298.0%** *(-489.8%, -104.9%)*	**+1** *(0, +2)*	**+198.5%** *(-10.9%, +406.9%)*
Respiratory conditions	**5** *(4, 7)*	**-1** *(-)*	**-16.7%** *(-22.3%, -10.7%*	**+1** *(0, +1)*	**+10.1%** *(+4.3%, +16.1%)*
Digestive conditions	**29** *(26, 31)*	**-5** *(-6, -3)*	**-16.1%** *(-21.9%, -10.3%)*	**+3** *(+1, +4)*	**+9.5%** *(+4.6%, +14.4%)*
Injury, poisoning and other consequences of external causes	**61** *(54, 68)*	**-17** *(-22, -11)*	**-27.5%** *(-35.3%, -18.7%)*	**+11** *(+4, +18)*	**+17.7%** *(+5.8%, +30.0%)*
Other or diagnosis missing	**31** *(27, 34)*	**-10** *(-13, -7)*	**-31.7%** *(-41.1%, -21.7%)*	**+7** *(+3, +10)*	**+21.7%** *(+10.3%, +34.2%)*
Total	**2 799** (2 754, 2 841)	**-1 091** (-1 323, -836)	**-39.0%** (-47.3%, -29.9%)	**+802** (+517, +1 146)	**+28.6%** (+18.5%, +40.9%)
Total Economic Costs (Euros, millions)	**€116** *(€114, €118)*	**-€45** *(-€55, -€35)*	**-39.0%** *(-47.3%, -29.9%)*	**+€33** *(+€21, +€48)*	**+28.7%** *(+18.5%, +41.0%)*

Table 12: *Impacts of alcohol consumption on cases dealt by criminal justice system for Finland in 2018, and changes under alternative policy scenarios*

Criminal justice system function	***Finland in 2018***	***Scenario 1*** *Only <3.5% beer in grocery stores*		***Scenario 2*** *All alcohol sold in grocery stores*	
	Estimate *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*
Police-reported crimes	**234 621** *(233 748, 235 383)*	**-51 741** *(-89 135, -8 944)*	**-22.1%** *(-38.0%, -3.8%)*	**+32 586** *(+8 259, +53 809)*	**+13.9%** *(+3.5%, +22.9%)*
Courts cases	**27 347** *(27 246, 27 436)*	**-6 031** *(-10 389, -1 043)*	**-22.1%** *(-38.0%, -3.8%)*	**+2 798** *(+967, +6 272)*	**+13.9%** *(+3.5%, +22.9%)*
Corrections cases	**10 276** *(10 238, 10 309)*	**-2 266** *(-3 904, -392)*	**-22.1%** *(-38.0%, -3.8%)*	**+1 427** *(+363, +2 357)*	**+13.9%** *(+3.5%, +22.9%)*
Total crime events	***272 244*** *(271 232, 273 129)*	***-60 039*** *(-103 428, -10 378)*	***-22.1%*** (-38.0%, -3.8%)	***+37 811*** *(+9 626, +62 438)*	***+13.9%*** *(+3.5%, +22.9%)*

Table 13: *Alcohol-attributable criminal justice system costs (EUR millions) for Finland in 2018, and changes under scenario conditions*

Criminal justice system function	***Finland in 2018***	***Scenario 1*** *Only <3.5% beer in grocery stores*		***Scenario 2*** *All alcohol sold in grocery stores*	
	Estimate (millions) *(95% CI)*	**Change** (millions) *(95% CI)*	**Percent Change** *(95% CI)*	**Change** (millions) *(95% CI)*	**Percent Change** *(95% CI)*
Police-reported crimes	**€359** *(358, 360)*	**-€71** *(-130, -3)*	**-19.7%** *(-36.1%, -0.9%)*	**+€62** *(+24, +96)*	**+17.3%** *(+6.7%, +26.7%)*
Courts cases	**€174** *(173, 175)*	**-€34** *(-63, -2)*	**-19.7%** *(-36.1%, -0.9%)*	**+€30** *(+12, +46)*	**+17.3%** *(+6.7%, +26.7%)*
Corrections cases	**€115** *(115, 116)*	**-€23** *(-42, -1)*	**-19.7%** *(-36.1%, -0.9%)*	**+€20** *(+8, +31)*	**+17.3%** *(+6.7%, +26.7%)*
Total (Euros, millions)	***€649*** *(646, 651)*	***-€123*** *(-234, -6)*	***-19.7%*** (-36.1%, -0.9%)	***+€112*** *(+43, +173)*	***+17.3%*** (+6.7%, +26.7%)

Overall impacts and economic costs of alcohol consumption on healthcare, productivity and the criminal justice system and estimated impacts of alternative alcohol policies

A summary of the above findings is provided in Table 14, which presents per capita alcohol consumption, counts of alcohol-related harms and economic costs for Finland in 2018 along with estimates of how these would change under each policy scenario. The final line shows the overall economic costs from hospitalisations, productive years of life lost and impacts on the criminal justice system, estimated to be €1 582 million (95% CI: €1 500, €1 655 million) i.e. €1.6 billion. In total, we estimated that the introduction of more restrictive alcohol policies like those in neighbouring Sweden would result in cost savings of €377 million, representing a 23.8% reduction. By contrast, the more liberal scenario of alcohol being sold only in grocery stores was estimated to increase economic costs by €271 million or 17.1%. A more detailed presentation of these results is given in Table A6 of the appendix, which displays costs by outcome.

Table 14: *Summary of estimated impacts on mortality, healthcare, productivity and criminal justice system in Finland, 2018 of different alcohol policy scenarios (Method A)*

Outcome	***Finland in 2018***	***Scenario 1*** *Only <3.5% beer in grocery stores*		***Scenario 2*** *All alcohol sold in grocery stores*	
	Estimate *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*
Per Capita Alcohol Consumption	**10.45L***	**-1.65L**	**-15.8%** (-19.7%, -11.8%)	**+0.94L**	**9.0%** (+6.2%, +11.8%)
Mortality	**4 071** (3 402, 4 711)	**-855** (-1 360, -340)	**-21%** (-33.4%, -8.4%)	**+556** (+35, +1 084)	**+13.7%** (+0.9%, +26.6%)
Productive years of life lost	**17 101** (15 769, 18 254)	**-3 901** (-5 021, -2 732)	**-22.8%** (-29.4%, -16.0%)	**+2 283** (+1 268,+3 313)	**+13.4%** (+7.4%, +19.4%)
Hospital admissions	**46 016** (40 548, 51 366)	**-14 659** (-18 972, -10 029)	**-31.9%** (-41.2%, -21.8%)	**+10 035** (+4 757, +15 793)	**+21.8%** (+10.3%, +34.3%)
Long-term Disability	**2 799** (2 754, 2 841)	**-1 091** (-1 323, -836)	**-39.0%** (-47.3%, -29.9%)	**+802** (+517, +1 146)	**+28.6%** (+18.5%, +40.9%)
Police-reported crimes	**234 621** *(233 748, 235 383)*	**-51 741** *(-89 135, -8 944)*	**-22.1%** *(-38.0%, -3.8%)*	**+32 586** *(+8 259, +53 809)*	**+13.9%** *(+3.5%, +22.9%)*
Economic Costs (Euros, millions)	**€1 582** *(€1 500, €1 655)*	**-€377** *(-€554, -€181)*	**-23.8%** *(-35.0%, -11.4%)*	**+€271** *(+€129, +€409)*	**+17.1%** *(+8.1%, +25.8)*

* Estimated total recorded plus unrecorded consumption based on data supplied by Valvira in September, 2018.

Discussion

The *first conclusion* to be drawn from the above analyses is that alcohol consumption in Finland is responsible for significant harms and economic costs. Adjusting all estimates to the population of Finland in 2018 we estimate that in this year there were 4 071 deaths, 17 101 productive years of life lost, 46 016 hospital admissions, 2 799 persons living with disability and 234 621 criminal offences all attributable to alcohol use. The total economic costs of these outcomes were estimated to be €1.6 billion. This latter estimate is certainly conservative as there are many other areas where alcohol creates costs that have not been included in this study. For example, in terms of healthcare, the alcohol-caused costs resulting from emergency room presentations, visits to family doctors, day surgery hospital visits, prescription drugs, and the cost of various “second-hand” harms to others were not included (107). In a recent Canadian study these excluded elements in the current study contributed the majority of healthcare costs attributed to alcohol use (2). In addition, the human cost of the pain and suffering experienced by individuals acquiring alcohol-related health conditions or missing work due to alcohol was not included as it is difficult to estimate.

The *second conclusion* is that the liberalisation of alcohol policies in recent decades in Finland by permitting sales of alcohol in grocery stores has already increased alcohol consumption and related harms and costs. Were Finland to "de-privatise" (or re-monopolise) alcohol sales and adopt the same policies as in neighbouring Sweden, it is estimated that per capita alcohol consumption would have been 16% lower in 2018. This would have led to generally positive health, safety and economic outcomes, such as reductions of 21% in alcohol attributable deaths, 32% in hospitalisations and total economic costs by €377 million. Sweden differs mainly from Finland on alcohol policy by only permitting sales of drinks with no more than 3.5% ABV in grocery stores, having no alcohol sales at all on Sundays, having shorter hours of sale, slightly higher prices and a lower density of liquor outlets. Consistent with our modelling of the extent of reduced alcohol consumption were Swedish policies to be adopted, the comparison of total recorded plus unrecorded alcohol consumption across 25 European countries in Figure 2 (in the executive summary) shows that the Scenario 1 estimate for Finland is very similar to the recorded estimate for Sweden in 2016.

The same broad conclusions are supported by the estimates from both the ARIMA and InterMAHP-based analyses. It should be noted, however, that the outcome measures used in these alternative analyses are not directly comparable. For example, the burden of disease analysis using InterMAHP considers deaths both wholly or partially caused by alcohol, counting only fractions of deaths for the latter. However, the time series method was applied directly to only 100% alcohol caused deaths, i.e. it starts from a subset of alcohol-caused deaths (estimated to be 1 759 versus 4 071 for InterMAHP in 2018). The ARIMA time series analysis also analysed all suicide and injury-related deaths separately to estimate changes in these under the alternative alcohol policy and consumption scenarios. Where more comparable estimates were made focusing on 100% alcohol attributable mortality, however, estimates of both total cases and changes in these under the different policy scenarios were very similar across the two methods. The broad directions of the results as obtained by both methods were also comparable with substantial reductions estimated in all health and crime outcomes estimated in Scenario 1, i.e. a scenario in which Finland adopts the same alcohol pricing and availability policies as Sweden.

Despite these negative impacts of liberalisation of alcohol policy in Finland to date, *the third conclusion* is that these would be further increased in a scenario involving the abolition of Alko and so allowing the sale of all types of alcohol in grocery stores i.e. a completely privatised market for alcohol sales. In summary, we estimate there would have been an additional 556 deaths attributable to alcohol in 2018 under this scenario along with an additional 2 283 productive years of life lost, over 10 000 hospital admissions, over 800 people living with a long-term disability and almost 38 000 crime events at an additional annual cost to Finnish society of €271 million.

The estimated increase in per capita alcohol consumption under this scenario of about 9% is plausible given the substantial increases that would occur in the number of outlets selling alcohol over more hours and with substantially lower prices than in Alko stores for directly equivalent products. On the basis of comparisons of advertised alcohol prices in October 2018 of exactly comparable products currently available in Alko and grocery stores, we estimated this would result in significant reductions in prices. Also the hours and days of sale of grocery stores are greater than in Alko stores. An inspection of advertised prices on the websites of Alko and the grocery store chain S revealed that on average identical products (beers, ciders and long drinks) were about 6.5% cheaper in the grocery stores. Furthermore, looking at the full range of products available for sale in the grocery stores, there were many much cheaper products. On average, the cheapest products available were almost 20% cheaper in S grocery stores than in Alko. For example, the cheapest beer in an Alko store was €1.42 per standard drink compared with €0.92 in S grocery stores. In addition, there would be a substantial increase in the number of outlets selling alcohol as there are many more grocery stores than Alko stores at present.

This third conclusion regarding the further liberalisation of Finnish alcohol policy is also supported by the alternative analysis provided by time series of Finnish alcohol consumption and harm data. These models estimate that were alcohol to be sold in all grocery stores (hence with lower prices, many more outlets and longer trading hours), there would be an additional 391 of 100% alcohol caused deaths, 52 more suicides, 119 more fatal injuries, and 4 371 more assaults reported to the police.

It is important to acknowledge and clarify some assumptions behind these estimates. The first is that we assumed there were no other policy, social or economic changes i.e. the only changes were in the specified alcohol policies and the resulting changes in alcohol consumption. This is a correct and important assumption to make because we are only estimating what would have changed if alcohol policies had been different, not making predictions for an actual future year when there will likely be all manner of as yet other unknown economic, political and cultural changes. Our models simply estimate how alcohol consumption and related harm would change if alcohol policies had been different in 2018.

The second assumption is that all effects of these changes in alcohol consumption are experienced immediately. Some alcohol-related diseases may take a few years to develop (e.g. liver cirrhosis or cancer) the InterMAHP-based estimates. There is, however, evidence that some major alcohol-related diseases such as liver cirrhosis do respond immediately to changes in per capita consumption (57). While, the majority are likely to occur within the first year of a consumption change, certainly all the acute outcomes (e.g. injuries and poisonings) and liver cirrhosis cases, we cannot be precise about how long the full impact on more chronic diseases will take. For simplicity's sake, we have combined the immediate and future effects together in one year. Such an approach is equivalent to estimating the full annual impact of an alcohol consumption change that has been sustained for a number of years, all other factors being equal. This issue does not, however, apply to the ARIMA-based estimates provided by the time series analyses of Finnish data as it is based on both simultaneous and lagged effects of changes to alcohol consumption. It is also important to note that a) the attribution of future costs of premature deaths occurring in a particular year to that year is a standard feature of the Human Capital approach to economic costing and b) in comparison with the ARIMA method, the InterMAHP method that contributed to many of the economic costs is relatively conservative.

The difference between modelled or predicted versus actual changes is illustrated by the smaller change in alcohol consumption that occurred in 2018 than had been predicted by some Finnish experts on alcohol policy, following the increase in the strength of alcohol permitted for sale of grocery stores this year. Two factors at least will have offset the predicted increase: a) firstly, since 2008 there had been a continuing decline in alcohol consumption (see earlier Figure 2) presumably due to a variety of social, cultural and political factors; b) at the same time as physical availability of alcohol was increased on 1 January 2018 there was also an increase in prices due to an increase in alcohol taxes. The purpose of the kind of modelling estimates presented here was to estimate the independent effect of specific policy changes assuming all other factors, policies and continuing trends are held constant.

Uncertainty in estimates

We acknowledge a number of areas of uncertainty in these estimates but suggest that, overall, the range of these estimates is based on solid ground. *Firstly*, the likely practical impacts on key policy levers (pricing and availability) of each scenario are largely based on observations of current policies at play in Finland and Sweden (e.g. of prices advertised in Alko and grocery stores) supported with advice from local experts. *Secondly,* multiple independent reviews have concluded that the policy levers of pricing, outlet density, hours and days of trading each have major impacts on alcohol consumption and public health/safety outcomes. We used comprehensive, systematic reviews of international as well as other Nordic studies to estimate how predicted policy changes would impact per capita alcohol consumption. We note that these estimated changes in per capita alcohol consumption are well within ranges of relatively recent changes in alcohol consumption in Finland and in differences between European countries.

Each of these chosen studies estimated levels of uncertainty around the observed estimates which we incorporated into our estimates in the present study. However, there were choices to be made as to which of these studies to rely on in the final estimates. As a result, we report two sensitivity analyses reflecting the impact of alternative plausible assumptions for pricing effects, namely (i) an overall alcohol price elasticity of -0.17 that incorporated cross elasticities between beverage types in Finland (80), and (ii) an overall alcohol price elasticity of -0.44 based on a highly cited international meta-analysis (64). In both cases, these resulted in slightly lower estimates for key outcomes. Under the first most conservative assumption (-0.17) for Scenario 2, estimated per capita consumption change was lower by 0.8%, alcohol attributable deaths by 1.3% and overall economic costs by 1.7% (see Table A7 in appendices).

We also conducted sensitivity analyses for different assumptions regarding the extent of changes in outlet density, the policy measure estimated to have most impact on alcohol consumption in our main models. These analyses showed that a 10% variance either way in the number of retail outlets assumed for Scenario 2 (i.e. the sale of all alcohol in grocery stores) made only a tiny impact on the outcomes of alcohol consumption, related harms and total economic costs, with no difference greater than 0.5%. This reflects our conservative assumption that the impact of increasing numbers of stores is for less and less effect on total alcohol consumption, following an assumed decay effect.

The next major step in this modelling exercise was to move from estimated changes in alcohol consumption to the impact of these on alcohol-related harms. There are now established methods for making such estimates and, as well, the underlying theories about the distribution of alcohol in any population have become well-articulated. Critically, the work of Kehoe et al. (33) has shown how the proportions of people drinking alcohol at different levels on an average day in any population follows a predictable pattern well characterised by the Gamma distribution, as described in the Methods. Thus, if one knows the number of drinkers in the population (through self-report surveys) and the total consumption of alcohol in the population (from official statistics of recorded consumption and estimates of unrecorded) then it is possible to estimate how many people are drinking at any particular level. Because there is now a substantial literature linking level of alcohol consumption to risks for a range of diseases and injuries (6, 108, 109) it becomes possible to translate observed or predicted changes in per capita consumption into realistic estimates of impacts on health and safety outcomes. Again, we have reported degrees of uncertainty around each of these estimates and, further, conducted a sensitivity test incorporating an alternative source for estimating the precise relationship between level of alcohol consumption and risk of cardiovascular disease. Using the highly cited meta-analysis of Roerecke and Rehm (91), which estimates greater protective effects for alcohol consumption in moderation, some interesting variations were observed depending upon the outcome examined from the main analysis in which we relied upon estimates from Zhao et al (110). There was a modest reduction in the number of alcohol attributable deaths estimated for the Baseline Scenario (-5%), a more substantial reduction in alcohol attributable hospitalisations (-14.4%) and, by contrast, an increase in productive years of life lost due to alcohol (+4.9%) (see Table A9 in appendices). The latter result reflects (i) most of the premature deaths thought to be prevented by light to moderate alcohol consumption involve elderly people and, (ii) Roerecke and Rehm (91) estimated higher risks for cardiovascular-related deaths for heavy drinkers than did Zhao et al (110). The impact on the overall estimate of economic costs from alcohol for Finland in the Baseline Scenario was a reduction of only -0.8% (see Table A9 in appendices).

Larger differences were observed when the chosen sensitivity test for the extent of alcohol involvement in non-violent crime was conducted. A much more conservative estimate derived from a recent Canadian study (2) yielded a 11.7% lower estimate for the overall economic costs from alcohol for Finland in 2018 (see Table A8 in appendices). Differences were also estimated for sensitivity tests regarding the annual rate at which future economic costs were discounted, drawing upon alternative assumptions in the economic literature for Finland of 0% and 3%. These ranged from an increase of 1.1% (for 0% rate) to an 8.4% decrease (for 3% rate) in the overall estimated costs for Finland (see Table A8 in the appendices).

Conclusions and recommendations

We have conducted this study to inform current debates in Finland over the future role of public control on the sale of alcohol, in particular the role of the partial government monopoly Alko. Access to convenient and affordable alcohol is likely highly valued by many people and alcohol plays a role in many social and cultural aspects of Finnish life. In determining how to regulate its availability, the Finnish people and their political leaders may wish to balance concerns for convenience and affordability of this commodity against how this impacts overall health, safety and economic prosperity in their communities. We suspect that some members of the public will be sceptical regarding the estimated impacts of pricing and availability policies on such mundane behaviours as how much people drink and their likelihood of having health, safety or legal problems. However, we have used the best published available regarding alcohol policy experiments from all over the world, with particular reference to Scandinavian countries and, of course, Finland in particular. Our estimates should be taken seriously in these public debates when recommendations and decisions are made about whether to allow a completely free market for alcohol.

One *overriding conclusion* is that, in general, the fewer restrictions placed on the retail sale of alcohol the more efficient the market becomes for delivering convenient and affordable alcohol to the population. Increased efficiency and competition both work to drive down prices and increase the ease of access, in turn driving up consumption.

The Finns and their decision makers have to weigh the benefits of better access and lower prices of alcohol against the strong evidence that these will lead to increasing alcohol related harms and economic costs. The two alternatives considered in our report, or Finland with similar alcohol policy as in Sweden, and Finland without alcohol monopoly, differ by hundreds of deaths and millions of euros each year. We suggest that the public debate and decision makers in Finland take this into account when considering the future of alcohol policy in Finland.

Should it be decided by the Finnish people to reduce the harms and economic costs of alcohol use, then the following actions are suggested:

1. Retain the Finnish alcohol monopoly as, once it is disbanded, it will become much harder to influence the alcohol market in a way that will reduce the costs and harm of alcohol.
2. Increase some restrictions on price and availability, for example by adopting some of Sweden's alcohol policies.
3. Consider introducing a "minimum unit price" (e.g. €1.00 per Finnish standard drink) and/or increasing alcohol taxes.

4. Reverse the trend towards longer hours of trading and greater numbers of outlets that currently sell alcohol e.g. gas stations, kiosks, grocery stores;
5. Continue to monitor levels of alcohol consumption, related harms and economic costs to help inform decision-makers and the wider community as to how best to minimise harms from alcohol use in Finland.

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Appendices

Table A1: Alcohol-related conditions and corresponding ICD-10 codes, by condition grouping

Condition Group	Condition Name	ICD10 Coding: Primary diagnosis	ICD10 Coding: External cause (anywhere on abstract)
(1) Communicable diseases	Tuberculosis	A15-A19	
	HIV	B20-B24, Z21	
	Lower respiratory tract infections	J09-J22	
(2) Cancer	Oral cavity and pharynx cancer	C00-C05, C08-C10, C12-C14, D00.0	
	Oesophageal cancer (SCC)	C15, D00.1	
	Colorectal cancer	C18-C21, D01.0-D01.4	
	Liver cancer	C22, D01.5	
	Pancreatic cancer	C25, D01.7	
	Laryngeal cancer	C32, D02.0	
	Breast cancer	C50, D05	
(3) Diabetes	Diabetes mellitus (Type 2)	E11, E13, E14	
(4) Neuropsychiatric conditions	Alcoholic psychoses	F10.0, F10.3-F10.9	
	Alcohol abuse	F10.1	
	Alcohol dependence syndrome	F10.2	

Condition Group	Condition Name	ICD10 Coding	
		Primary diagnosis	External cause (anywhere on abstract)
	Degeneration of nervous system due to alcohol	G31.2	
	Epilepsy	G40-G41	
	Alcoholic polyneuropathy	G62.1	
	Alcoholic myopathy	G72.1	
(5) Cardiovascular conditions	Hypertensive disease / hypertension	I10-I15	
	Ischaemic heart disease	I20-I25	
	Alcoholic cardiomyopathy	I42.6	
	Cardiac arrhythmias	I47-I49	
	Haemorrhagic stroke	I60-I62,I69.0-I69.2	
	Ischaemic stroke	I63,I65-I67,I69.3	
	Oesophageal varices	I85	
(6) Digestive conditions	Alcoholic gastritis	K29.2	
	Liver cirrhosis	K70,K74	
	Acute pancreatitis	K85.0, K85.1, K85.8, K85.9	
	Chronic pancreatitis	K86.1-K86.9	
	Alcohol-induced pancreatitis	K85.2, K86.0	
(7) Motor vehicle collisions	Motor vehicle collisions		V1*, Y85.0
(8) Unintentional injuries	Falls		W00-W19, Y30
	Drowning		W65-W74, Y21

Condition Group	Condition Name	ICD10 Coding Primary diagnosis	ICD10 Coding External cause (anywhere on abstract)
	Fires		X00-X09, Y26
	Accidental poisoning by substances other than alcohol	T36-T50, T52-T65, T96-T97	X40-X44, X46-X49, Y10-Y14, Y16-Y19
	Accidental poisoning by alcohol	T51	X45, Y15
	Other unintentional injuries		V2*, W20-W64, W75-W87, W92, W93, W99, X10-X33, X51, X53-X59, Y20, Y22-Y25, Y27-Y29, Y31-Y34, Y60-Y69, Y83, Y84, Y85.9, Y86, Y87.2, Y88, Y89.9
(9) Intentional injuries	Intentional self-poisoning by substances other than alcohol	T36-T50, T52-T65, T96-T97	X60-X64, X66-X69
	Intentional self-poisoning by alcohol	T51	X65
	Other intentional self-harm		X70-X84, Y87.0
	Assault / homicide		X85-Y09, Y87.1
	Other intentional injuries		Y35, Y89.0

V1*:

V02.1-V02.9,V03.1-V03.9,V04.1-V04.9,V09.2,V09.3,V12.3-V12.9,V13.3-V13.9,V14.3-V14.9,V19.4-V19.6,V20.3-V20.9,V21.3-V21.9,V22.3-V22.9,V23.3-V23.9,V24.3-V24.9,V25.3-V25.9,V26.3-V26.9,V27.3-V27.9,V28.3-V28.9,V29.4-V29.9,V30.4-V30.9,V31.4-V31.9,V32.4-V32.9,V33.4-V33.9,V34.4-V34.9,V35.4-V35.9,V36.4-V36.9,V37.4-V37.9,V38.4-V38.9,V39.4-V39.9,V40.4-V40.9,V41.4-V41.9,V42.4-V42.9,V43.4-V43.9,V44.4-V44.9,V45.4-V45.9,V46.4-V46.9,V47.4-V47.9,V48.4-V48.9,V49.4-V49.9,V50.4-V50.9,V51.4-V51.9,V52.4-V54.9,V53.4-V53.9,V54.4-V54.9,V55.4-V55.9,V56.4-V56.9,V57.4-V57.9,V58.4-V58.9,V59.4-V59.9,V60.4-V60.9,V61.4-V61.9,V62.4-V62.9,V63.4-V63.9,V64.4-V64.9,V65.4-V65.9,V66.4-V66.9,V67.4-67.9,V68.4-V68.9,V69.4-V69.9,V70.4-V70.9,V71.4-V71.9,V72.4-V72.9,V73.4-V73.9,V74.4-V74.9,V75.4-V75.9,V76.4-V76.9,V77.4-V77.9,V78.4-V78.9,V79.4-V79.9,V80.3-V80.5,V81.1,V82.1,V83.0-V83.3,V84.0-V84.3,V85.0-V85.3,V86.0-V86.3,V87.0-V87.8,V89.2

V2*: All codes beginning with V, except V1*.

Table A2: International Classification on Diseases Editions 9 and 10 diagnoses used to define mortality outcomes in the ARIMA analyses

	ICD9	ICD10
Mortality by alcohol-specific causes	291, 303, 3050, 3575, 4255, 5353, 5710–5713, 5770D–5770F, 5771C–5771D, 7607A, 7795A E851.	F10, G312, G4051, G621, G721, I426, K292, K70, K860, K852, 0354, P043, Q860 and X45.
Suicide	E950-E959	X60-X84
Composite measure for injuries comprising:		
Drownings	E910	W65-W74
Fall injuries	E880-E888, E848	W00-W19
Fire injuries	E890-E899	X00-X09
Motor-vehicle traffic crashes	E810-E819	V02-V04, V12-V14, V20-V79, V89.2
Undetermined	E980–E989	Y10–Y34,Y87.2,Y89.9

Table A3: Alcohol-attributable deaths among Finnish people aged 0 to 64 years in 2018, and estimated impacts of alternative alcohol policy scenarios

Condition Category	***Finland in 2018***	***Scenario 1*** *Only <3.5% beer in grocery stores*		***Scenario 2*** *All alcohol sold in grocery stores*	
	Estimate *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*
Communicable diseases	**7** *(6, 8)*	**-1** *(-2, -1)*	**-17.6%** *(-22.8%, -12.2%)*	**+1** *(0, +1)*	**+10.2%** *(+5.8%, +14.8%)*
Cancer	**134** *(116, 151)*	**-21** *(-30, -13)*	**-15.8%** *(-22.1%, -9.3%)*	**+12** *(+5, +20)*	**+9.3%** *(+3.4%, +15.1%)*
Type 2 diabetes	**-1** *(-)*	**0** *(-)*	**-1.6%** *(-17.5%, +14.6%)*	**0** *(-)*	**+0.9%** *(-15.4%, +17.2%)*
Neuropsychiatric conditions	**92** *(90, 94)*	**-29** *(-36, -22)*	**-31.8%** *(-39%, -17.8%)*	**+18** *(+12, +25)*	**+19.9%** *(+13.4%, +26.7%)*
Cardiovascular conditions	**207** *(176, 239)*	**-40** *(-56, -23)*	**-19.1%** *(-26.8%, -11.1%)*	**+24** *(+9, +40)*	**+11.6%** *(+4.2%, +19.2%)*
Digestive conditions	**448** *(418, 467)*	**-108** *(-134, -80)*	**-24%** *(-30%, -17.8%)*	**+65** *(+42, +87)*	**+14.4%** *(+9.5%, +19.5%)*
Transportation	**36** *(33, 39)*	**-8** *(-11, -6)*	**-22.6%** *(-29.4%, -15.5%)*	**+5** *(+2, +7)*	**+12.7%** *(+6.3%, +19.2%)*
Injuries (unintentional)	**275** *(263, 287)*	**-59** *(-76, -42)*	**-21.6%** *(-27.6%, -15.3%)*	**+33** *(+19, +48)*	**+12%** *(+6.8%, +17.4%)*
Injuries (intentional)	**127** *(116, 137)*	**-31** *(-41, -21)*	**-24.7%** *(-32.1%, -16.8%)*	**+18** *(+8, +28)*	**+14.2%** *(+6.4%, +22%)*
Total	***1 326*** *(1 216, 1 422)*	***-298*** *(-385, -207)*	***-22.5%*** *(-29%, -15.6%)*	***+176*** *(+97, +256)*	***+13.3%*** *(+7.3%, +19.3%)*

Table A4: Estimated costs of lost productivity costs (EUR thousands) due to alcohol attributable mortality among Finnish people aged 0 to 64 years in 2018, and changes under alternative policy scenarios

Condition Category	***Finland in 2018***	***Scenario 1 No Grocery Store Sales***		***Scenario 2 All Alcohol in Grocery Stores***	
	Estimate (thousands) *(95% CI)*	**Change** (thousands) *(95% CI)*	**Percent Change** *(95% CI)*	**Change** (thousands) *(95% CI)*	**Percent Change** *(95% CI)*
Communicable diseases	**2 867** *(2 327, 3 370)*	**-€502** *(-€653, -€348)*	**-17.5%** *(-22.8%, -12.1%)*	**+€291** *(+€162, +€424)*	**+10.1%** *(+5.7%, +14.8%)*
Cancer	**44 313** *(38 251, 49 802)*	**-€7 033** *(-€9 841, -€4 166)*	**-15.9%** *(-22.2%, -9.4%)*	**+€4 116** *(+€1 549, +€6 706)*	**+9.3%** *(+3.5%, +15.1%)*
Type 2 diabetes	**-220** *(-303, -138)*	**-€12** *(-€64, +40)*	**-5.5%** *(-29%, +18.3%)*	**+€7** *(-46, +€59)*	**+3.2%** *(-20.7%, +27%)*
Neuropsychiatric conditions	**37 129** *(35 939, 38 173)*	**-€11 579** *(-€14 266, -€8 718)*	**-31.2%** *(-38.4%, -23.5%)*	**+€7 230** *(+€4 830, +€9 728)*	**+19.5%** *(+13.0%, +26.2%)*
Cardiovascular conditions	**77 501** *(66 941, 87 781)*	**-€14 198** *(-€19 629, -€8 600)*	**-18.3%** *(-25.3%, -11.1%)*	**+€8 469** *(+€3 397, +€13 633)*	**+10.9%** *(+4.4%, +17.6%)*
Digestive conditions	**190 800** *(178 252, 198 717)*	**-€46 516** *(-€58 038, -€34 449)*	**-24.4%** *(-30.4%, -15.9%)*	**+€27 908** *(+€18 407, +€37 517)*	**+14.6%** *(+9.6%, +19.7%)*
Transportation	**24 642** *(22 437, 26 696)*	**-€5 697** *(-€7 405, -€3 915)*	**-23.1%** *(-30.4%, -18.1%)*	**+€3 209** *(+€1 600, +€4 836)*	**+13.0%** *(+6.5%, +19.6%)*
Injuries (unintentional)	**145 721** *(138 905, 152 111)*	**-€30 978** *(-€39 776, -€21 924)*	**-21.3%** *(-27.3%, -15.0%)*	**+€17 118** *(+€9 682, +€24 639)*	**+11.7%** *(+6.6%, +16.9%)*
Injuries (intentional)	**93 400** *(85 699, 100 524)*	**-€23 134** *(-€30 054, -€15 801)*	**-24.8%** *(-32.2%, -16.9%)*	**+€13 214** *(+€6 129, +€20 352)*	**+14.1%** *(+6.6%, +21.8%)*
Total	***616 155*** *(568 448, 657 080)*	***-€139 648*** *(-€179 725, -€97 883)*	***-22.7%*** *(-29.2%, -15.9%)*	***+€81 562*** *(+€45 709, +€117 893)*	***+13.2%*** *(+7.4%, +19.1%)*

Table A5: Alcohol-attributable lost productivity costs (EUR thousands) due to LTD workforce in Finland among productive (15-64 years) individuals, 2018, and changes under scenario conditions.

Condition Category	***Finland in 2018***	***Scenario 1*** *Only <3.5% beer in grocery stores*		***Scenario 2*** *All alcohol sold in grocery stores*	
	Estimate (thousands) *(95% CI)*	**Change** (Thousands) *(95% CI)*	**Percent Change** *(95% CI)*	**Change** (thousands) *(95% CI)*	**Percent Change** *(95% CI)*
Communicable diseases	**8** *(7, 10)*	**-€2** *(-€1, -€3)*	**-22.9%** *(-29.6%, -15.8%)*	**+€1** *(+€1, +€2)*	**+14.5%** *(+7.6%, +21.6%)*
Cancer	**404** *(343, 462)*	**-€59** *(-€90, -€28)*	**-14.7%** *(-22.4%, -6.9%)*	**+€36** *(+€6, +€67)*	**+8.9%** *(+1.4%, +16.5%)*
Type 2 diabetes	**-252** *(-317, -187)*	**+€7** *(-€39, +€53)*	**+2.9%** *(-15.4%, +21.2%)*	**-€4** *(-€52, +€44)*	**-1.4%** *(-20.6%, +17.4%)*
Neuropsychiatric	**104 097** *(-)*	**-€45 553** *(-€51 273, -€32 904)*	**-40.9%** *(-49.3%, -31.6%)*	**+€31 571** *(+€20 751, +€44 820)*	**+30.3%** *(+19.9%, +43.1%)*
Diseases of the nervous system	**6 574** *(5 524, 7 565)*	**-€1 274** *(-€1 651, -€879)*	**-19.4** *(-25.1%, -13.4%)*	**+€768** *(+€413, +€1 134)*	**+11.7%** *(+6.3%, +17.3%)*
Cardiovascular	**-17** *(-87, +53)*	**-€52** *(-€85, -€18)*	**-298.0%** *(-489.8%, -104.9%)*	**+€34** *(-€1, +€70)*	**+198.5%** *(-10.1%, +406.8%)*
Respiratory	**221** *(178, 263)*	**-€37** *(-€49, -€24)*	**-16.7%** *(-22.4%, -10.7%)*	**+€22** *(+€10, +€35)*	**+10.1%** *(+4.3%, +16.1%)*
Digestive	**1 152** *(1 058, 1 235)*	**-€186** *(-€253, -€119)*	**-16.1%** *(-21.9%, -10.3%)*	**+€109** *(+€53, +€166)*	**+9.5%** *(+4.6%, +14.4%)*
Injury, poisoning and other external causes	**2 572** *(2 270, 2 867)*	**-€707** *(-€909, -€482)*	**-27.5%** *(-35.3%, -18.7%)*	**+€455** *(+€150, +€772)*	**+17.7%** *(+5.8%, +30%)*
Other or diagnosis missing	**1 277** *(1 126, 1 425)*	**-€405** *(-€525, -€277)*	**-31.7%** *(-41.1%, -21.7%)*	**+€277** *(132, +€436)*	**+21.7%** *(+10.3%, +34.2%)*
Total	***116 035*** *(114 198, 117 791)*	***-€45 268*** *(-€54 875, -€34 678)*	***-39.0%*** *(-47.3%, -29.9%)*	***+€33 270*** *(+€21 460, +€47 546)*	***+28.7%*** *(+18.5%, +41.0%)*

Table A6: Summary of total estimated economic impacts on mortality, healthcare, productivity and criminal justice system in Finland, 2018 of different alcohol policy scenarios using InterMAHP and other attributable fraction methods

Outcome	*Finland in 2018*	*Scenario 1* *Only <3.5% beer in grocery stores*		*Scenario 2* *All alcohol sold in grocery stores*	
	Estimate *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*	**Change** *(95% CI)*	**Percent Change** *(95% CI)*
Per Capita Alcohol Consumption	**10.45L***	**-1.66L**	**-15.9%** (-19.7%, -11.8%)	**+0.94L**	**8.6%** (+6.2%, +11.8%)
Mortality	**€616** *(€568, €657)*	**-€140** *(-€180, -€98)*	**-22.7%** *(-29.2%,15.9%)*	**+€82** *(+€46, +€118)*	**+13.2%** *(+7.4%, +19.1%)*
Hospital admissions	**€201** *(€171, €229)*	**-€64** *(-€85, -€42)*	**-32%** (-42.2%, -21.1%)	**+€43** *(+€18, +€70)*	**+21.6%** *(+9.1%, +34.9%)*
Long-term Disability	**€116** *(€114, €118)*	**-€45** *(-€55, -€35)*	**-39.0%** *(-47.3%, -29.9%)*	**+€33** *(+€21, +€48)*	**+28.7%** *(+18.5%, +41.0%)*
Criminal Offences	**€649** *(€646, €651)*	**-€123** *(-€234, -€6)*	**-19.7%** *(-36.1%, -0.9%)*	**+€112** *(+€43, +€173)*	**+17.3%** *(+6.7%, +26.7%)*
Total Economic Costs (Euros, millions)	**€1 582** *(€1 500, €1 655)*	**-€377** *(-€554, -€181)*	**-23.8%** *(-35.0%, -11.4%)*	**+€271** *(+€129, +€409)*	**+17.1%** *(+8.1%, +25.8)*

* Estimated consumption of Finns abroad is not included here. It is assumed that it is broadly equivalent to the amount of alcohol consumed by visitors to Finland i.e. it is cancelled out.

Table A7: Summary of sensitivity analyses by effect on total per-capita alcohol consumption (PCAC), attributable counts, and attributable costs by scenario and affected sensitivity area

Outcome		Sensitivity regarding baseline Scenario		Scenario 2 sensitivity test results under different assumptions				
		Study estimate	IHD Roerecke & Rehm	Study estimate	Cross-Elasticity (-0.17)	Wagenaar Elasticity (-0.44)	Density -10%	Density +10%
Total PCAC		10.45	n/a	11.39	11.30	11.34	11.36	11.40
Percent change in Total PCAC		+0.00%	n/a	+8.96%	+8.11%	+8.56%	+8.73%	+9.12%
Counts	Mortality	4 071	3 886	4 627	4 568	4 597	4 608	4 633
	Productive years of life lost	17 101	17 933	19 384	19 003	19 116	19 159	19 257
	Long-term disability cases	2 799	2 762	3 601	3 480	3 524	3 540	3 579
	Hospital admissions	46 016	39 367	56 051	55 022	55 554	55 756	56 221
	Criminal offences	272 244	272 244	310 055	306 735	310 397	310 452	310 817
Costs, in millions of Euros	LOP due to mortality	616	649	698	683	687	689	692
	LOP due to LTD	116	114	146	144	146	147	148
	Hospital costs	201	157	244	240	242	243	245
	Crime costs	649	649	762	753	762	762	763
	Total	1 582	1 569	1 852	1 821	1 838	1 841	1 849

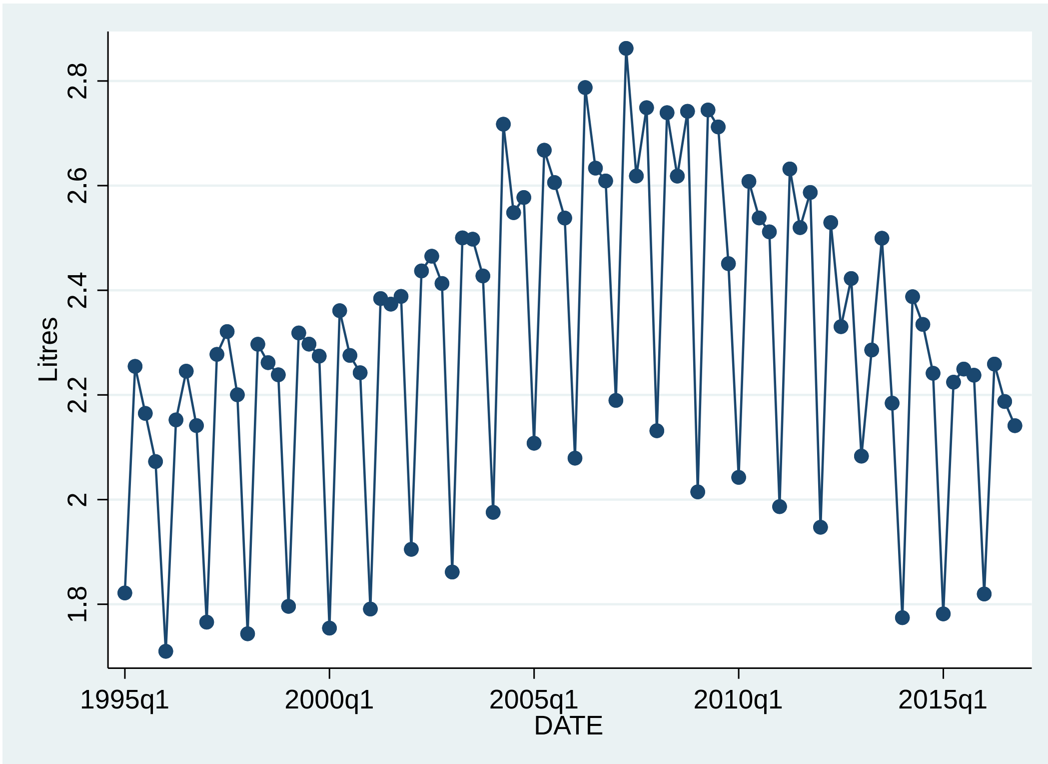
Table A8: Sensitivity Analysis Summary, total and percent count and cost changes for criminal justice, baseline scenario

Outcome		Sensitivity regarding Criminal Justice analysis	
		Study estimate	*0.080 non-violent crime AF*
Counts *n (% change)*	All crime events	272 244	138 649 (-49.1%)
Costs (Euros, millions)	Crime costs	649	464 (-28.5%)
	Total costs	*1 582*	*1 397 (-11.7%)*

Table A9: Sensitivity Analysis Summary, total and percent count and cost changes for mortality lost productivity, baseline scenario

Outcome		Sensitivity regarding Lost Productivity (LOP) discount analysis		
		Study estimate	0%	3%
Costs (Euros, millions)	LOP due to mortality	616	749 (+21.6%)	565 (-8.4%)
	Total Costs	*1 582*	*1 715 (+8.4%)*	*1 530 (-3.3%)*

Figure A1: Trend in Quarterly Recorded Per Capita Alcohol Consumption in Finland, 1995 to 2016



Source: National Institute for Health and Welfare (THL)

Figure A2: Suicide, rate per 100 000 population, 15 years and above

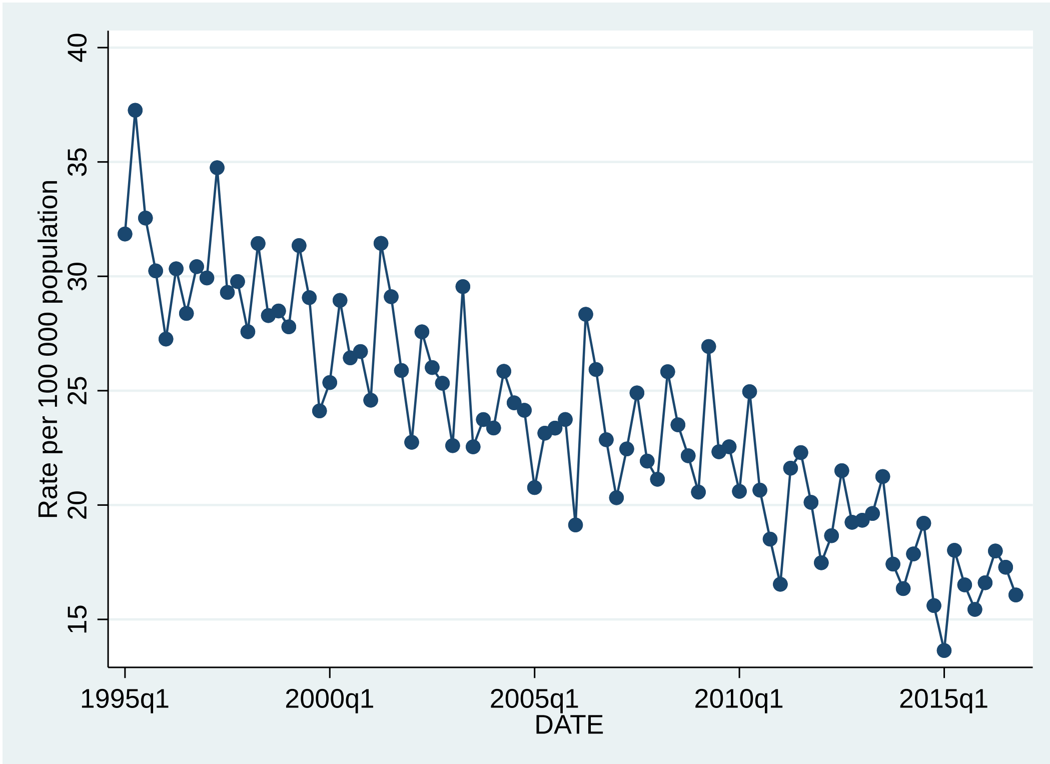


Figure A3: Unintentional injuries, rate per 100 000 population, 15 years and above