Research Project Protocol

Project title
Integrated evidence synthesis for joint appraisal of tobacco and alcohol tax interventions for harm reduction in the UK

Funder
NIHR PHR 16/105/26

Duration of project
01/03/2018 to 28/02/2021 (36 months)

Research sponsor and host organisation
The University of Sheffield

Email: syntax@sheffield.ac.uk

Protocol registration
www.researchregistry.com
Research Registry Unique Identifying Number: researchregistry3814
Registration Date: March 13, 2018

University of Sheffield research team:
Professor Alan BRENNAN (Principal investigator)
Dr Duncan GILLESPIE (Project manager)
Dr Penny BUYKX
Mr Colin ANGUS
Dr John HOLMES
Professor Petra MEIER
Dr Robert PRYCE
Dr Luke WILSON

University of Bath research team:
Professor Anna GILMORE
Dr Jenny HATCHARD
Dr Rosemary HISCOCK

Background

Current taxation on tobacco and alcohol in the UK

How the UK sets tobacco and alcohol taxation is limited by the European Union (EU) under the Tobacco Tax Directive [1] and two Alcohol Tax Directives [2, 3]. These directives aim to harmonise how tax is applied across the EU. The rules vary across the spectrum of tobacco and alcohol products and set boundaries in terms of:

(1) *structure*, e.g., whether taxation is applied in proportion to pre-tax product value (*ad valorem* duty) or content (specific duty);
(2) *level*, i.e. at what rate.

The Tobacco Tax Directive requires that taxation on manufactured cigarettes includes both an *ad valorem* component and a specific component and sets minimum thresholds for the amount of duty on tobacco products. The Alcohol Tax Directives set minimum rates for excise duty on a range of alcohol product categories. The EU Tax Directives for Tobacco and Alcohol are currently under review.

In the last five years, UK levels of taxation on alcohol and tobacco have diverged significantly. In 2011 both tobacco [4, 5] and alcohol [6] products were subject to a duty escalator which ensured an annual 2% rise above inflation. In 2013/14, the duty escalator on alcohol (introduced in 2008) was ended [6] and duty on most alcohol products was subsequently cut. The effect of this by 2016, was that UK alcohol prices were lower than would have been the case under the duty escalator [7]. In contrast, the 2% p.a. above inflation tobacco duty escalator is expected to continue until 2020 (the end of the current Parliament), and in 2016 the duty rate for hand rolling tobacco (HRT) was set at 5% above inflation [8] in an attempt to narrow the duty gap between cigarettes and HRT. On 20 May 2017, the government will introduce a Minimum Excise Tax for cigarettes to target the cheapest tobacco [9], with the minimum tax £268.63 per 1000 cigarettes. The government has consulted on introducing a new duty band for still cider just below 7.5% by volume to target white ciders, and on a new duty band for still wine and made-wine between 5.5% and 8.5% by volume.

Individual variation in prices paid

Modelling tax interventions on tobacco and/or alcohol requires baseline information on social patterns of spending. Social patterns in prices paid and consumption lead to differential exposure to tax interventions [10]. However, to date the majority of research into patterns of consumer behaviour with respect to tobacco and alcohol has treated smoking and drinking as separate behaviours and has paid little attention to the relationship between behaviours. This relationship begins at the consumer's decision on what to purchase, which can be studied using data on product types and prices paid. There is wide variation in the prices at which alcohol or tobacco can be purchased. This variation has been expanding over time as the tobacco and alcohol industries seek to maintain cheap products in order to maintain their consumer base (there is evidence that individuals with lower socio-economic status [11, 12] and individuals with higher levels of consumption [13] buy cheaper products). For alcohol, prices have been reduced further by a shift in availability from the on-trade to the off-trade due to the closure of pubs and nightclubs, which has happened alongside an increase in shops and supermarkets that sell alcohol at significantly cheaper prices [14, 15]. In addition to the products purchased and the prices paid it is essential to know the amounts of tobacco and alcohol consumed by individuals with different socio-demographic characteristics. There is evidence that heavier consumption of tobacco is more prevalent among individuals with lower socio-economic position [16]. For alcohol the situation is more complex, with lower socioeconomic groups having lower prevalence of drinking overall [17], but higher rates of drinking at very heavy levels [18]. In addition there is evidence that smoking/higher consumption of tobacco is associated with higher consumption of alcohol [19].

Industry modification of tax effects on retail price – Tax Pass-through

The product price seen by consumers is largely the result of an interaction between government taxation and industry pricing strategies. Government sets taxation but industry can decide whether to meet the tax demands through increasing products' prices uniformly or by increasing prices on some products whilst leaving the prices of other products unchanged or increasing i.e. modifying the tax 'pass-through' to product prices. For tax pass-through on alcohol, there is a small body of recent literature [20]. Members of the Sheffield team have analysed weekly data on supermarket prices over a 3 year period to quantify how alcohol duty pass-through on off-trade beverages (beer, cider & RTDs, wine and spirits) varies across the price spectrum (in deciles of price per unit of alcohol) [21]. This showed under-shifting for cheaper products (in terms of price per unit of alcohol) and over-shifting for more expensive ones. For tobacco the literature is

sparse. There is one recent US study of Nielsen store-level scanner data on cigarette prices over 2011-2012, which found on average that cigarette taxes were over-shifted, and that pass-through rates were higher for premium brands than for discount brands [22]. Members of the Bath team have had access to commercial market data that provides prices on different tobacco products over several years, and have been undertaking descriptive statistical analyses of price changes seen alongside specific tax events [11]. The findings suggest that industry-initiated cigarette price changes in the UK are timed to maintain the low price of the cheapest brands. However, these analyses do not include modelling equivalent to that for off-trade alcohol above.

Therefore, there is a need for an updated analysis of tax pass-through rates in the UK that uses a methodology that is coherent across both tobacco and on- and off-trade alcohol products. This analysis is critical to understanding the overall impact of taxation policies on health, as the extent to which taxation changes are passed through to consumers of different products is the key driver of changes in consumption and thus health. More importantly, establishing the ways in which pass-through differs between products and across the price spectrum enables a fuller understanding of the ways in which taxation policies change the shape of the retail landscape by, for example, changing the relative prices of beer in the pub and in the supermarket, or between ultra-low price and premium cigarettes. When combined with an understanding of the extent to which different socio-economic groups purchase these different products this will allow us to quantify the extent to which different groups experience changes in taxation and the implications that tax changes might have for socio-economic inequalities in spending, consumption and health.

Effects of changes in retail prices on demand for tobacco and alcohol – Price Elasticities

Changes in consumer purchasing when prices change are a combination of the decision to purchase the product at all (participation), and how much to purchase. Estimates of consumer responses to price changes take the form of 'price elasticities of demand', or the proportional change in consumption for a unit proportional change in price. The 'own-price' elasticity tells us the response of demand for a product to a change in its own price. The 'cross-price' elasticity tells us the response due to a change in another product's price. Price elasticities for alcohol have been studied extensively [23, 24]. Members of the Sheffield team have estimated UK own and cross-prices elasticities for 10 categories of alcohol (beers, cider, wine, spirits, RTDs separating on-trade and off-trade). Our analysis used data from the Living Costs and Food Survey for 2001 to 2009 and grouped individuals into 72 defined subgroups for longitudinal fixed effects statistical modelling, a method known as a pseudopanel approach [24]. These have been used for analyses of alcohol minimum pricing and taxation for Public Health England and for the Scottish government [17, 25]. HMRC have undertaken a series of price elasticity analyses over the last 15 years. Huang et al [26] estimated the price elasticities using aggregate time series approaches. For tobacco, there is also a substantial literature on price elasticities including studies which examine the price responsiveness of four different metrics: participation in smoking, quantity purchased, money spent on tobacco and share of budget spent on tobacco [27]. In the UK, HMRC has examined price elasticities for tobacco using quarterly aggregate time series analysis in 2010 [28]; with updated analysis in 2015 [29]. This work did not examine three important issues however: it did not distinguish between manufactured and hand-rolled tobacco, did not consider any relationship with alcohol purchasing and did not examine participation elasticities i.e. the effects of price changes on individuals' quitting tobacco.

Jointly estimated price elasticities for both tobacco and alcohol are rare and the findings show substantial uncertainty around the effects of changes in the price of one substance on purchase of the other. The OECD recently reviewed the international literature [30]. The evidence shows a complex relationship between tobacco and alcohol consumption. Studies reviewed suggested that smokers who drink respond to changes in alcohol prices by reducing both alcohol and tobacco consumption (complementary commodities), while drinkers who smoke respond less (or not at all) to changes in cigarette prices. When analysing categories of alcohol, one study found alcohol to be a substitute for cigarettes when the price of the latter changed, but found a complementary relationship when the price of beer changed. This complexity requires further research, and most importantly, there are no studies in the UK in which a single econometric modelling approach is used to estimate joint price elasticities for participation in and consumption of both tobacco and alcohol products simultaneously.

Related Issues – Illicit Tobacco and E-cigarettes

Illicit tobacco use, by which we mean tobacco on which UK tax duty has not been paid, is estimated by HMRC to have been falling over the last 10 years [31]. The government publication "From Leaf to Light" highlights that the estimated proportion of manufactured cigarettes on which duty has not been paid has fallen from 22% to 10% between 2000 and 2013/14, while for hand rolled tobacco the fall has been from 61% to 39%.

This is despite the fact that over this period tax has risen consistently. The reason for the fall is held to be the increased enforcement and restriction of illicit trade over the years. One UK study has attempted to understand the potential impact of illicit tobacco on price elasticities for tobacco finding that price elasticities were slightly lower if adjustment for smuggling were undertaken, but this did not provide any cross-price elasticity estimation between illicit and duty paid tobacco [32]. It is methodologically challenging to estimate cross-price elasticities between duty paid tobacco products and illicit tobacco because one ideally needs complete survey data on the quantity purchased and price paid for both kinds of product and to our knowledge this is not available. The price of illicit products is understood to be around half of that of duty paid products and it is unclear whether, for example, the LCFS contains data on illicit tobacco purchases. Because of these data issues and the issue of enforcement as a determining and confounding factor, we cannot estimate cross-price elasticities between duty paid and illicit tobacco in the LCFS.

E-cigarettes are an important issue in tobacco control. By 2018, there were three papers estimating price elasticities of e-cigarettes [33-35]. The latest of these papers [33] used time-series data (from December 2011 to October 2014 for UK) on e-cigarette sales as well as e-cigarette and cigarette prices for six EU markets including the UK, obtained from the Nielsen Company. Coverage of the e-cigarette market is low (e.g. 34% in Ireland, 20-30% in Estonia, 1% in Sweden, and not provided for UK) because a significant proportion of sales are online or in 'vape shops', and are not covered by Nielsen or any other consumer data collection organisation. LCFS does not collect purchasing of e-cigarettes or the refills for them. For these reasons, we cannot at this stage estimate cross-price elasticities using our proposed methods.

Mathematical population modelling to support decision-making on interventions

Models are in effect a method for synthesising the diverse range of quantitative evidence that pertains to an intervention and presenting this evidence in the context of an intervention's likely future effects. The Sheffield Alcohol Policy Model (SAPM) was built and continues to be developed in consultation with a broad range of stakeholders to provide decision support to local and national level policymakers in developing strategies for alcohol harm reduction in the UK (for price interventions this includes duty changes, minimum thresholds for the duty applied and minimum unit pricing) [36]. The Sheffield modelling has been successful because of the close fit of the modelled outcomes and interventions with the information needs of a range of stakeholders [37]. SAPM models a wide range of outcomes: cause-specific disease and death and the costs of treatment, tax revenues, effects of ill-health on businesses through time off sick, change to the disposable income of consumers [38]. This latter outcome is important because studies have shown that expenditure on tobacco and alcohol can 'crowd out' expenditure on other purchases, including healthy food and housing, thus potentially contributing to the negative effects of poverty [39, 40]. It also models realistic detail on the mechanisms that link the implementation of price interventions to consumer behaviour, e.g., for specific alcoholic products it models tax changes, subsequent industry modification of tax pass-through and consumer responses through the price elasticities of demand [41]. SAPM provides detailed cause-specific health outcomes for the range of alcohol attributable diseases. It also provides outcomes specific to socio-demographic subgroups of the population, which allows conclusions on the potential effect of interventions on health and economic inequalities [12, 13].

For tobacco modelling, within the range of models worldwide [42] the key models in the UK are: (1) the modelling by Action on Smoking and Health that is used to provide evidence to government consultations on changes to taxation [43], (2) the modelling by Brunel University that produced the NICE return on investment tool for tobacco that appraises the health economic effects of a range of interventions [44], (3) the modelling by Cancer Research UK and the UK Health Forum that extends the Foresight Obesity Project methods to tobacco [45]. The ASH model is the closest in structure to SAPM and has been used to appraise the effects of increasing the duty escalator at different rates for cigarettes and hand rolling tobacco. The submission of the modelled findings to government ahead of the 2016 Budget supported the subsequent decision to implement a faster duty escalator for HRT to reduce its use as a cheap option for smoking. Tax interventions for tobacco that have not so far been appraised include the Minimum Excise Tax (MET) for cigarettes to be implemented on 20 May 2017, and the Minimum Consumption Tax (MCT) for tobacco that was a proposed alternative to MET that includes VAT in the calculation of the minimum tax applied and would therefore also affect the price of HRT. None of these models have the ability of SAPM to model the mechanisms of price interventions in detail and to show the socio-demographic differentials in outcomes.

The reason for modelling alcohol and tobacco together is to show the potential scale of effect that joint tax changes on tobacco and alcohol could have on health and social inequalities in health. Funded by the UK

Centre for Tobacco and Alcohol Studies, the research team have extended SAPM to the Sheffield Tobacco and Alcohol Policy model (STAPM) [46, 47]. We will begin the proposed research with model components that (1) project future individual consumption, and (2) translate changes in consumption to estimated effects on deaths, hospital admissions and the associated NHS costs of those admissions. We have designed work packages 1-3 to provide the essential inputs for us to use STAPM to appraise tax interventions. WP4 will build the additional model components required to use this information (based on SAPM) and conduct the appraisals.

Research objectives

In this project we will define a set of relevant new taxation options across tobacco and alcohol for the UK. We will then examine the available evidence on how these changes to taxation are likely to affect consumer behaviour, health and the wider economic implications.

Population The population covered by our proposed evidence synthesis is adults over 18 in the UK. The setting for almost all of our study is the whole UK, because tax interventions are country wide. The data to inform WP1 on policy options will come from UK wide stakeholder research. WP2 will focus on LCFS data which includes England, Scotland and Wales, but with individual analysis relating to consumption for England. WP3 joint price elasticities will be for the UK. WP4 model appraisal with focus on England.

Interventions From our stakeholder engagement and research in WP1, we will define the details of a set of taxation interventions across tobacco and alcohol for appraisal in WP4.

Comparisons The 'control treatment' is current UK tobacco and alcohol tax. We will appraise effects up to 30 years from the baseline year.

Outcomes We will calculate the expected outcomes of changes to taxation for:

1) total and social differentials in cause-specific disease and death from 63 conditions;
2) the costs of treatment to the NHS;
3) Government tax receipts;
4) the effects of ill-health on businesses through time off sick;
5) social differentials in individual spending.

We will address the following specific objectives:

Work package 1: Qualitative research to define and understand relevant tax interventions

WP1 aims to define an evidence-based and stakeholder informed set of 'candidate' alcohol and tobacco tax interventions relevant to the UK context that will be modelled, AND to provide a grounded understanding of the policy effects valued by stakeholders, of mediating factors they perceive as affecting deliberation and implementation, and of gaps they identify in the evidence base.

Objectives

1. To conduct a rapid review to provide each participant with background information on the range of possible and implemented tax interventions.
2. To conduct semi-structured interviews with 5 sets of key stakeholders to elicit more detailed technical descriptions of tax changes, grounded in an understanding of the policy effects valued by stakeholders, of mediating factors they perceive as affecting deliberation and implementation, and of gaps they identify in the evidence base.

Work package 2: Analysis of social patterns in spending on tobacco and alcohol

WP2 aims to describe the socio-demographic variation[1] in patterns of spending (product type and price) across the spectrum of tobacco and alcohol products and the impact on household budgets.

Objectives

1. To examine the relationship between household spending on alcohol and tobacco and overall household budgets and how this varies by socio-demographic sub-groups.

[1] sub-groups include age, sex, education, social class, employment status, family status, equivalised household income, the household index of multiple deprivation score, and government office region.

2. To describe the joint patterns in consumption and spending of tobacco and alcohol, and how these vary by socio-demographic subgroups and by the level of smoking and drinking.

Work package 3: Analysis of industry and consumer responses to tax changes
WP3 aims to estimate the responses of industry and consumers to changes in taxation.

Objectives
1. To investigate the extent to which tax changes are likely to be passed on to consumers as retail price changes across the product and price spectrum for tobacco and alcohol products (using a consistent approach for tobacco and alcohol).
2. To harmonise estimates across tobacco and alcohol in terms of how retail price changes affect participation in tobacco use, participation in alcohol use, quantity of tobacco products purchased and quantity of alcohol products purchased including the interactions between these behaviours.

Work package 4: Population modelling to appraise the health and economic outcomes of tax interventions
WP4 aims to conduct a prospective long-term health economic assessment of the taxation interventions for tobacco and alcohol.

Objectives
1. To develop the model structure so that it can implement the taxation interventions from WP1.
2. To model further outcomes relevant to tax interventions
3. To appraise the interventions from WP1.
4. To assess the uncertainty in estimated outcomes due to uncertainty around industry modification of tax pass-through and consumer price elasticities of demand, from WP3.
5. To compare our model results with other model-based appraisals of tax changes to understand and explain why the models give similar or different answers.

Research design

Work package 1: Qualitative research to define and understand relevant tax interventions and their policy context

<u>Objective 1: Conduct a rapid review to provide each participant with background information on the range of possible and implemented tax interventions.</u>

We will conduct a 'rapid review' [48, 49] of contemporary UK tobacco and alcohol taxation intervention options, and associated evidence and debates. The review will expand on an academic and stakeholder workshop that the research team organised which led to the conceptualisation of interventions across tobacco and alcohol as acting on a common system that links consumer behaviour and social actors, including government and industry [47]. The review will also make use of a policy document dataset collected during a Cancer Research UK funded research project examining tobacco, alcohol and sugar tax policy networks.[2]

Inclusion criteria
*Geography***:** UK. *Methodologies***:** No methodological restrictions, quantitative and qualitative analyses to be included. *Search tools***:** PubMed, Scopus, Google, Existing policy document dataset, Project Management Group. *Dates***:** 1997-2017. *Language***:** English language documents only.

Search strategy
*Topic***:** Sources must include description and/or analysis of one or more taxation intervention for either or both tobacco and alcohol. *Search terms***:** ((Tobacco OR cig* OR alcohol OR drink OR beer OR wine OR cider OR spirits) AND (tax* OR excise OR duty) AND (UK OR "United Kingdom" OR Scotland OR England OR

[2] Hatchard, J, Voices in Fiscal Cancer Prevention: An investigation of non-governmental organisations engaged in tobacco, alcohol and sugar taxation and price policy debates in the UK, Cancer Research UK Tobacco Advisory Group Project Award C58487/A22731, 2016-18.

Wales OR "Northern Ireland" OR Britain)). *Sources***:** Peer-reviewed research papers and grey literature governmental and non-governmental reports.

Data extraction
We will use a standard form to extract data according to the PICO framework: *Population***:** The geographical context, population group and timeframe in which the tax intervention was posited or implemented *Intervention***:** The technical definition of the tax intervention, including the rationale for the change. *Comparator***:** The system, or aspect of the system, of taxation across tobacco and/or alcohol products that was changed by the intervention. *Outcome***:** Primary effects on consumer behaviour and secondary effects on health, social and economic outcomes, mediating factors impacting effectiveness (e.g. subsequent industry modification of effect), and differential effects among subgroups.

Synthesis
The data will be synthesised into a technical report to be shared with the SYNTAX team for use in WPs 2-4. This report will be summarised in a briefing to be shared with stakeholders prior to interviews. The WP1 team and subsequently the Project Management Group will critically appraise this document before use.

Review management
One reviewer only will select the literature and the WP1 team and subsequently the Project Management Group will assess the selection for completeness and relevance [48]. One reviewer will extract the data and the WP1 team will work collaboratively to produce the synthesis. Peer discussion will be used throughout to ensure rigour within the review process. The review will not assess the quality of the papers.

Objective 2: Conduct semi-structured interviews with key stakeholders to elicit thick descriptions of potential tobacco and alcohol tax changes that are relevant for SYNTAX to model, grounded in an understanding of the policy effects valued by stakeholders, of mediating factors they perceive as affecting deliberation and implementation, and of gaps they identify in the evidence base.

We will conduct and analyse five rich semi-structured elite interviews [50] undertaken with 2-3 participants each. Participants will be drawn from six key stakeholder organisations with an influence over and/or technical expertise in tobacco and/or alcohol taxation interventions. Interviews will cover UK tobacco and alcohol tax options, stakeholder views on priority effects, mediating factors and evidence gaps in relation to both separate and joint tobacco and alcohol taxation intervention options. These interviews will enable the SYNTAX team to gain a rich understanding of the complex policy space in which tobacco and alcohol taxation changes take place, co-exist and interact.

Preparation
Informed by the rapid review synthesis, we will develop a topic guide for our interviews and a deductive codebook to structure our analysis of the interview data. In the development of both resources, the WP1 team will liaise with the WP4 modelling team to ensure that interviews and analysis will generate a candidate set of tax changes for modelling in WP4, each accompanied by a thick description of rationale, barriers and drivers to implementation and stakeholder priorities. These tax changes are likely to be both changes to the level of taxation e.g. increase duty by 1% on beer and structural changes to how tax is applied e.g. remove the current EU requirement that cigarettes be subject to a mixture of specific and ad valorem duty.

Sample
We aim to engage with Government (HMRC, HM Treasury, and Department of Health) and Government arms-length knowledge brokers at the forefront of this process, and with health advocacy groups experienced in submitting technical evidence on tax changes to public consultations.

These participant organisations have been selected purposively on the basis of their influence over and/or demonstrated expertise in tobacco and/or alcohol taxation and we aim to interview 2 or 3 people from each of them (n=10). We will not interview representatives from the tobacco or alcohol industries.

Procedure

Participants will be contacted by phone or email and invited to participate – a short summary of the project will be shared with participants and written consent obtained where agreement to participate is given. Prior to interview, the review briefing will be shared with participants.

Interviews will be semi-structured, based on the topic guide. Interviews will be conducted in person or by telephone if a face-to-face meeting is not possible. Where consent is given, an audio recording will be made. Notes will be taken by a second researcher if consent to record is not granted by participants.

Adopting a joint interview data collection methodology will stimulate an exchange of perspectives about options for tax change. In governmental organisations where there are both tobacco and alcohol experts, participants will be consulted in the same interview setting to enable this exchange. Substance-specific organisation representatives will be brought together in a single joint interview.

Interviews will explore the options for tobacco and/or alcohol taxation interventions identified in the rapid review and any new options identified by interviewees. Participants will be asked to reflect on their perceptions of each taxation option for tobacco and/or alcohol. Discussions will encompass four key inter-related aspects:

i. Technical descriptions of tobacco, alcohol and co-ordinated taxation options – what is the intervention, what will it achieve, how will it work?
ii. Stakeholders' priorities regarding the effect(s) of each intervention – which effects, and in what order, are regarded as important in taxation policy deliberation settings? For example, overall changes in consumption (e.g. quitting vs. cutting down); consumption and socio-economic effects on population subgroups (e.g. lower socio-economic groups, those with mental health needs, young people, 'harmful users'); as well as effects on other socio-economic aspects of the system (e.g. industry or government revenue, crime prevalence, societal value of consumption, costs and benefits to the NHS).
iii. The specific factors that stakeholders suggest might mediate the anticipated effect of each intervention – what specific factors do participants consider may increase (drive) or decrease (create barriers) the feasibility of the intervention being successful in achieving its intended effect(s)? These include pre-implementation factors. For example, the political salience or societal palatability of policy options may affect their likelihood of being introduced as intended or at all. They also include post-implementation factors that stakeholders perceive may mediate or interrupt the intended effects of each taxation intervention option. For example, possible issues could include: how different industry players might respond with novel pricing structures to circumvent a new tax; how consumers might switch between types of alcohol/tobacco products as prices change; or how government might or might not complement taxation changes with other interventions.
iv. Gaps in the policy context and the evidence base which would be required to enable taxation policy progression – what policy and societal changes and new research will be needed to facilitate joint or co-ordinated tobacco and alcohol taxation in the future?

For each aspect, where relevant, participants will be asked to consider the issues from three perspectives: tobacco, alcohol and tobacco *and* alcohol.

This research design will facilitate the research team's understanding of the complex context of each taxation intervention option within its overarching tobacco and/or alcohol taxation policy space.

Ethics and consent

Ethics approval was received for 'Workpackage 1 of Integrated evidence synthesis for joint appraisal of tobacco and alcohol tax interventions for harm reduction in the UK' on 09/03/2018 from the School of Health and Related Research at the University of Sheffield with reference number 017409. An ethics amendment to ensure compliance with GDPR was approved on 19/06/2018.

All participants will be provided with an information sheet outlining the study and steps taken to ensure confidentiality. Prior to the interview we will ask participants to read this sheet and sign a consent form or, those being interviewed by phone, to send an email confirming they have read the information and consent to participate. Audio recordings will be made where consent is given. Participants will participate anonymously. Hard copies will be destroyed. Data will be stored securely at both the Sheffield and Bath sites.

Coding and analysis
Data will be coded and analysed using the 'framework method' [51] of qualitative content analysis. The interview data will be transcribed and uploaded into the qualitative analysis software programme NVivo 10. The WP1 team will use transcripts and audio recordings to become familiar with the data. Two coders will code the data deductively using the codebook developed from the rapid review. We will first test the codebook on a small sample of interview data and the WP1 team will then adapt the codebook where necessary prior to full data coding. This revised codebook will form the 'working analytical framework' for the study [51], which will then be used to code all transcripts in NVivo 10. In line with the framework method, coded data will be 'charted': placing cases (participants) and codes in a matrix and summarising the data by category from each transcript. The matrix will then be used to undertake systematic comparison of characteristics and differences between the data across the matrix [51] and to produce a summary of relevant taxation interventions for tobacco and alcohol for the UK, possible combinations of tax changes across the two product types, and the rationale for them as well as specific barriers and drivers to implementation, as described by research participants. Participants' perceptions of the hierarchy of systemic factors affecting tax policy preferences and decisions will also be compared and synthesised. Maintaining an audit trail, systematic coding and peer debriefing will ensure rigour and transparency in analysis [51, 52].

Data will be used to refine WPs 2 and 3, to inform the scenarios to be modelled in WP4 and to describe future research needs. The thick qualitative description generated during the coding and analysis of the interview data will give essential context to our modelled results. This will be used in SYNTAX's pathway to impact activities.

Outputs

1. A research paper presenting the results of our qualitative analysis to define the emergent space of tax intervention options when tobacco and alcohol are considered both separately and jointly. The appendix to this paper will constitute a technical report detailing the policy options to model in wp4 and information to support refinements to WPs 2-4 (e.g. population groups, outputs).

2. A research paper on our rapid review findings.

3. A methods research paper focused on developing deductive analytical frameworks for qualitative data analysis.

4. Public/stakeholder oriented dissemination materials: A suite of materials including a briefing to be shared publicly and disseminated to research participants to coincide with the conclusion of the work package.

Work package 2: Analysis of social patterns in spending on tobacco and alcohol

Data
In our study we will make full use of the samples sizes available for England in each of the datasets below.

Individual-level survey data

Living Cost and Food Survey. The LCFS is a cross-sectional survey of UK private households that collects individual level diary data on purchasing of alcohol and tobacco products. We will examine 2006 to 2016 data covering in excess of 12,000 individuals in 5,000 households each year (accessed via the UK Data Service's secure lab). Alcohol data is collected via a confidential two-week personal diary. This provides product volume and sales value (in pence) for 25 types of alcohol, which we group into 10 categories (off- and on-trade separated for beer, cider, wine, spirits and RTDs). In our previous analysis of these data, we have grouped the 25 types of alcohol into 10 categories (off- and on-trade separated for beer, cider, wine, spirits and RTDs). These 10 categories are each subject to a different form of taxation (HMRC also use these 10 categories). For tobacco, data are collected only on the amounts spent (in pence) on two main product types: manufactured cigarettes (in packs of approximately 10s or 20s) and HRT (in packs of 12.5g and 25g). The data does not record amount of product bought, but our pilot work indicates they can be imputed because the price distribution of 10 packs of manufactured cigarettes does not overlap with the price of larger packs.

For HRT the price distributions overlap more but it is still possible to distinguish packs of 12.5g and 25g. LCFS demographic data includes age, sex, 5-year birth cohort, marital status, and if children are in the household, plus socio-economic characteristics - usual weekly income, total expenditure, socioeconomic status in 3 categories, and employment status.

Ethics approval for our use of the LCFS data was received for 'Investigation of the geographic and socioeconomic variation in alcohol and tobacco purchasing to support models for policy in England' on 03/03/2018 from the School of Health and Related Research at the University of Sheffield with reference number 006733.

Health Survey for England. The HSE is a cross-sectional survey of approx. 5,000 households and 10,000 individuals. We will use data from 2011 (first detailed alcohol data) onwards. Data on alcohol consumption is by beverage type (beer and cider, wine, spirits and RTDs) but does not specify whether the location of purchase was the on- or off-trade. The main data on smoking is in terms of cigarette consumption, for which it reports whether an individual smoked or not and how many manufactured hand rolled cigarettes they consumed per day. There is also extensive demographic and socioeconomic information.

Ethics approval was not needed for the use of these data as they are not risk-bearing.

Population-level sales surveillance data

Nielsen UK prices for tobacco. We have access to AC Nielsen UK Scantrak data on monthly pricing and volumes sold of 1505 manufactured and HRT products on the market in supermarkets and convenience stores from November 2008. These data can be aggregated to produce an overall sales distribution at category level (e.g. for cigarettes or HRT).

Ethics approval was not needed for the use of these data as they are not risk-bearing.

Nielsen/CGA prices for alcohol. We have annual UK sales data for alcohol in the on-trade containing volume and retail price of products sold by low-level beverage category for years 2008 and 2011. We also have annual England and Wales combined sales data for alcohol in the off-trade (via NHS Health Scotland) containing volume and retail price of products sold by low-level beverage category for 2009- 2015 (2016 to follow). For the analysis of trade tax pass-through in WP3, we have negotiated a fee for access to commercial market research data from CGA Ltd which contains the prices of 50 widely-distributed products in 2,000 outlets across the UK both before and after tax/duty changes between 2006-2016.

Ethics approval was not needed for the use of these data as they are not risk-bearing.

Objective 1: Examine the relationship between household spending on alcohol and tobacco and overall household budgets and how this varies by socio-demographic sub-groups.

Task 1: Processing the LCFS data
The data will need some preparation before analysis:

Alcohol
The first task is to convert the number of drinks in the on-trade into millilitres of product. We will then convert millilitres of products in the on- and off-trades to the units of pure ethanol that they contain. For the on-trade, we use standard 'drink sizes' provided by the data owners, e.g., a pint of beer is 568ml, a glass of wine is 175ml etc. We then use evidence on the strength of the different types of alcohol to convert to units (e.g. 500ml of 4.5% ABV beer is therefore 2.25 units of pure alcohol). The second task is to combine the units of alcohol purchased with the price paid in a transaction to give the price paid per unit of alcohol. Our experience has shown some extreme values for prices paid per unit that we understand to be misreporting within the data of either the numerator or denominator. We therefore remove transactions which are outside a plausible defined range.

Tobacco
The first task is to estimate the volume of tobacco purchased in each transaction as these data are missing. To do so we will use external information from the Nielsen data on price distributions for each year. Whilst

there is wide variation in prices, there is a clear bimodality to the distribution, with little overlap between major pack sizes (e.g. a pack of 10 cigarettes is always cheaper than a pack of 20). For every price point, the Nielsen data implies a probability distribution for the volume of cigarettes, or hand rolling tobacco purchased. For every transaction we will assign the volume which corresponds to the highest probability in this distribution. The second task is to convert the data on number of cigarettes purchased to a price per gram of tobacco. The particular rate of conversion used is subject to some debate, e.g., 1 cigarette might be said to equal 1g, 0.7g or 0.5g of tobacco. We will create separate variables that have converted at different rates.

Outcomes
The result of this process will be a version of the LCFS with sales value and product volume attached to every transaction for both alcohol and tobacco. This data, which describes the joint price distributions and purchase volumes across 12 product types (on- and off-trade beer, cider, wine, spirits and RTDs, cigarettes and hand-rolled tobacco), will feed into WP3 and WP4.

Task 2: Calibrate LCFS price distributions against Nielsen/CGA data
For analysis in this WP, two further data processing steps are required. First, using aggregate price distributions from Nielsen (for tobacco and off-trade alcohol) and CGA (for on-trade alcohol) we will adjust the transaction-level prices paid to match empirical sales data. We do this by partitioning each of the 12 product types into deciles of the distribution, mapping the decile cutpoints from the LCFS distribution onto the equivalent decile cutpoints in the Nielsen/CGA data and interpolating the points in between. Second, we will sum the volume and value of all transactions for each product type for each LCFS respondent to give individual-level information on total expenditure, quantity purchased and average price paid per unit (either per unit of alcohol or per gram of tobacco) for each product. The outcome of this data processing is a version of the LCFS which is calibrated to external data and includes individual level purchasing patterns alongside demographic data (age, sex, 5-year birth cohort, marital status and whether there are children in the household) and socioeconomic data (usual weekly income, total household expenditure, socioeconomic status (using the NS-SEC occupation-based classification) and employment status). Missing data on key demographic and socio-economic variables will be imputed using appropriate Multiple Imputation techniques.

Task 3: Analyse household spending on alcohol and tobacco and the relationship to household budgets
In order to understand the potential impacts across the socio-economic spectrum of changes in taxation level and structure for alcohol and tobacco, it is vital to understand how spending on these products relates to overall household budgets. We will examine this jointly for tobacco and alcohol by first, calculating the total amount spent within each household represented in the LCFS on alcohol and tobacco (separately and together) and presenting the distribution of these figures across the socio-economic spectrum. Secondly we will calculate, for every LCFS household, the proportion of disposable household income that is accounted for by spending on alcohol and tobacco. These figures will be presented descriptively to illustrate how the proportion of household budget allocated to alcohol and tobacco varies across the socioeconomic spectrum. Finally, we will fit statistical models relating these proportions of expenditure to household-level characteristics, including socioeconomic status, region, household composition and volumes of alcohol and tobacco purchased. These models will provide insight into which groups are the most 'exposed' to alcohol or tobacco taxation increases by virtue of spending on these products representing a large proportion of their income.

Objective 2: Describe the joint patterns in consumption and spending of tobacco and alcohol, and how these vary by socio-demographic subgroups and by the level of smoking and drinking.

Task 1: Map the LCFS prices onto the HSE
To examine individual level patterns of consumption and spending on alcohol and tobacco and how these co-vary, we need to integrate spending data from the LCFS with consumption data from the HSE. This process mirrors that used in the Sheffield Alcohol Policy Model [38] and which will underpin the WP4 modelling. Taking the HSE respondents as our baseline population, we will define subgroups based on sex, age (18-24, 25-34, 35-54, 55+), socio-economic status (income quintiles), drinker group (abstainer, moderate, increasing risk, high risk) and smoking status (smoker, non-smoker). Equivalent subgroups are defined in the LCFS. For each individual in the HSE, we will partition their beer consumption into beer and cider consumption based on the average beer/cider purchasing volume ratio for individuals in the same subgroup in the LCFS. We will then use a similar technique to partition beer, cider, wine, spirits and RTD consumption for the HSE individuals into on- and off-trade. For each HSE individual we will take the price

distributions made up of purchases by the same subgroup in the LCFS and apply them to the HSE, to give us price distributions for every individual. The outcome of this step is a combined HSE/LCFS dataset which includes demographics, consumption levels for 10 alcohol and 2 tobacco categories and the distribution of prices paid for both tobacco and alcohol for each individual.

Task 2: Analysis of joint patterns in prices paid at the individual level
In several pieces of past work we have described typologies of drinking behaviour [53, 54] and in pilot work have investigated the joint typology of smoking and drinking behaviour in the HSE. This analysis first used multiple correspondence analysis to reduce the dimensionality of variables and then defined joint smoking and drinking behaviour using hierarchical clustering. The results identified 15 clusters defined by a mixture of smoking and drinking level and product preferences. We will build on this typology to understand how patterns in prices paid also vary at the individual level across different consumer groups. This analysis will be undertaken in two stages. First, we will conduct a descriptive analysis of average prices paid for alcohol (per unit) and tobacco (per gram) by the subgroups described above (i.e. those defined by socio-demographic variation, drinker group and smoking status). Second, we will map the HSE/LCFS price distributions onto the existing typology of smokers and drinkers by including additional price-band variables our pilot analysis. The result is likely to be an expanded set of typologies that describes further joint variation in the prices paid for tobacco and alcohol. These findings will highlight which groups of individuals – defined in terms of their smoking and drinking behaviour and socio-demographic characteristics - are most exposed to taxation changes across different product types.

Outputs
1) A paper presenting the outcomes of the analysis described under Objective 1 on the relationship between household characteristics and budget share accounted for by alcohol and tobacco purchases.
2) A decision-maker oriented paper presenting the outcomes of the analysis described under Objective 2 which shows the potential implications of social patterns in spending for how changes to taxation on tobacco and alcohol might affect inequalities / negative side effects on the poorest
3) A linked HSE/LCFS dataset to input as baseline data on spending and consumption into the WP4 modelling.

Work package 3: Analysis of industry and consumer responses to tax changes

Objective 1: Investigate the extent to which tax changes are likely to be passed on to consumers as retail price changes across the product and price spectrum for tobacco and alcohol products (using a consistent approach for tobacco and alcohol).

Members of the research team have already developed analysis of tax pass-through for off-trade alcohol using data on 204 different alcohol products sold in supermarkets over 180 weeks [21]. We do not propose to do further research on off-trade tax pass-through within this grant. We do propose to extend this work to on-trade alcohol products. We will analyse tax pass-through by making use of commercial market research data from CGA Market Research Ltd. The CGA data contains information and detailed sales value and volume data on a large sample of pubs, bars, clubs and other outlets across England, Scotland and Wales. This is important because unlike supermarkets there is no standard set national price for particular brands of alcoholic drink in different on-trade settings and there can be substantial regional variation. We have negotiated a fee for access to a sample of these data covering the prices of 50 widely-distributed products in 2,000 outlets across the country both before and after tax and duty changes over the period from 2006-2016. This will allow us to examine the extent to which the price of individual products changed as alcohol taxation changed, across the price spectrum and across a wide range of outlet types and locations. Adapting our previously used quantile regression approach to this data-set, we will estimate the tax pass-through rate across the price spectrum (in terms of price per unit of alcohol) for detailed product categories and summarise this for the 5 on-trade product categories used in the Sheffield model i.e. beers, cider, wines, spirits and RTDs. As a cross-check on these we will update the simple analyses undertaken previously by RAND in 2011 [20] which use HMRC data to enable a broad overall estimate (with no distinction by price per unit) of tax pass-through for on-trade bitter and on-trade lager and compare with our more detailed CGA data based results.

For tobacco tax pass-through, we will develop a similar set of analyses. Members of the research team already have access to a data-set from Nielsen Ltd which can be used within this grant. These data are collected monthly from 2008 onwards for tobacco products in brands and pack sizes – technically known at 'stock keeping units' (SKUs). In all, the data has 1505 SKUs, but we plan to utilise the 776 SKUs in the data which represent almost 90% of the market each month, because we will exclude some products that Nielsen have advised are likely to have price distributions that are insufficiently sampled to be valid. The shape of these data is broadly similar to that with which we developed the quantile regression based tax pass-through estimates for off-trade alcohol except on this case there is monthly (rather than weekly) data, it includes the sales volume for each product as well as the price, there is a longer time period available, but there are also SKUs for which missing price data is an issue in some months or at the beginning or end of the period. We will therefore adapt the methods of Ally et al, to this slightly different data-set but retain the principles of the approach to estimate tobacco tax pass-through. This includes estimating the counterfactual price over the period i.e. the price that would have been in existence if retailers/manufacturers passed the tax changes through to retailers exactly rather than over- or under-shifting tax changes onto different products differently. It also includes accounting for inflation on a monthly basis across the time series.

Objective 2: Harmonise estimates across tobacco and alcohol in terms of how retail price changes affect participation in tobacco use, participation in alcohol use, quantity of tobacco products purchased and quantity of alcohol products purchased including the interactions between these behaviours.

Two methods will be tested for 12 products (2 tobacco and 10 alcohol categories): Task 1. Longitudinal pseudopanel elasticities for participation (i.e. purchase in 2-week window) and amount consumed; Task 2. Cross-sectional Heckman model elasticities for participation and quantity. Finally, in Task 3 we will describe differences between these estimates and other literature and develop guidance on how uncertainty in elasticities should be accounted for in tax modelling.

Task 1: Estimate Pseudopanel elasticities using LCFS for 12 alcohol and tobacco products focussing on both participation (i.e. purchase in two week window) and quantity purchased

The ideal dataset would have individual level longitudinal data over several years on prices paid and tobacco and alcohol products purchased in order to model effect of changes in price on change in participation and on quantities purchased. Unfortunately such a dataset does not exist in the UK. Instead we will re-analyse the LCFS data-set from 2006 to 2016 as described in WP2. In particular we will analyse the data-set in terms of 12 products – beers, cider, wine, spirits and RTDs (separated for off-trade and off-trade) together with manufactured cigarettes and hand-rolled tobacco.

A pseudopanel is created by grouping individuals into defined subgroups with each of these subgroups then treated as an individual pseudopanel member for longitudinal fixed effects statistical modelling. The groupings are based on largely time-invariant criteria. In our proposed base case this will be sex, birth cohort and socioeconomic status. Each respondent is assigned to a pseudopanel "cell". The data for the individuals in each cell are then summed (using the survey weights) to give the total expenditure and quantity of product purchased for each of the 12 proposed alcohol and tobacco product types. Dividing a cell's total expenditure by total quantity for each product type gives a "mean price-per-unit paid" for each product type. In the case of alcohol; this is the pence per unit of alcohol; for cigarettes this will be pence per stick; for hand-rolled tobacco this will be pence per gram. We will also calculate the proportion of people in the cell who are unemployed, have children, are married, and the mean usual weekly income for the cell.

Price elasticities of participation will be examined by modelling how the proportion of each pseudopanel group (cell) that uses tobacco or alcohol products changes over time as mean prices change. Price elasticities of consumption will be estimated in a similar way. These will estimate the percentage change in quantity of each of the 12 products purchased as a function of the mean prices.

There are some methodological issues and challenges in estimating and interpreting elasticities from the pseudopanel approach. The key advantages of the pseudopanel are that it accounts for longitudinal trends and fixed effects. By collapsing the individuals into the cells/groups there is a loss of sample size and thus the confidence intervals for estimated elasticities are wider than with approaches which retain analysis of each individual. It has the disadvantage that it produces one overall average elasticity estimate for the whole population. Resolving the issue of whether population subgroups have different elasticities is problematic in a pseudopanel approach e.g. is the drinking of non-smokers affected by the price of tobacco? It would be

possible to construct a pseudopanel with just non-smokers, or e-cigarette smokers and compare the resulting estimates of elasticities with those of the whole population, or indeed smokers alone. However, this has technical implications in terms of adherence to the time invariant rule for defining cells in the pseudopanel. Some of these disadvantages can be addressed by cross-sectional individualised analysis as described next.

Task 2: Estimate Heckman cross sectional elasticities using LCFS for 12 alcohol and tobacco products incorporating both participation and quantity purchased.
We propose to extend the methods used by HMRC to estimate price elasticities for alcohol to include tobacco [55]. HMRC chose to utilise a cross-sectional analysis of the LCFS data using a Heckman model. The Heckman method provides an approach which accounts for the fact that many of the individuals do not purchase any alcohol in the two week diary period ('zero observations'), or do not purchase any of a specific type of alcohol ('zero observation for a category'). The key advantage of the Heckman model is that it integrates the participation / quantity purchased elasticity estimation in a single model. We will first replicate this analysis with our extended time period LCFS data-set for alcohol and secondly include in two additional products – manufactured cigarettes and hand-rolled tobacco. This will generate an estimated 12 products (i.e. 144 cells) elasticity matrix. Thirdly, we will investigate refining the population examined in the Heckman model to consider whether it is possible to estimate elasticities differently for population subgroups. In particular, we will investigate price elasticities for each category of alcohol e.g. off-trade beer in terms of participation and quantity (modelled together in the Heckman) separately for non-smokers and for smokers only. We will investigate whether non-smokers participation and consumption of say off trade beer is unaffected by tobacco prices. We will also investigate whether it is possible to estimate elasticities for smokers and non-smokers using interaction terms in in a single model rather than partitioning the data-set. We will also use the Heckman model to investigate price elasticities for smokers versus a non-smokers sub-population.

It is worth emphasising why we do not plan to invest time in undertaking an aggregate time series approach to estimating joint price elasticities for tobacco and alcohol products. HMRC does use aggregate time series based elasticities for its tobacco tax impact assessments – in terms of monetary effects. However, for our health economic impact modelling it is crucial to estimate the effects of price changes on quitting smoking. An aggregate time series analysis does not easily enable analysis of the zero observations which are able to be undertaken as we have planned here in both the pseudopanel (Task 1) and the Heckman (Task 2) formulations.

Task 3: Assessment of uncertainty
We will undertake a series of exercises and engagements with stakeholders to establish how to incorporate the uncertainty around the tax pass-through and price elasticity of demand evidence from Objectives 1 and 2 into the tax modelling in WP4.

Parameter uncertainty
Our standard approach to analysis of uncertainty in elasticity estimates would be to estimate the standard errors on the regression model parameters and undertake Monte-Carlo (probabilistic) sampling from the variance-covariance matrix produced from the statistical model. Essentially this would mean generating a range of (say 100) different elasticity matrices and running the tax analysis model with each in turn to see what the effects of the uncertainty are on the outcome estimates. We will do such for both the pseudopanel and Heckman models, and will also develop a mechanism to do this for the uncertainty in the tax pass-through quantile regression models.

Structural uncertainty
Once we have undertaken our new analyses we will work with the international academic and grey literature and our stakeholder group to place our new estimates in the context of this other evidence. Our objective will be to generate scenarios for structural sensitivity analysis in WP4 that show how our outcomes might have changed had we used different data and modelling methods. For elasticity estimates we will look at the international literature that uses cross-sectional data and pseudopanel methods. If there are studies that estimate elasticities for categories of alcohol including on- and off- trade and categories of tobacco, and their cross-price elasticities, then we will use them to design a sensitivity analysis (applying reasonable assumptions where necessary). For example, one sensitivity analysis will be to repeat our modelling using only published elasticities estimated by the HMRC. We will also look for genuine panel studies with a view to developing a sensitivity analysis based on these estimates (however, because a genuine panel can suffer

from the non-random attrition of members with respect to consumption, there are technical arguments for why a pseudopanel approach might be better). Ideally, if we find a genuine panel study with the right features then we will endeavour to ask the authors to re-analyse their data using our pseudopanel method. This would allow a direct assessment of the difference between genuine panel estimated and a cross-sectional pseudopanel estimated elasticities. We will also explore options to develop sensitivity analyses that address the wider issues of consumers trying to avoid the impact of tax rises by switching to illicit non-duty paid products and to e-cigarettes.

Outputs

1) Journal paper on tax pass-through for tobacco and alcohol
2) Journal paper (or possibly two papers) on consumer responses to price changes for tobacco and alcohol using both pseudo panel and Heckman approaches
3) A technical report on the outputs to feed into WP4.
4) A briefing report for government / policymakers on the evidence for both tax pass-through and price elasticities for tobacco and alcohol
5) A public facing media presentation of the key novel findings to get across their meaning and importance to the public.

Work package 4: Population modelling to appraise the health and economic outcomes of tax interventions

Existing model technology and the data this uses

The description of tobacco and alcohol consumption at baseline

Our STAPM prototype uses the HSE to inform the socio-demographic patterns in the consumption of tobacco and alcohol in the baseline year. Each individual in the HSE is input into our model along with their consumption and socio-demographic characteristics and survey weights. We then use the LCFS to inform the socio-demographic patterns in the prices of product purchased based on transaction-level data. We subsequently adjust these data for underreporting using population-level sales data (see WP2). In STAPM we have added new Monte-Carlo methods that improve how we track consumption over the life course of individuals. The main driver to do so was to allow our modelling to incorporate the natural rates of smoking initiation, quit and relapse over the life course that are likely to modify any intervention effect applied in the baseline year.

Linking behaviour to health harms

As with SAPM, STAPM links changes in consumption between years to changes in the relative risk of different diseases carried by the individuals in our HSE sample. In STAPM we consider 63 diseases that are attributable to tobacco and/or alcohol. This list is a combination of the diseases considered in SAPM and in the NICE Tobacco Return on Investment Tool for England [44]. We estimate each individual's relative risk of disease at baseline using published epidemiological evidence (risk functions) [56, 57]. For alcohol these are dose-response relationships between current consumption level and the risk of developing a specific disease. For tobacco these show how relative risk varies among never, current and former smokers. Although the available evidence is sparse, where possible we also incorporate the interactive effects of combined tobacco and alcohol consumption on the risk of disease. When we update the relative risk of disease following a changes to consumption, we account for the estimated lag-time between a change in consumption and a change in risk [58, 59]. For example, for cancers the risk can remain relatively high for a decade after consumption reduces/stops. We then use the lagged change in risk to adjust the disease-specific rates of hospital admission (estimated from the Hospital Episode Statistics) and death (from Office for National Statistics death and population counts) for each socio-demographic group proportionally upwards or downwards [60]. This means that the estimated change in relative risk for a disease in each year is used to adjust the estimated prevalence of hospital admissions and deaths for that year. We have also added new methods to STAPM that improve our estimation of the change in the NHS costs of hospital admissions by linking the Healthcare Resource Group fields to standard NHS treatment costs.

New model technology to be added by the project and the new data this will use

Objective 1: Develop the model structure so that it can implement the taxation interventions from WP1.

SAPM models price intervention effects on an individual's mean weekly consumption of alcohol, stratified by beverage type (see uploaded logic model). The logic goes as follows: (a) tax is changed on a specific product type e.g. duty on beer rises by 1%, (b) industry might subsequently modify the effects on retail price for specific price bands of products e.g. the price of cheap beer might change less than expected but the price of premium beer might change more than expected), (c) changes in product price are linked to consumption using the price elasticities of demand, with own and cross price elasticities for 10 beverage types in the on- and off- trade [24], (d) we have a post-intervention population with a new level of consumption and spending. For STAPM we need to build the model component that calculates the combined effect of taxation changes on tobacco and alcohol consumption. We will use the existing SAPM method as the exemplar for this model development. We will also tailor the new methods to fit with the WP1 definitions of the taxation interventions, the WP2 baseline data on the amounts of tobacco and alcohol products consumed and the prices paid, and the WP3 data on tax pass-through and price elasticities.

Objective 2: Model further outcomes relevant to tax interventions

Our modelling in STAPM already allows us to compute outcomes for (1) disease-specific mortality and the consequent life years gained, (2) disease-specific hospital admissions and the consequent NHS treatment costs saved. In the proposed work we will add the data and methods to compute the further outcomes detailed below. These are already outcomes that we model for alcohol is SAPM. Our aim is to compute them for tobacco such that a fair comparison of effects on the same outcomes can be compared fairly across alcohol and tobacco. This need to ensure fair comparison across tobacco and alcohol means that we will focus on a few core outcomes rather than trying to replicate the full range of outcomes present in other tobacco models for England e.g. the modelling by ASH [43]. It also means that where possible we will limit ourselves to the methodologies used to compute the outcomes that are already implemented in SAPM e.g. SAPM currently uses a different method to calculate effects on work absenteeism to that used by the CRUK and UK Health Forum modelling for tobacco [45]. We will endeavour to apply a method for tobacco that fits with our existing method for alcohol. However, if we cannot find a way to a fair comparison, then we will explore new methods for both tobacco and alcohol.

The further outcomes that we will compute will be:

- *Time off sick due to ill-health (work absenteeism).* Work absence effects will require some analytical development because methods recently used are different for alcohol (where published evidence on alcohol consumption caused absence is used [61]) than for smoking (where broader relationships on diseases experienced and quality of life have been used to estimate productivity losses [45]). We will review these and develop a consistent approach.
- *Tax revenues to Government.* Modelling the effect on revenues from alcohol sales have proven to be central to the impact of our alcohol modelling [17, 41, 43]. We will also explore the potential to model the tax lost due to consumers purchasing illicit products (e.g. from switching to illicit products to try to avoid price rises).
- *The differential impact on consumer finances.* Modelling effects on personal budgets has also been key to the impact of our alcohol modelling by allowing conclusions about the effects on social inequality and potential unintended negative consequences of tax rises [13]. The results of WP2 will make us well-positioned to discuss the social differentials.

Objective 3: Appraise tax interventions

For the population of England over the age of 18 years we will model the outcomes of the taxation interventions defined in WP1. We will compute outcomes in each year from our baseline year to a 30 year time-horizon. This 30 year period will give sufficient time for lagged effects on chronic diseases such as cancers to manifest. For each outcome, we will estimate the total population effect and differential effects across socio-demographic subgroups (following the subgroupings defined in WP2). Our comparator will be the expected outcomes of a continuation of the current levels in real terms (rising with inflation) and structure of taxation on tobacco and alcohol products. We will estimate the difference between the comparator and intervention arms under alternative scenarios of the future trends in tobacco and alcohol consumption that would have occurred anyway, independently of changes to taxation.

Objective 4: Assess the uncertainty in estimated outcomes due to uncertainty around industry modification of tax pass-through and consumer price elasticities of demand, from WP3.

We will assess the uncertainty in our outcomes that derives from the evidence produced in WP3 on (1) industry modification of tax pass-through and (2) consumer responses to changes in retail price (price

elasticities). First we will assess the impact of statistical uncertainty around our estimated parameters through probabilistic Monte Carlo simulation. This will allow us to present uncertainty intervals around each point-estimate of effect for each tax intervention, where the interval represents only the uncertainty contributed by either our tax pass-through or price elasticity estimates. Second we will assess structural uncertainty by estimating how our results might have been different had we used different data and methods. For tax pass-through we will re-compute our results with alternative scenarios of how industry might modify tax pass-through e.g. extreme under-shifting price rises to cheap products. For price elasticities we will re-compute our results with alternative estimates of price elasticities that aim to (1) reflect variation in the international literature, (2) test the implications of our choice of pseudopanel data and methods, and (3) show the difference in our results from using the official price elasticities for tobacco and alcohol estimated by HM Revenue and Customs. These scenario analyses will enable us to understand where the assumptions underlying our modelling work are likely to have a substantive effect on our results and provide valuable insights into where the greatest needs for future research may be.

Objective 5: Compare our model results with other model-based appraisals of tax changes to understand and explain why the models give similar or different answers.
In preparing this proposal we have discussed our work with modellers of tobacco tax from ASH [43] and NICE [44]. In these conversations it was emphasised that it is crucial for us to understand and explain how our modelling methods and results sit alongside other models that aim to provide similar evidence for the effects of tobacco taxation in the UK. We will therefore look to engage with modellers from other teams during the project and once we have our preliminary findings to compare our methods and results to theirs e.g. in terms of predicted changes in participation, consumption and health. We will also look for opportunities to appraise the same intervention using different models so that we can assess how different methods affect the results.

Outputs

1) The main paper will present our modelling results to a general audience.
2) Technical modelling paper outlining the modelling methods used to combined tobacco and alcohol into a common modelling framework
3) Full technical report
4) Set of media to communicate our findings to a lay audience

Summary of ethics approvals for quantitative data
Ethics approvals were obtained for the following datasets used for our quantitative modelling in Workpackages 2-4 due to these datasets comprising data that is potentially disclosive of individual identities, thereby requiring storage and analysis in secure environments and compliance with appropriate information governance standards.

Hospital Episode Statistics data
Ethics approval was received for 'Investigation of the geographic and socioeconomic variation in alcohol and tobacco related hospital admissions to inform decision support models for policy in England' on 03/03/2018 from the School of Health and Related Research at the University of Sheffield with reference number 018108.

Living Costs and Food Survey data
Ethics approval was received for 'Investigation of the geographic and socioeconomic variation in alcohol and tobacco purchasing to support models for policy in England' on 03/03/2018 from the School of Health and Related Research at the University of Sheffield with reference number 006733.

Office for National Statistics Mortality microdata
Ethics approval was received for 'Investigation of the geographic and socioeconomic variation in alcohol and tobacco related mortality to inform decision support models for policy' on 25/09/2018 from the School of Health and Related Research at the University of Sheffield with reference number 023092.

Public Involvement

We will engage with three PPI panels: the UKCTAS Smokers Panels (Nottingham), the UKCTAS Drinkers panel (Stirling) and the Sheffield Addiction Recovery Research Panel.

We will visit each of these panels in years 1 and 3 to discuss issues, plans, findings and think through the complex social setting in which behaviour change induced by taxation sits. Year 3 meetings will involve panel members in co-developing dissemination materials. If feedback on specific issues is required we will request this ad hoc through the panel organisers.

We will also invite a panel member to attend our major project meetings (2 per year) in which we review progress and plan the next steps for research and dissemination.

Project management

Roles and responsibilities of the project team

All staff will be involved throughout the 36 months of the project to ensure strong links between workpackages, stakeholder engagement and dissemination.

- *WP1*: Hatchard will lead and Buykx will contribute to the qualitative methodological development, data collection and analysis.
- *WP2*: Angus will lead and Hiscock will support data preparation tasks and methodological development for the analysis.
- *WP3*: Pryce will lead the methodological development and analysis with support from Brennan, Angus and Hiscock.
- *WP4*: Gillespie will lead the methodological development and analysis with support from Angus and Brennan.

Wilson will have responsibility for day-to-day project operations on WPs 2-4. Gillespie will be responsible for the day-to-day project management and coordination. Brennan will be the PI and Chair the Project Management Group, comprising Hatchard, Angus, Pryce, Gillespie and Wilson. Holmes, Meier and Gilmore will provide oversight on project management and coordination, expertise on all work packages with input on methods and analysis, and contribute to stakeholder engagement and dissemination.

Project meeting structure

Agendas for each meeting will be circulated in advance. Minutes of each meeting will be taken and actions assigned.

We will have the following types of meetings:

- *Workpackage specific sessions:* To be organised by workpackage leader as needed.

- *Meetings of core project team:* Approximately monthly, lasting 1-1.25 hours. Involving work package leads (JH, CA, RP, DG), the project lead (AB) and LB. DG and AB will meet a week before to plan.

- *Working meetings involving all project co-investigators*: Approximately 3 monthly, lasting 90 minutes. DG and AB will meet a week before to plan.

- *Strategic review and planning meetings involving all project co-investigators*: Approximately 6 monthly, lasting 3 hours. Planning will be done in the preceding meeting of the core project team. We will endeavour to make this a face-to-face meeting that alternates location between Sheffield and Bath. We will invite a PPI panel member to this meeting and will therefore schedule meetings at convenient times, using jargon free language to assist participation.

Study Advisory Group

We have established a semi-formal Study Advisory Group comprised of 12 international experts in public health and economics relating to tobacco and alcohol. As this group is international it will primarily meet through teleconference, with opportunistic meetings (e.g. at conferences) held when feasible. Advice will also be sought via email. We aim to consult the group 3-4 times during the project.

Project timetable and milestones (as of 1st August 2019)

	Year 1												Year 2												Year 3											
Task	**03/18**	**04/18**	**05/18**	**06/18**	**07/18**	**08/18**	**09/18**	**10/18**	**11/18**	**12/18**	**01/19**	**02/19**	**03/19**	**04/19**	**05/19**	**06/19**	**07/19**	**08/19**	**09/19**	**10/19**	**11/19**	**12/19**	**01/20**	**02/20**	**03/20**	**04/20**	**05/20**	**06/20**	**07/20**	**08/20**	**09/20**	**10/20**	**11/20**	**12/20**	**01/21**	**02/21**
Rapid review																		M																		
Interview prep and interviews																																				
Analysis and synthesis																																				
Integrate review and analysis, write and publish paper and dissemination materials																																				
Prep. of data																																				
Analysis and manuscript prep – household spending																			M																	
Analysis and manuscript prep – individual spending																										M										
Analysis and manuscript prep. - tax pass-through																						M														
Data prep. and preliminary analysis – price elasticities																																				
Analysis - exploring different methods – price elasticities																																				
Assessment of uncertainty – price elasticities																																				
Prep. of manuscripts – price elasticities																														M						
Develop model of tax interventions																																				
Development outcomes																																				
Appraise tax interventions																											M									
Manuscript prep - modelling methods																														M						
Feedback on model findings																																				
Manuscript prep. – model findings																																				M

Yellow = WP1, green = WP2, blue = WP3, red = WP4

In chart: dark blue = original plan, grey = less than expected progress in this period, light blue = timetable slippage

Updated milestones and timetable (as of 1st August 2019)

Reasons for timetable slippage

- One month delay to starting workpackage 1.
- Further delays to workpackage 1 due to reduced resource arising from changes in work arrangements of team and from additional outputs – rapid review and methods papers.
- Delay to recruitment of our research associate – Dr Luke Wilson – who started on 02/07/18 (4 months after the project start date).
- Delays to workpackage 3 preparation of the manuscript for tobacco tax passthrough due to LW unexpectedly having to travel to Bath to complete data analysis.

Milestones from project start: 1st March 2018

WP1

M1. Paper on interview findings & technical report to feed into WP4: 31st August 2019. The main research paper will present the results of our qualitative analysis to define the emergent space of tax intervention options when tobacco and alcohol are considered both separately and jointly. The appendix to this paper will consitute a technical report detailing the policy options to model in WP4 and information to support refinements to WPs 2-4. We have also prepared a research paper on our rapid review findings, and a methods research paper focused on developing deductive analytical frameworks for qualitative data analysis.

WP2

M2. Paper on household spending: 31st September 2019.
M3. Paper on individual spending & a linked HSE/LCFS dataset to feed into WP4: 31st April 2020.

WP3

M4. Papers on tax pass-through & technical report to feed into WP4: 1st May 2019. Paper on tax pass-through for on-trade alcohol submitted 31st July 2019. Paper on tax pass-through for tobacco expected to be submitted by 31st December 2020.
M5. Paper(s) on price elasticities & technical report to feed into WP4: expected 31st August 2020 (at latest).

WP4 ***(Milestones remain unchanged)***
M6. Preliminary model findings: 1st June 2020.
M7. Paper on modelling methods: 1st September 2020.
M8. Paper on final model findings: 1st March 2021.

We will disseminate findings through our ongoing contact with stakeholders. Dissemination materials will be produced as findings become available. Final visits to stakeholders will take place in months 33-36.

References

1. European Council. DIRECTIVE 2011/64/EU on the structure and rates of excise duty applied to manufactured tobacco. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:176:0024:0036:EN:PDF: 2011.
2. European Council. DIRECTIVE 92/84/EEC on the approximation of the rates of excise duty on alcohol and alcoholic beverages. 1992.
3. European Council. Directive 92/83/EEC on the harmonization of the structures of excise duties on alcohol and alcoholic beverages http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31992L0083:en:HTML: 1992.
4. Cancer Research UK. Briefing: Tobacco tax and pricing. http://www.cancerresearchuk.org/sites/default/files/policy_june2015_tax_pricing_briefing.pdf: 2015.
5. Action on Smoking and Health. ASH analysis of tobacco tax increases in the United Kingdom: Timeline of changes in tobacco taxation in the UK from 1993 to the present. http://ash.org.uk/information-and-resources/taxation-illicit-trade/taxation/ash-analysis-of-tobacco-tax-increases-in-the-united-kingdom/: 2016.

6. Seely. Beer taxation and the pub trade. House of Commons Library: http://researchbriefings.parliament.uk/ResearchBriefing/Summary/SN01373#fullreport: 2014.
7. HM Revenue and Customs. Updates to the alcohol duty rates. https://www.gov.uk/government/publications/updates-to-the-alcohol-duty-rates/updates-to-the-alcohol-duty-rates: 2016.
8. HM Revenue and Customs. Hand-rolling tobacco duty rate. https://www.gov.uk/government/publications/hand-rolling-tobacco-duty-rate/hand-rolling-tobacco-duty-rate: 2016.
9. McLaughlin I, Pearson A, Laird-Metke E, Ribisl K. Reducing tobacco use and access through strengthened minimum price laws. American journal of public health. 2014;104(10):1844-50.
10. Meier PS, Purshouse R, Brennan A. Policy options for alcohol price regulation: the importance of modelling population heterogeneity. Addiction. 2010;105(3):383-93. doi: 10.1111/j.1360-0443.2009.02721.x.
11. Gilmore AB, Tavakoly B, Taylor G, Reed H. Understanding tobacco industry pricing strategy and whether it undermines tobacco tax policy: the example of the UK cigarette market. Addiction. 2013;108(7):1317-26. doi: 10.1111/add.12159. PubMed PMID: WOS:000320120400024.
12. Holmes J, Meng Y, Meier PS, Brennan A, Angus C, Campbell-Burton A, et al. Effects of minimum unit pricing for alcohol on different income and socioeconomic groups: a modelling study. Lancet. 2014;383(9929):1655-64. doi: 10.1016/s0140-6736(13)62417-4. PubMed PMID: WOS:000335670800028.
13. Meier PS, Holmes J, Angus C, Ally AK, Meng Y, Brennan A. Estimated Effects of Different Alcohol Taxation and Price Policies on Health Inequalities: A Mathematical Modelling Study. PLoS Med. 2016;13(2):e1001963. doi: 10.1371/journal.pmed.1001963.
14. Sheen. The British Beer & Pub Association. Statistical Handbook 2016. London: 2016.
15. Angus C, Holmes J, Maheswaran R, Green MA, Meier P, Brennan A. Mapping Patterns and Trends in the Spatial Availability of Alcohol Using Low-Level Geographic Data: A Case Study in England 2003–2013. International Journal of Environmental Research and Public Health. 2017;14(4):406.
16. Hiscock R, Bauld L, Amos A, Fidler JA, Munafo M. Socioeconomic status and smoking: a review. In: Uhl GR, editor. Addiction Reviews. Annals of the New York Academy of Sciences. 12482012. p. 107-23.
17. Angus C, Holmes J, Pryce R, Meier P, Brennan A. Model-based appraisal of the comparative impact of Minimum Unit Pricing and taxation policies in Scotland. 2016.
18. Lewer D, Meier P, Beard E, Boniface S, Kaner E. Unravelling the alcohol harm paradox: a population-based study of social gradients across very heavy drinking thresholds. BMC public health. 2016;16(1):599.
19. Buck D, Frosini F. Clustering of unhealthy behaviours over time: Implications for policy and practice2012.
20. Hunt P, Rabinovich L, Baumberg B. Economic impacts of alcohol pricing policy options in the UK. 2011.
21. Ally AK, Meng Y, Chakraborty R, Dobson PW, Seaton JS, Holmes J, et al. Alcohol tax pass‐through across the product and price range: do retailers treat cheap alcohol differently? Addiction. 2014;109(12):1994-2002.
22. Wang X, Zheng Y, Reed MR, Zhen C. Cigarette Tax Pass-Through by Product Characteristics: Evidence from Nielsen Retail Scanner Data. Available at SSRN 2686274. 2015.
23. Wagenaar AC, Tobler AL, Komro KA. Effects of alcohol tax and price policies on morbidity and mortality: a systematic review. American Journal of Public Health. 2010;100(11):2270-8.
24. Meng Y, Brennan A, Purshouse R, Hill-McManus D, Angus C, Holmes J, et al. Estimation of own and cross price elasticities of alcohol demand in the UK—a pseudo-panel approach using the Living Costs and Food Survey 2001–2009. Journal of health economics. 2014;34:96-103.
25. Brennan A, Meng Y, Holmes J, Hill-McManus D, Meier PS. Potential benefits of minimum unit pricing for alcohol versus a ban on below cost selling in England 2014: modelling study. 2014.
26. Huang C-D. Econometric models of alcohol demand in the United Kingdom. Government Economic Service Working Paper. 2003;140:1-51.
27. Gallet CA, List JA. Cigarette demand: a meta‐analysis of elasticities. Health economics. 2003;12(10):821-35.
28. Czubek M, Johal S. Econometric analysis of cigarette consumption in the UK: HM Revenue & Customs; 2010.
29. HM Revenue and Customs. Update to HMRC Working Paper Number 9: Econometric Analysis of Cigarette Consumption in the UK. 2015.

30. Sassi F, Belloni A, Capobianco C. The role of fiscal policies in health promotion. 2013.
31. HM Revenue and Customs. Tackling illicit tobacco: From leaf to light. The HMRC and Border Force strategy to tackle tobacco smuggling. 2015.
32. Duffy M. Tobacco consumption and policy in the United Kingdom. Applied Economics. 2006;38(11):1235-57.
33. Stoklosa M, Drope J, Chaloupka FJ. Prices and E-Cigarette Demand: Evidence from the European Union. Nicotine & Tobacco Research. 2016:ntw109.
34. Grace RC, Kivell BM, Laugesen M. Estimating cross-price elasticity of e-cigarettes using a simulated demand procedure. Nicotine & Tobacco Research. 2014:ntu268.
35. Huang J, Tauras J, Chaloupka FJ. The impact of price and tobacco control policies on the demand for electronic nicotine delivery systems. Tobacco control. 2014;23(suppl 3):iii41-iii7.
36. Brennan A, Meier P, Purshouse R, Rafia R, Meng Y, Hill-Macmanus D. Developing policy analytics for public health strategy and decisions—the Sheffield alcohol policy model framework. Annals of operations research. 2016;236(1):149-76.
37. Katikireddi SV, Hilton S, Bond L. The role of the Sheffield model on the minimum unit pricing of alcohol debate: the importance of a rhetorical perspective. Evidence & Policy: A Journal of Research, Debate and Practice. 2016;12(4):521-39.
38. Brennan A, Meier P, Purshouse R, Rafia R, Meng Y, Hill-Macmanus D, et al. The Sheffield Alcohol Policy Model – A Mathematical Description. Health Economics. 2015;24(10):1368-88. doi: 10.1002/hec.3105.
39. Belvin C, Britton J, Holmes J, Langley T. Parental smoking and child poverty in the UK: an analysis of national survey data. BMC public health. 2015;15(1):1.
40. Gell L, Meier P. The nature and strength of the relationship between expenditure on alcohol and food: An analysis of adult‐only households in the UK. Drug and alcohol review. 2012;31(4):422-30.
41. Angus C, Ally A. Modelling the potential impact of duty policies using the Sheffield Alcohol Policy Model, Version 3. University of Sheffield. 2015.
42. Feirman SP, Donaldson E, Glasser AM, Pearson J, Niaura R, Rose S, et al. Mathematical modeling in tobacco control research: initial results from a systematic review. Nicotine & Tobacco Research. 2015:ntv104.
43. Reed H. The effects of increasing tobacco taxation: a cost benefit and public finances analysis: Action on Smoking & Health; 2010.
44. Pokhrel S, Owen L, Lester-George A, Coyle K, Coyle D., West R., et al. Tobacco Control Return on Investment Tool. London: National Institute for Health and Care Excellence, 2013.
45. Bhimjiyani A, Knuchel-Takano A, Hunt D. Aiming high: Why the UK should aim to be tobacco-free. Cancer Research UK and the UK Health Forum, 2016.
46. Gillespie DOS, Ally AK, Angus C, Gell L, Sadler S, Stone T, et al. How inequalities in tobacco and alcohol consumption might modify the effects of public health action: a modelling case study of head, neck and oesophageal cancer. Kettil Bruun Society2015.
47. Gillespie DOS, Hatchard J. Use of experts to inform the development of multi-behaviour models of public health policy: case study of tobacco and alcohol. UKCRC16 Change and Exchange Conference; Norwich2016.
48. Tricco AC, Antony J, Zarin W, Strifler L, Ghassemi M, Ivory J, et al. A scoping review of rapid review methods. BMC medicine. 2015;13(1):1.
49. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. International journal of social research methodology. 2005;8(1):19-32.
50. Mikecz R. Interviewing Elites:Addressing Methodological Issues. Qualitative Inquiry. 2012;18(6):482-93. doi: 10.1177/1077800412442818.
51. Gale NK, Heath G, Cameron E, Rashid S, Redwood S. Using the framework method for the analysis of qualitative data in multi-disciplinary health research. BMC medical research methodology. 2013;13(1):117.
52. Lincoln V, Guba E. Naturalistic Inquiry.(Beverly Hills, CA., Sage) Google Scholar. 1985.
53. Ally AK, Lovatt M, Meier PS, Brennan A, Holmes J. Developing a social practice‐based typology of British drinking culture in 2009–2011: implications for alcohol policy analysis. Addiction. 2016;111(9):1568-79.
54. Purshouse RC, Brennan A, Moyo D, Nicholls J, Norman P. Typology and Dynamics of Heavier Drinking Styles in Great Britain: 1978-2010. Alcohol and alcoholism. 2017.

55. Sousa J. Estimation of price elasticities of demand for alcohol in the United Kingdom. London: Her Majesty's Revenue and Customs. 2014.
56. Carter BD, Abnet CC, Feskanich D, Freedman ND, Hartge P, Lewis CE, et al. Smoking and Mortality - Beyond Established Causes. New England Journal of Medicine. 2015;372(7):631-40. doi: 10.1056/NEJMsa1407211. PubMed PMID: WOS:000349143900007.
57. Rehm J, Gmel GE, Gmel G, Hasan OSM, Imtiaz S, Popova S, et al. The relationship between different dimensions of alcohol use and the burden of disease—an update. Addiction. 2017:n/a-n/a. doi: 10.1111/add.13757.
58. Holmes J, Meier PS, Booth A, Guo Y, Brennan A. The temporal relationship between per capita alcohol consumption and harm: a systematic review of time lag specifications in aggregate time series analyses. Drug and alcohol dependence. 2012;123(1):7-14.
59. Kontis V, Mathers CD, Rehm J, Stevens GA, Shield KD, Bonita R, et al. Contribution of six risk factors to achieving the 25x25 non-communicable disease mortality reduction target: a modelling study. Lancet. 2014;384(9941):427-37. doi: 10.1016/s0140-6736(14)60616-4. PubMed PMID: WOS:000340195800026.
60. Gunning-Schepers L. The health benefits of prevention: a simulation approach. 1988.
61. Cadilhac DA, Magnus A, Sheppard L, Cumming TB, Pearce DC, Carter R. The societal benefits of reducing six behavioural risk factors: an economic modelling study from Australia. Bmc Public Health. 2011;11. doi: 10.1186/1471-2458-11-483. PubMed PMID: WOS:000293326800001.