Guide to the ASH Cost Benefit and Public Finance Model of Smoking, Version 2.1

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Introduction

This document provides an overview of the structure and workings behind version 2.1 of the ASH Cost Benefit and Public Finance Model of Smoking (referred to in this document as the CBPF model) and also presents headline results for the cost of smoking to the UK economy and the UK public finances.

Version 1 of the CBPF model was developed by Howard Reed in 2009-10 building on the cost-benefit model developed for ASH by Paul Johnson (Johnson, 2009; Reed, 2010).

Version 2.0 of the model, coded in 2021-22, was a complete rewrite which brings the model up to date while incorporating the latest and widest evidence on the costs of smoking to the UK economy and public finances. The model is designed to be updated at regular intervals as new evidence on the costs of smoking is produced and new data become available. See Reed (2023a) for details of Version 2.0.

Version 2.1 (as outlined in this report), completed in autumn 2023, is a minor update which adds the most recent data to the model and uses Quality-Adjusted Life Years (QALYs) to estimate the value of lives lost due to smoking.

The structure of this document is as follows:

Section 1 provides an overview of the components of the cost-benefit and public finance aspects of the model as well as showing which aspects are new in this version of the model.

Sections 2, 3 and 4 explain how each element of the costs of smoking to the economy and the public finances is estimated in the current (or most recent) year of the model – currently 2022. Section 2 looks at costs relating to productivity, Section 3 looks at taxes and benefits, and Section 4 explains how the costs of smoking to services (healthcare, social care and the fire service) are estimated.

Section 5 explains the assumptions and modelling processes used to produce estimates for future years (over a 50-year time period).

Section 6 focuses on particular methodological issues which have been addressed during the rewrite of the CBPF model.

Section 7 presents estimates from the model for the cost of smoking to the UK economy and the public finances in 2023, and the gains from implementing policies recommended in the recent report by the All-Party Parliamentary Group on Smoking and Health (2023).

Section 8 offers conclusions.

Acknowledgements

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The data from the UK Family Resources Survey and Understanding Society (UK Household Longitudinal Study) used in this report were made available through the UK Data Archive and are Crown Copyright.

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1 Overview

1.1 Aims

The CBPF model is designed with two main functions in mind:

1) Estimating the total costs of smoking to the UK (at a national level) and the impact of changes in smoking prevalence on these costs – both now, and decades into the future.
2) Estimating the overall impact of smoking on the public finances (taking into account tax revenue and public spending impacts) and the impact of changes in smoking prevalence on the public finances.

1.2 Overview of model components

Table 1.1 gives an overview of the components of costs of smoking and public finance impacts of smoking which are included in the current version of the CBPF model. The left-hand column outlines each component of the model and also indicates whether the component is a new addition to version 2.0 or 2.1 of the model, or whether it is an update of a component that was already in version 1.

Table 1.1 Components of the CBPF model Version 2.1 and guide to where they are discussed in detail in the report

Component	Costs to the economy and society	Impact on public finances
1. productivity related costs	**Lost & reduced productivity – *Section 2***	**tax and benefit impacts related to lost & reduced productivity – *Section 3***
Early deaths due to smoking	Lost productivity due to early death	i) Reduced tax receipts due to lost productivity due to early death ii) Reduced pension payments due to early death
Reduced employment levels for smokers compared to non-smokers	Reduced productivity due to lower employment levels	i) Reduced tax receipts due to lower employment levels ii) Increased benefit payments (e.g. ESA) due to lower working age employment levels for smokers
Lower wages for smokers compared to non-smokers	Reduced earnings for smokers compared to non-smokers (conditional on being in employment)	Reduced tax receipts due to lower wages
Economic impacts of tobacco expenditure compared to other goods and services ***New in version 2.0***	Reduced Gross Value Added resulting from expenditure by smokers on tobacco products compared to other goods and services that they would have bought instead if they were non-smokers (including multiplier effects of spending)	Reduced tax receipts resulting from lower GVA and employment due to expenditure on tobacco compared to other goods and services
2. Increased costs of service provision	**Service costs (public and private) – *Section 4***	**Public service costs – *Section 4***
Costs of smoking to NHS	i) Additional hospital admissions for smoking-related conditions ii) Treating smoking-related illness via primary and ambulatory care service	i) Additional hospital admissions for smoking-related conditions ii) Treating smoking-related illness via primary and ambulatory care service
Costs of smoking to social care system ***New in version 2.0***	i) Cost to local authority social care budgets ii) Additional self-funding costs for individuals/families who fund private care iii) Implicit cost of additional informal care iv) Cost of additional unmet need	Cost to local authority social care budgets
Costs of house fires ***New in version 2.0***	i) Cost to Fire and Rescue services for responding to smoking-related fires ii) Property damage arising from smoking-related fires	i) Cost to Fire and Rescue services for responding to smoking-related fires

3.Value of preventable fatalities due to smoking – *Section 6.5*. *New in Version 2.1*	Value of fatalities due to early deaths from smoking-related diseases – measured and valued using QALYs	n/a

In addition, the model also contains a module which estimates the relationship between changes in tobacco taxation and smoking prevalence using assumptions about the elasticity of demand for cigarettes and handrolling tobacco in the UK. This is discussed further in Section 3.4.

2 Estimation of productivity costs of smoking: 2023

This section explains how each component of the productivity costs of smoking is estimated in the calendar year 2023, and future years (up to 2072).

2.1 Early deaths due to smoking

The economic costs arising from smokers and ex-smokers dying earlier than they would have otherwise done had they never smoked are a new estimate made specifically for version 2 of the CBPF model (rather than being an existing estimate which was incorporated into the model). This module estimates the number of early deaths due to smoking and then calculates the productivity losses due to early death (among people of working age). The technical details of these calculations are set out in the Appendix to this report.

Section 6.5 of this report also discusses estimation of the value of preventable fatalities due to smoking (the third component of the costs of smoking in Table 1.1 above). The value of preventable fatalities due to smoking is estimated based on the total number of years of life lost due to smoking among the current smoking population aged 35 and older. This is converted into a total number of Quality-Adjusted Life Years (QALYs) lost due to smoking using data on the distribution of deaths due to smoking by age and sex. The value of lost QALYs is estimated using the HM Treasury Green Book estimate of the value of a QALY (HMT, 2022) and is distinct from the productivity costs of early death due to smoking.

2.2 Reduced employment levels for smokers compared to non-smokers

Recent work for ASH by Reed (2023b)[1] models the relationship between smoking and employment status and smoking and earnings using data from a British longitudinal dataset, Understanding Society (USoc)[2]. The research estimates the impact of smoking in Waves 2 through 11 of the survey (interviewed annually between 2010-11 and 2019-20)– as well as information on whether people were smokers before Wave 2 of the survey – on the probability of employment and the

[1] The estimates in Reed (2023b) are an updated version of Reed (2020). As discussed in Reed (2023b), the new estimates are robustness-checked using data from Wave 10 of USoc (interviews for which concluded in December 2019, just before the Covid-19 pandemic) to ascertain whether Covid affected the estimated employment and earnings impacts from Waves 11 and 12. Overall, there is no statistically significant impact of Covid on the estimated results.

[2] For more details see “Understanding Society: The UK Household Longitudinal Study”, https://www.understandingsociety.ac.uk/

earnings from employment of respondents in Wave 12 of the survey, in 2020-21. The estimate of the lower probability of employment for smokers compared to non-smokers from Reed (2023b) is used in the CBPF model (adjusted to take account of changes in overall employment rates since the original estimate was made). Full details of the methodology and empirical specification for the employment model are given in Reed (2023b).

2.3 Lower wages for smokers compared to non-smokers

The estimate of lower average earnings for smokers compared to non-smokers in Reed (2023b) is used in the CBPF model (adjusted to take account of changes in average earnings since the original estimate was made). Full details of the methodology and empirical specification for the earnings model are given in Reed (2023b).

2.4 Economic impacts of tobacco expenditure compared to other goods and services

Consumption of goods and services in the UK economy has multiplier effects because of the derived demand for goods and services used by industries which supply goods and services for final consumption. Every pound spent on cigarettes or hand rolling tobacco is a pound not spent on something else in the economy. The approach taken is an updated version of the methodology used by Buck et al (1995) at the Centre for Health Economics, University of York. The multiplier effects of tobacco consumption are relatively limited compared to most other goods and services that consumers can spend their money on, for three reasons:

a) employment in the tobacco industry in the UK is close to zero[3].
b) Tobacco expenditure supports relatively few jobs in the supply chain (e.g. distribution, retail).
c) Taxes (excise duties and VAT) make up around three-quarters of the price of a typical pack of cigarettes. Therefore, only around one-quarter of expenditure on cigarettes supports employment in the tobacco industry or its supply chain.

Therefore, as tobacco consumption declines, we would expect output and employment in the UK to increase as consumers switch expenditure away from tobacco and towards other goods and services which support additional output and employment due to larger multiplier effects. Previous work for ASH by Reed (2021a) estimates the positive economic impact of tobacco consumption falling from current levels to zero on output and employment in the UK using an input-output analysis. The estimate of the output gain (measured as Gross Value Added) from tobacco expenditure falling to zero in the UK is used as a measure of the economic cost

[3] The Tobacco Manufacturers Association (2017) gives a total figure of 5,000.

arising from current levels of tobacco expenditure. The CBPF model uses the estimate from Reed (2021a) adjusted to take account of changes in tobacco consumption since the original estimate was made. Full details of the methodology and empirical specification for the economic impacts model are given in Reed (2021a).

3 Estimation of tax and social security impacts of smoking: 2023

This section explains how each component of the impacts of smoking on tax receipts and social security expenditure (also known as benefits or welfare expenditure) is estimated in the most recent year.

3.1 Reduced tax receipts due to early deaths, lower employment and lower earnings in employment

This estimation procedure uses the distribution of earnings from employment and self-employment in the UK estimated using the Family Resources Survey dataset. Because the UK income tax and National Insurance system is non-linear (due to the progressivity of the tax system), quantile points from across the distribution (10 within-decile means) are used to estimate the income tax and national insurance payable at different distributional points. This provides a more accurate estimate of lost tax receipts due to early deaths than simply using the income tax and NICs payable on average earnings.

A similar approach is used for estimating the reduced tax receipts due to lower employment for smokers compared to non-smokers. To estimate the reduced earnings of smokers relative to non-smokers, an extended version of the earnings model outlined in Reed (2023b) is used to model the difference in earnings *across the distribution of earnings* for smokers compared to non-smokers – i.e. the difference in within-decile earnings means across the ten deciles of the distribution.

3.2 Increased social security payments due to lower employment and increased working age morbidity

The estimate of increased social security payments due to lower employment and increased working age morbidity uses data from Understanding Society on smoker status and receipt of various types of benefit received by people with disability and ill health including Employment and Support Allowance, Disability Living Allowance, Income Support, and Housing Benefit. The USoc data contains information on benefit receipt and smoker status which makes it possible to model differences in the propensity to receive various benefits by smoker status. The estimates from USoc are combined with data on average payments of each type of benefit from the DWP's Stat-Xplore data to estimate the relationship between smoker status and overall benefit expenditure.

3.3 Changes to state pension and other social security payments for pensioners

Because smoking increases the numbers of early deaths it results in lower aggregate state pensions and other social security payments (such as Pension Credit and Housing Benefit) to pensioners; conversely, reducing smoking prevalence in the population leads to a higher overall pensions and social security bill.

The model estimate of the impact of smoking on state pensions costs assumes that people who have retired receive a state pension until death, and models state pensions based on a breakdown of levels of state pension payment by age group from the DWP's Stat-Xplore data[4]. We do not assume that everyone who is retired gets the full state pension payment because there are a large number of people who do not have a full contribution record and therefore do not have a full entitlement[5].

We also model additional payments of means-tested benefits – principally Pension Credit and Housing Benefit – for pensioners, using an analysis of amounts received by individuals aged 66 and over from recent Family Resources Survey data to calibrate the results.

3.4 Modelling the impact of changes in tobacco taxation on smoking prevalence and tax receipts

The estimate of the impact of changes in the level of tobacco taxation on smoking prevalence and tax receipts uses the same methodology as the original public finance model as set out in Reed (2010), Section 3.1. The 2010 model used a tobacco consumption elasticity of -0.5 based on estimates by Townsend (1996) and assumed that the *prevalence* elasticity of tobacco consumption (the extent to which smoking prevalence falls in response to an increase in tobacco prices) is equal to 50% of the consumption elasticity. This version of the model uses the latest consumption elasticity estimates from HMRC, of -0.57 in the short-run and -1.19 in the long run (see Czubek and Johal, 2010 and HMRC, 2015[6]).

[4] https://stat-xplore.dwp.gov.uk/webapi/jsf/login.xhtml

[5] Analysis of the number of state pension claims by amount of benefit paid per week is shown in DWP (2022), *State Pension statistics from November 2020 to February 2022*, Worksheet 4. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1098120/dwp-state-pension-statistics-to-february-2022.ods

[6] Czubek M, Johal S. (2010) Econometric analysis of cigarette consumption in the UK. HM Revenue & Customs; HMRC (2015) "Update to HMRC Working Paper Number 9: Econometric Analysis of Cigarette Consumption in the UK" https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/463686/Update_to_HMRC_Working_Paper_Number_9.pdf

Version 2 of the CBPF model continues to assume that the prevalence elasticity of tobacco consumption is equal to 50 per cent of the consumption elasticity, based on recent reviews by Ekpu and Brown (2015) and the World Bank (2017).

The baseline projections for smoking prevalence are modelled as set out in Section 5.1 below, while baseline assumptions regarding future increases in tobacco taxation are set out in Section 5.5. We do not model the relationship between tobacco prices and smoking prevalence explicitly for the baseline scenarios as we assume that the impact of tobacco tax increases on smoking prevalence is already taken into account in the baseline smoking prevalence projections. However, the model is capable of analysing the impact of changes to tobacco taxation (for example, an additional increase in tobacco taxation over and above the increase in the tobacco duty escalator) on smoking prevalence, using the elasticity estimates presented above.

3.5 Modelling the tax implications of diversion of expenditure from tobacco products to other goods and services

As explained in Reed (2021a), reductions in smoking prevalence have the direct effect of reducing tax revenue (because of reductions in tobacco duty and VAT receipts) but there is also an indirect *increase* in tax revenues due to the higher employment generated when consumers reallocate expenditure from tobacco products to other goods and services which support higher levels of employment. This increase in tax revenues comprises the additional income tax and NICs payments from the extra workers employed due to the consumption shift, as well as any additional indirect taxes paid by those workers.

3.6 Reductions in indirect tax revenues arising from reduced employment due to smoking

As well as the impact of smoking on the public finances through reduced employment due to increased numbers of early deaths and lower employment and earnings for smokers compared to non-smokers, there is also a knock-on impact on indirect tax revenues because of lower aggregate consumer expenditures due to lower employment. This is calculated using estimates from the Office for Budget Responsibility of the marginal propensity to consume out of net earnings (after income tax and NICs).

4 Estimate of public service costs of smoking: 2023

This section explains how the model estimates how the cost of smoking to public services – health, social care and fire services – is estimated in the most recent year.

4.1 Costs of smoking to NHS

The estimate of the costs of smoking to the NHS from DHSC (2017) is used, combined with new estimates from Public Health England for hospital admissions attributable to smoking[7]. These are adjusted to take account of increases in NHS costs and changes in population size, smoking prevalence and the distribution of ex-smokers (in terms of years since quitting) since the original estimate (which estimated NHS costs in 2015) was made. The data are also scaled up from the England level to the UK level using data on the size of the adult smoking population in the UK compared to England.

4.2 Costs of smoking to social care system

Local authority social care spending

Previous work for ASH by Reed (2021b) estimates the cost of smoking to the local authority-funded components of the social care system, including domiciliary care and residential care, using data from English Longitudinal Study of Ageing (ELSA) and the Health Survey for England. Full details of the methodology and empirical specification for the economic impacts model are given in Reed (2021b). The estimate from Reed (2021b) is used, adjusted to take account of increases in social care costs and population changes since the original data period which the estimate refers to. The data are also scaled up from the England level to the UK level as with the NHS costs above.

Cost of social care to self-funders

Unlike healthcare where private healthcare expenditure is very small in comparison to NHS funding, private expenditure on social care ("self-funding") is a significant

[7] Public Health England (2021), *Response to consultation on proposed changes to the calculation of smoking attributable mortality and hospital admissions*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/964447/Consultation_response_on_proposed_changes_to_smoking_relative_risks.pdf

part of overall social care expenditure[8]. Social care is means-tested and needs-tested, with local authorities only funding care for individuals whose income and assets are below a certain level. Reed (2021b) models the relationship between smoker and ex-smoker status and the cost of self-funded social care for individuals in the ELSA survey, but no significant impact of smoker status on self-funded care expenditure was found. Therefore, the cost of smoking to self-funded social care is not included in the CBPF model.

Informal care costs of smoking

Informal care - where social care services are provided by relatives and friends of the care recipient on an unpaid basis – accounts for a significant proportion of social care in the UK[9]. Reed (2021b) estimates the costs of smoking to the informal care system in terms of the additional informal care required for smokers (conditional on age) compared to non-smokers. The additional informal care required for smokers is then valued as if it were purchased on the market and an aggregate figure estimated for the cost of smoking to the informal care system. The estimate from Reed (2021b) is used in the CBPF model, adjusted for population changes and care costs and scaled up from the England to the UK level. These costs are not included in the public finances analysis (because informal care is not publicly funded) but they are included in the cost-benefit analysis.

Unmet need for social care

There is a significant amount of unmet need for social care in the UK – where individuals require social care services but do not receive them[10]. Unmet need is defined as a situation where an individual's receipt of formal and/or informal care services does not meet all their care needs. Reed (2021b) estimates the costs of smoking in terms of additional unmet needs for social care using data from the Health Survey for England. The cost of meeting the additional unmet social care needs due to smoking is estimated using assumptions on how much it would cost to provide the additional social care to meet those unmet needs. The estimate from Reed (2021b) is used in the CBPF model, adjusted for population changes and care costs and scaled up from the England to the UK level. As with informal care costs, the additional unmet care needs associated with smoking are included in the cost-benefit analysis but not the public finances analysis.

[8] A report by the National Audit Office (2018) into social care provision and funding in England found that in 2016/17, self-funder expenditure on social care was £10.9 billion, compared to local authority expenditure on social care of £16.9 billion.
[9] The NAO (2018) reports that estimates of the total value of informal care in England range from £59 billion to nearly £100 billion per year.
[10] Age UK (2019) estimated that 1.4 million people over the age of 65 had some level of unmet care needs in 2018.

4.3 Costs of house fires

The UK Government's *Fire Statistics Data Tables* (Home Office, 2023) are combined with estimates for the economic cost of fire (DCLG, 2011) to produce estimates for the overall cost of smoking-related fires across England, which is then scaled up to the UK level using population data. Full details of the methodology are given in ASH (2022, Section 4.

5 Producing estimates for future years

Sections 2, 3 and 4 explain how costs and public finance estimates are produced for the most recent completed calendar year (2023 at the time of writing). However, the CBPF model is designed to produce estimates for future years as well – up to 50 years into the future. This section explains the assumptions used to uprate each data source for future years and the methodology used to produce each component of the estimates using the uprated data.

5.1 Assumptions regarding future smoking prevalence and future investments in tobacco control

The two forecast scenarios

The CBPF model uses two different forecast scenarios for future trends in smoking prevalence in England. A crucial parameter here is the date when adult smoking prevalence falls to 5 per cent – which is the UK Government's definition of a "Smokefree" England. The two different scenarios utilised are:

Scenario 1: a trend reduction in smoking prevalence of 0.5 percentage points per year from 12.7% in 2022 (the most recent estimates for smoking prevalence in England from the Annual Population Survey – ONS, 2023). Assuming this rate of decrease, smoking prevalence reaches 5 per cent by 2038 – eight years later than the UK Government's current target of 2030.

Scenario 2: modelling the additional impact of tobacco control policies recommended by the APPG on Smoking and Health (2023) for the years 2024 through 2029 inclusive, plus the new spending announced in the government's Command Paper published in October 2023. Overall, this package comprises:

- Implementation of all current DHSC commitments in particular increased funding for Stop Smoking Services, anti-smoking campaigns in 2024, and provision of free e-cigarettes to help smokers quit, and financial incentives to support pregnant smokers to quit from 2025. All measures to be sustained throughout the next parliament between 2025 and 2029.
- Implementation of NHS Long Term Plan commitments to provide tobacco dependence treatment for all inpatients, long-term mental health patients and pregnant smokers. To be rolled into business as usual during the next parliament.
- Implementation of additional APPG 2021 recommendations including annual opt out referral for stop smoking support for all smokers, additional investment in anti-smoking campaigns in the North and Midlands, plus additional targeted support to quit for smokers in social housing and undergoing NHS Talking Therapies.

The detailed modelling of the tobacco control policies in Scenario 2 was undertaken by the Tobacco and Alcohol Research Group at University College London. Table 5.1 shows the results from the UCL analysis in terms of modelled smoking prevalence for the years 2024 to 2029 inclusive and the difference from Scenario 1.

Table 5.1. Forecast adult smoking prevalence (percent) in Scenario 1 and the modelled impact of tobacco control policies in Scenario 2

Year	2024	2025	2026	2027	2028	2029
Scenario 1	11.7	11.2	10.7	10.2	9.7	9.2
Scenario 2	11.4	10.6	9.8	9.1	8.3	7.3
Modelled change	-0.3	-0.6	-0.9	-1.1	-1.4	-1.9

Source: calculations by Tobacco and Alcohol Research Group at UCL

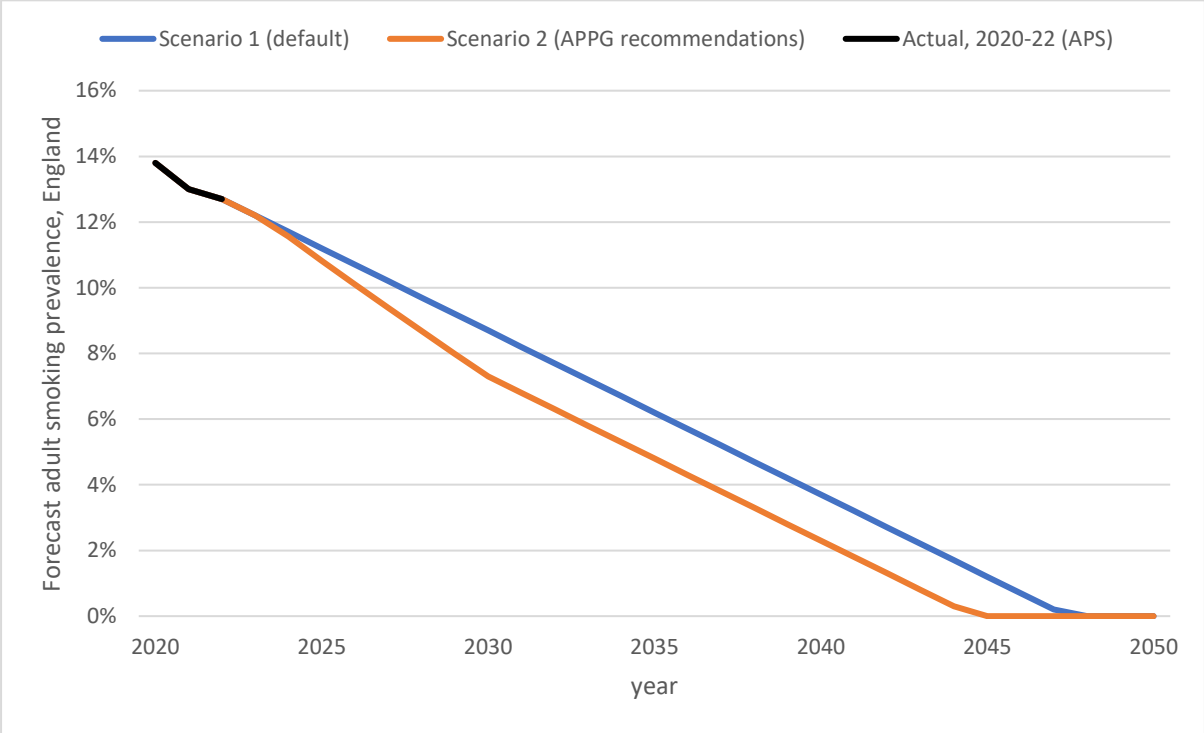
Table 5.1 shows that the tobacco control policies recommended by the APPG (2023) in Scenario 2 are forecast by the UCL team to reduce smoking prevalence by about one third during the next parliament, from about 11.4% in 2024 to 7.3% in 2029. This is compared to a baseline scenario (Scenario 1) where smoking prevalence declines by around one fifth in the next parliament.

For the other three countries in the UK we assume that the percentage point reduction in smoking prevalence each year under both scenarios is the same as for England but from a slightly higher base, reflecting the most recent smoking prevalence statistics from the 2022 Annual Population Survey[11].

Figure 5.1 shows the projections from Scenarios 1 and 2 for adult smoking prevalence from 2023 up to 2050. With the additional tobacco control investments recommended in Scenario 2, we forecast that smoking prevalence in England will fall to 5 per cent by 2035 – three years earlier than in Scenario 1.

[11] As measured by the Annual Population Survey, adult smoking prevalence in 2022 was 12.7% in England, 13.9% in Scotland, 14.1% in Wales and 14.0% in Northern Ireland (ONS, 2023).

Figure 5.1. Adult smoking prevalence forecasts for England, Scenario 1 (default) and Scenario 2 (with additional tobacco control investment as recommended by APPG): 2023 to 2050



Sources: Scenario 1 – assume smoking prevalence falls by 0.5 percentage points per year from 2023 onwards. Scenario 2 – additional impact of policies announced by UK Government for 2024 and as recommended by APPG on Smoking and Health (2023).

5.2 Forecasts for England, Scotland, Wales and Northern Ireland population by age group

The CBPF model uses the population forecasts from the ONS's 2020-based central projection, which provides projections forward for the next 100 years (only the years up to 2072 are currently used in the model)[12].

5.3 Smoking-attributable mortality rate

The number of deaths due to smoking per 100,000 adults aged over 35 in the England population is assumed to be constant in future years, at the level of the estimate used in Section 2.1 above. This means that the number of deaths due to

[12] Sources for population forecasts: ONS (2022b, 2022c, 2022d, 2022e).

smoking evolves in proportion with the size of the over-35 smoking population. The over-35 smoking population is assumed to fall in future years in proportion to the trends in the whole adult smoking population, using the prevalence estimates for the whole adult smoking population in Figure 4.1 above.

5.4 Economic forecasts

Labour market variables

The two labour market variables used in the model are average earnings growth and working-age employment rate. For the years 2023 through 2027 these are assumed to evolve as outlined in the Office for Budget Responsibility's March 2023 *Economic and Fiscal Outlook* (OBR, 2023). For 2028 and subsequent years the forecasts in the OBR's most recent *Long Term Economic Determinants* publication (from March 2021) are used (OBR, 2021).

Price indices

The model uses Consumer Prices Index (CPI) and Retail Prices Index (RPI) forecasts from the OBR's March 2023 *Economic and Fiscal Outlook* (OBR, 2022) for the years 2023 through 2027. For 2028 and subsequent years the long-term OBR forecasts from OBR (2021) are used.

5.5 Uprating of tobacco duties

The current commitment is for a tobacco duty escalator for this parliament which increases duties on factory made (FM) cigarettes by RPI plus 2 per cent each year. This and the escalator are assumed to continue for the entire duration of the model (the next 50 years). Handrolling tobacco (HRT) duties are assumed to increase by RPI plus 4 per cent until tax as a proportion of average retail price for HRT is equal to tax as a proportion of average retail price for FM cigarettes; after this point, HRT and FM cigarette duties are both assumed to increase by RPI plus 2 per cent.

5.6 Tax and benefit thresholds and rates

Income tax and National Insurance rates and thresholds

Tax and NICs thresholds are assumed to be uprated each year with CPI inflation (the default) unless overridden by pre-announced policy decisions (for example, the announcement that income tax and NICs thresholds will be frozen in nominal terms until 2028). Income tax and NICs percentage rates are assumed to be fixed.

Universal credit and benefit uprating

Universal credit and other benefits except the state pension are assumed to be uprated in line with CPI inflation each year unless overridden by pre-announced policy decisions. The state pension is assumed to be uprated by the "triple lock"[13] each year, with long-run triple lock projections taken from OBR (2021).

5.7 Public services cost increases

NHS costs are assumed to rise by 2 per cent per year above CPI, with social care and fire costs increasing in line with CPI. The higher cost increase assumption for the NHS compared to other public services reflects the fact that spending in the NHS has tended to increase at a faster rate than other public services in recent years (King's Fund, 2022).

[13] The triple lock uprates the state pension each year by whichever is the highest of (a) CPI inflation, (b) average earnings growth, or (c) 2.5 per cent.

6 Methodological issues

This section sets out specific parts of the model where we have revisited the modelling assumptions used in version 1 of the CBPF model back in 2010 to assess whether they were still optimal, and adjusted them if this was not the case.

6.1 Choice of forecast time period

Version 1 of the model used a 50-year time horizon for calculating the costs of smoking and the benefits of reducing smoking prevalence, discounting the future stream of costs of benefits into Net Present Values (NPVs) using a 3.5% per year discount rate (as specified in the Treasury Green Book[14]).

The public finance aspect of the 2010 model used a five-year time horizon as the default timeframe for the model results, for two reasons, as given in the 2010 report that accompanied the original version of the model:

"First, public finance issues are a particular concern for governments in the short term. It is most important for them to know what the effect of policy changes on revenue and spending in the next few years will be. The longer-term effects of policy decisions are of less immediate usefulness (although obviously still interesting). Second, there is huge uncertainty regarding the long-term effect of some of the components which would have to be included in a public finances analysis over a fifty year time horizon" (Reed, 2010).

Version 2 of the model includes an option to display the public finance results as NPVs over a 50-year time horizon as well as over shorter timescales such as 5 or 10 years. This reflects the fact that official analysis of the long-term public finance impacts of policy decisions is more sophisticated now than it was in 2010 (for example, the OBR regularly publishes long term fiscal modelling analysis).

6.2 The relationship between NHS costs and the profile of ex-smokers by length of time since quitting smoking

When people stop smoking, their relative risk of developing smoking-related diseases (compared to smokers) does not fall instantaneously, but declines gradually. Some risks fall faster, and others slower. For example, there is evidence of a small more-or-less instantaneous decline in the risks of acute myocardial

[14] HM Treasury (2022), *The Green Book: Appraisal and evaluation in central government*. https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-govenent/the-green-book-2020

infarction and stroke following smoking cessation[15]. Following this initial decline, the risks of stroke and coronary heart disease fall gradually to the same level as for non-smokers within 5 and 15 years (respectively)[16]. The risk of developing lung cancer falls dramatically but remains positive even 25 years after the last cigarette.[17]

The previous version of the cost benefit and public finance model developed in 2009-10[18] followed Naidoo *et al* (2000) in assuming that the aggregated risk of developing smoking-related diseases declines by 2 percentage points instantaneously for ex-smokers compared with people who carry on smoking. For the rest of the risk profile, the previous version of the model followed the approach adopted in Rasmussen *et al* (2005)[19] in assuming that the aggregated risk declines linearly for 15 years and stabilises afterwards.

Version 2 of the CBPF model takes a different approach which is more data-driven. The new version of the model analyses the relationship between current and ex-smoker status and use of NHS services directly using data from the Understanding Society panel survey[20], which contains information on the number of visits to GPs, the number of hospital outpatient appointments and the number of nights spent in hospital as an inpatient for all adult survey respondents. Regression equations are estimated for GP services, hospital outpatient, and hospital inpatient services controlling for gender and age. The results from the regression are used to apportion NHS costs to current smokers, ex-smokers (quit up to 8 years ago), ex-smokers (quit more than 8 years ago) and never-smokers. Simulated changes in future smoking prevalence produce a time profile for current smokers and ex-smokers by quit date (including assumptions on how the reduction in smoking prevalence breaks down into number of quitters and people who never start smoking, building on analysis of the Understanding Society data (see Section 5.3 below).

6.3 Assumption about how the reduction in the number of smokers breaks down into quitters and non-starters

A reduction in smoking prevalence can be achieved either by (a) current smokers quitting (and becoming ex-smokers), or (b) a reduction in the number of non-smokers starting smoking for the first time, or a combination of these two impacts.

[15] Naidoo, B et al (2000) “Modelling the short term consequences of smoking cessation in England on the hospitalisation rates for acute myocardial infarction and stroke” *Tobacco Control* 9: 397-400
[16] See for example Hurley S (2005) “Short-term impact of smoking cessation on myocardial infarction and stroke hospitalisations and costs in Australia” *MJA* 183 (1): 13-17
[17] Peto R, Darby S, Deo H, Silcocks P, Whiteley E and Doll R (2000) “Smoking, smoking cessation and lung cancer in the UK since 1950: combination of national statistics with two case-control studies”, *BMJ* 321: 323-329
[18] H Reed (2010), *The effects of increasing tobacco taxation: A Cost Benefit and Public Finance analysis*, ASH.
[19] Rasmussen A, Prescott E, Sorensen T and Sogaard J (2005) “The total lifetime health cost savings of smoking cessation to society” *European Journal of Public Health* 15(6): 601-660
[20]Understanding Society: the UK Household Longitudinal Study. Institute for Social and Economic Research at the University of Essex.. https://www.understandingsociety.ac.uk/

(a) is an increased *outflow* from the pool of current smokers, whereas (b) is a reduced *inflow* to the pool of smokers. The assumption in the model regarding the balance between these two effects will affect the model results (primarily because ex-smokers have a higher cost to the NHS than never-smokers). The default assumption in the original version of the CBPF model was that 50% of any reduction in smoking prevalence was achieved through quits, and 50% through a reduction in the number of new starters. This default assumption could be altered by the front end user.

Version 2 of the CBPF model uses data from the ONS's *Adult Smoking Habits in Great Britain* publication (ONS, 2023), which features time series data on the breakdown of the adult population into current smokers, ex-smokers and never smokers from 1974 to 2022. Analysis of the data for the decade 2012 to 2022 suggests that around 20% of the decline in smoking prevalence was due to smokers quitting, whereas around 80% was due to fewer people taking up smoking for the first time. The model assumes that this 20/80 split between quitters and non-starters is maintained in future years.

6.4 Treatment of end-of-life healthcare costs

Sometimes it is argued that in cost benefit analyses of policies which result in a reduction in the number of premature deaths in the population (such as tobacco tax increases or tougher tobacco regulations), the additional end-of-life healthcare costs incurred by the people who live longer should be taken into account. In the 2010 version of this model we argued that, even if this were the case, it would be a mistake to include these costs in the cost-benefit analysis (CBA) because there is a fundamental methodological flaw in this approach.

Taken to its logical conclusion, the inclusion of end-of-life healthcare costs in CBAs of this type would lead to the perverse conclusion that policies which result in larger numbers of premature deaths in the population have a positive benefit to society because they reduce healthcare expenditure on elderly people.

The health impact evaluation literature in medicine and epidemiology, which uses very similar techniques to those employed in this model, has already taken this insight on board. Evaluations of healthcare interventions, such as new drugs or other treatments, do not generally include the medical costs of people living longer as an addition to costs for obvious reasons: one of the key objectives of advances in medical care is to increase life expectancy in the population.

For these reasons, neither the original version nor the new version 2 of the CBPF model include end-of-life healthcare costs.

6.5 Valuing life using Quality Adjusted Life Years (QALYs) instead of the Value of a Prevented Fatality (VPF) method

The methodology for valuing lives lost due to smoking-related illnesses in Version 1 of the CBPF model (as well as Version 2.0, as discussed in Reed (2022) used the Value of a Prevented Fatality (VPF) method for each life lost as specified in the Treasury Green Book (HMT 2022, Section 6.37-6.38):

> "The Value of a Prevented Fatality (VPF) measures the social value of changes in risk to life. It is used to value small changes in fatality risks, where levels of human safety vary between options. This is not the value of a life, it is the value of a small change in the risk of probability of losing a statistical life. Not to value this in appraisal would effectively value human safety at zero.
>
> In cases where alternative levels of fatality risk are involved in option design, VPF allows this to be taken into account. The value concerned is known as the value of the risk of "a statistically prevented fatality". It has been widely used for many years, particularly in transport."

For Version 2.1 of the model, lives lost due to smoking-related illnesses are valued using Quality Adjusted Life Years (QALYs) instead of the VPF method. Using QALYs produces a more realistic estimate of the value of lives lost as most early deaths due to smoking-related illnesses occur for adults aged above 35 (and in most cases above age 50) and the number of QALYs lost is smaller for early deaths when aged 50 or older than for deaths at the median age of the whole UK population.

The data from DHSC's Local Tobacco Control Profiles data are used to produce the England-wide smoking attributable mortality rate per 100,000 population, age 35 years and over, broken down by sex and age. For men of women of each year of age, an average number of years of life lost is calculated using data from the ONS National Life Tables (ONS, 2021). These age- and sex-specific average number of years of life lost are then converted into average number of QALYs lost for men and women in each age year using tables in McNamara *et al* (2023), who calculate quality-adjusted life expectancy norms for the English population[21]. These estimates for QALYs lost are then summed across the estimated number of lives lost for men and women in each year-of-age group (from 35 up to 99 and above) to produce an estimate of total number of QALYs in the UK lost due to smoking-related illnesses.

The QALYs are then valued using the HMT Green Book (HMT, 2022) suggested value of £50,000 per QALY (in 2015 terms) which is uprated to 2023 levels using the Consumer Price Index (giving a value per QALY of just under £62,000 at 2023 prices).

This QALYs-based method produces an estimate for "value of lives lost due to smoking-related illnesses" which is substantially smaller than the VPF-based method

[21] Because we do not have separate quality-adjusted life expectancy norms for the populations of the other three UK countries, we use the England conversion tables from McNamara *et al* (2023) for Scotland, Wales and Northern Ireland as well as England.

used in earlier versions of the CBPF model. We believe that the results using the QALY-based method are more realistic.

7 Headline results from the CBPF model

This section presents headline results from Version 2.1 of the CBPF model.

7.1 Costs and public finance impacts of smoking in 2023

Costs of smoking to the UK economy and society

Table 7.1 shows the estimated overall costs of smoking for England alone and for the whole UK in 2023, presented in billions of pounds. The figures are presented in three sections:

1. **Productivity costs.** These total just under £32 billion for England, and just over £38 blllion for the UK. The largest single component is reduced output due to expenditure on tobacco products compared to other goods and services (as discussed in Section 2.4 above), amounting to just under £14 billion for England and just over £16 billion for the UK. Reduced employment for smokers compared to non-smokers accounts for just under £9 billion of reduced productivity for the UK, and reduced earnings for working smokers compared to non-smokers accounts for just over £11 billion.
2. **Service costs.** These total just over £17 billion for England, and around £20.5 billion for the UK. The additional cost of informal care in the social sector is the largest single component of service costs at £10 billion for the UK, followed by the cost of additional unmet need for social care services at just around £6.4 billion, and the cost of smoking to the NHS at £2.2 billion.
3. **Cost of early deaths from smoking.** This is estimated to be just under £26 billion for England, and £30.8 billion for the UK.

The total cost of smoking to the UK economy in 2023 is estimated to be just over £89 billion for the UK, and just over £75 billion for England.

Table 7.1. Overall costs of smoking, England and UK: 2023

Costs of smoking	**£bn**	**£bn**
1: productivity costs	**England**	**UK**
Lost productivity due to early death	1.788	2.125
Reduced employment levels for smokers compared to non-smokers	7.295	8.670
Reduced earnings for smokers compared to non-smokers	9.301	11.054
Reduced GVA due to expenditure on tobacco products compared to other goods and services	13.602	16.166
Total productivity costs	**31.985**	**38.015**
2: service costs		
Healthcare: cost of smoking to NHS	1.886	2.242
Social care: cost to local authorities	1.232	1.465
Social care: cost of additional informal care	8.414	10.000
Social care: cost of additional unmet need	5.403	6.422
Fire service: cost to fire and rescue services for responding to smoking-related fires	0.331	0.394
Total service costs	**17.267**	**20.522**
3: Cost of early deaths due to smoking		
Cost of early deaths valued using QALYs	**25.915**	**30.800**
TOTAL COST OF SMOKING	**75.167**	**89.337**

Source: Landman Economics calculations using CBPF model version 2.1

Public finance costs of smoking

Table 7.2 shows the estimated net impacts of smoking on the public finances in England and the UK in 2023. Section 1 of the table shows the impact of smoking on tax receipts, while section 2 shows the impacts on social security spending. Any impact of smoking that worsens the public finances has a negative sign in Table 7.2, while impacts that improve the public finance have a positive sign. Mostly the public finance impacts in table 7.2 have a negative sign, indicating that the impact worsens the public finances (i.e. a net cost). For example, reduced tax (and NICs) receipts due to lower employment for smokers compared to non-smokers are estimated to worsen the UK Government's fiscal position by just over £3.3 billion in 2023 (for England only the equivalent result is just under £2.8 billion). The only positive values in the table (i.e positive fiscal benefits from smoking) are:

- the revenue from cigarette and handrolling tobacco taxation (comprising duty receipts plus VAT receipts), which is estimated at just over £13 billion at the UK level in 2023;
- reduced pension payments due to early deaths from smoking (estimated at £275 million for the UK).

At the UK level, the total tax impact of smoking is estimated to worsen the public finances by around £1.65 billion in 2023, while the additional social security expenditure worsens the public finances by just under £5.5 billion.

The bottom half of the table shows the cost of smoking in terms of additional spending public services, which totals £4.1 billion for the UK, and just under £3.5 billion for England. Note that for social care we only include the cost of smoking to the public finances (additional local authority expenditure) in Table 7.2, not the informal care or unmet need costs.

In total, the net cost of smoking to the public finances in 2022 is estimated at just over £11.2 billion for the UK, and just over £9.4 billion for England. Were it not for the revenue from cigarette and handrolling tobacco taxation, smoking would cost the public finances around £24.6 billion in total for the UK, and around £20.7 billion for England.

Table 7.2. Net impacts of smoking on public finances, England and UK: 2023

Public finance net costs of smoking	**£bn**	**£bn**
1: impact on tax receipts arising from productivity costs	**England**	**UK**
Reduced tax receipts due to early death	-0.565	-0.671
Reduced tax receipts due to lower employment levels for smokers	-2.799	-3.327
Reduced tax receipts due to lower earnings levels for smokers	-3.818	-4.538
Reduced tax receipts due to fewer jobs being generated by tobacco spending compared to other goods and services	-5.481	-6.514
Revenue from cigarette and HRT taxation (excise duties plus VAT)	11.274	13.339
Total impact on tax receipts	**-1.390**	**-1.652**
2: impact on social security spending		
Increased spending due to lower employment rates for smokers	-1.900	-2.258
Increased in-work social security spending due to lower earnings for smokers	-0.502	-0.597
Increased spending due to reduction in jobs due to tobacco spending	-2.421	-2.877
Reduced pension payments due to early death	0.232	0.275
Total social security spending impact	**-4.591**	**-5.456**
3: public service costs		
Healthcare: cost of smoking to NHS	-1.886	-2.242
Social care: cost to local authorities	-1.232	-1.465
Fire service: cost to fire and rescue services for responding to smoking-related fires	-0.331	-0.394
Total public service costs:	**-3.450**	**-4.100**
Total impact of smoking on public finances (before adding revenue from cigarette and HRT taxation)	-20.704	-24.608
TOTAL IMPACT OF SMOKING ON PUBLIC FINANCES	**-9.431**	**-11.209**

Source: Landman Economics calculations using CBPF model version 2.1

7.2 Impact of modelled tobacco control policies for England in Scenario 2, 2024 through 2029

This section shows results for the impact between 2024 and 2029 inclusive of the full package of tobacco control policies in Scenario 2 (as described in detail in Section 5.1 above). Table 7.3 shows the impact of the package of tobacco control policies on the economic and social costs of smoking. Note that unlike in earlier tables in this report the total cost estimates in this table (and Table 7.4) are in **millions** of pounds, not billions of pounds. All the results presented in this section are for England alone.

Table 7.3. Impact of tobacco control measures in Scenario 2 on costs of smoking to the economy and society (England)

Costs of smoking	Total cost	Change in costs due to additional policies		
	2023	2024	2025-29 average	2025-29 cumulative
1: productivity costs	**£m**			
Lost productivity due to early death	1,788	-20	-138	-692
Reduced employment levels for smokers compared to non-smokers	7,295	-82	-577	-2,883
Reduced earnings for smokers compared to non-smokers	9,301	-104	-735	-3,675
Reduced GVA due to expenditure on tobacco products compared to other goods and services	13,602	-162	-1.229	-6,146
Total productivity costs	**31,985**	**-367**	**-2,679**	**-13,397**
2: service costs				
Healthcare: cost of smoking to NHS	1,886	-5	-36	-181
Social care: cost to local authorities	1,232	-14	-97	-485
Social care: cost of additional informal care	8,414	-94	-646	-3,229
Social care: cost of additional unmet need	5,403	-61	-437	-2,187
Fire service: cost to fire and rescue services for responding to smoking-related fires	331	-4	-25	-127
Total service costs	**17,267**	**-178**	**-1,242**	**-6,210**
3: Cost of early deaths due to smoking				
Cost of early deaths valued using QALYs	**25,915**	**-293**	**-1,958**	**-9,792**
TOTAL COST OF SMOKING	**75,167**	**-838**	**-5,880**	**-29,398**

Source: smoking costs calculations by Landman Economics calculations using CBPF model version 2.1, based on modelled reductions in prevalence by UCL Tobacco and Alcohol Research Group as outlined in Section 5.1.

Table 7.3 shows that the package of tobacco control measures contained in Scenario 2 is forecast to reduce the total costs of smoking to the economy and society in England by just over £800 million in 2024. Over the next parliament (assumed to run from 2025 to 2029), the costs of smoking are forecast to reduce by almost £6 billion each year of the parliament on average. This reduction in the average cost per year of smoking to England's economy and society comprises a fall of just under £2.7 billion in productivity costs, just over £1.2 billion in costs to public services and just under £2 billion in the costs of early deaths due to smoking.

Table 7.4 shows the public finance impacts of the tobacco control measures in scenario 2 at the England level.

Table 7.4. Impact of tobacco control measures in Scenario 2 on costs of smoking to the public finances (England)

	Total cost	Reductions due to additional policies		
Public finance net costs of smoking	**2023**	**2024**	**2025-9 average**	**2025-9 cumulative**
1: tax impacts arising from productivity costs	**£m**	**£m**	**£m**	**£m**
Lost tax receipts due to early death	-565	6	47	233
Lost taxes due to lower employment for smokers compared to non-smokers	-2,799	32	233	1,163
Lost taxes due to lower earnings for smokers	-3,818	44	316	1,578
Lost taxes due to fewer jobs generated by tobacco spending compared to other goods and services	-5,481	67	522	2,609
Revenue from tobacco taxation	+11,274	-134	-1,011	-5,054
Total impacts on taxes due to smoking	**-1,390**	**15**	**106**	**529**
2. Impact on social security spending				
Increased benefits due to lower employment rates for smokers	**-1,900**	**22**	**145**	**727**
Increased in-work benefits due to lower earnings for smokers	-502	6	40	199
Increased benefits from reduction in jobs due to tobacco spending	-2,421	27	200	1,001
reduced pension payments due to early death	+232	-8	-21	-107
Total impact on public finances due to benefit spend	**-4,591**	**47**	**364**	**1,819**
3: public service costs				
Healthcare: cost of smoking to NHS	-1,886	5	36	181
Social care: cost to local authorities	-1,232	14	97	485
Fire service: cost of responding to smoking-related fires	-331	4	25	127
Total public service costs:	**-3,450**	**23**	**159**	**794**
Total gross costs of smoking to public finances (before tobacco tax subtracted)	-20,936	226	1,661	8,303
TOTAL COSTS OF SMOKING TO PUBLIC FINANCES	**-9,431**	**84**	**628**	**3,142**

Source: public finance impact calculations by Landman Economics using CBPF model version 2.1, based on modelled reductions in prevalence by UCL Tobacco and Alcohol Research Group as outlined in Section 5.1.

Table 7.4 shows that in 2024 the public finances are forecast to improve by £84 million, comprising a net increase of £15 million in tax receipts, a reduction of £47

million in social security spending and a reduction of £23 million in public service costs. Across the 2025-29 parliament the public finances are forecast to improve by an average of just over £600 million per year due to reduced smoking prevalence in scenario 2 (or just over £3 billion summing the total over the five year parliament). The annual average improvement in the public finances during 2025-29 comprises a net increase of over £100 million per year in tax receipts, reductions of just over £350 million per year in social security spending and reductions of just over £150 million per year in public service costs.

8 Conclusion

This report explains the rationale and methodology for Version 2.1 of the ASH Cost Benefit and Public Finances (CBPF) model of smoking.

Many of the data inputs into the model are based on previous work conducted by the author of this report for Landman Economics, and we plan to update these on a regular basis as well as checking for updates to external data sources on an annual basis.

The results from the model show that increased investment in tobacco control programmes as recommended in the November 2023 report by the APPG on Smoking and Health – most of which were previously set out in the APPG's 2021 report – will deliver very substantial gains to the economy and public finances in England before 2023. Over a five year parliament between 2025 and 2029 the modelled policies are forecast to reduce the cost of smoking to the public finances in England by over £3.1 billion, and to reduce the cost of smoking to the economy and society in England by over £29 billion, summing the impacts across all five years of the parliament.

References

Age UK (2019), *Health and care of older people in England 2019.* https://www.ageuk.org.uk/globalassets/age-uk/documents/reports-and-publications/reports-and-briefings/health--wellbeing/age_uk_briefing_state_of_health_and_care_of_older_people_july2019.pdf

All-Party Parliamentary Group on Smoking and Health (2023), [insert name of report and URL when ready]

ASH (2022), *ASH Ready Reckoner 2022: Methodology*. https://ash.org.uk/uploads/RR-methods-December-2021.pdf?v=1649167840

Branston JR, McNeill A, Gilmore AB, Hiscock R, Partos TR. Keeping smoking affordable in higher tax environments via smoking thinner roll-your-own cigarettes: Findings from the International Tobacco Control Four Country Survey 2006–15. Drug and Alcohol Dependence. 2018 Dec 1;193:110-6.

Buck C, Godfrey C and Sutton M (1995), "Tobacco and jobs: the impact of reducing consumption on employment in the UK", Society for the Study of Addiction/ Centre for Health Economics, University of York.

Cancer Research UK (2022), *Smoking prevalence projections for England based on data to 2021*. December 2022. https://www.cancerresearchuk.org/sites/default/files/cancer_research_uk_smoking_prevalence_projections_england.pdf

Department for Communities and Local Government (2011), "The economic cost of fire: estimates for 2008". https://webarchive.nationalarchives.gov.uk/ukgwa/20121105004836mp_/http://www.communities.gov.uk/documents/corporate/pdf/1838338.pdf

Department of Health (2017), *Towards a Smokefree Generation: A Tobacco Control Plan for England*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/630217/Towards_a_Smoke_free_Generation_-_A_Tobacco_Control_Plan_for_England_2017-2022__2_.pdf

Ekpu V and Brown A (2015), "The Economic Impact of Smoking and of Reducing Smoking Prevalence: Review of Evidence". *Tobacco Use Insights*, 2015 Jul 14;8:1-35. doi: 10.4137/TUI.S15628. PMID: 26242225; PMCID: PMC4502793.

HM Treasury (2022), *The Green Book: Appraisal and Evaluation in Central Government*. https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent/the-green-book-2020

Home Office (2023), "Fire statistics data tables". https://www.gov.uk/government/statistical-data-sets/fire-statistics-data-tables

Johnson, P (2009) "Cost Benefit Analysis of the FCTC Protocol on Illicit Trade in Tobacco Products", Action on Smoking and Health.

https://ash.org.uk/resources/view/cost-benefit-analysis-of-the-fctc-protocol-on-illicit-trade-in-tobacco-products

Khan, J (2022), *Making smoking Obselete: Independent review into smokefree 2030 policies by Dr Javed Khan OBE*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1081366/khan-review-making-smoking-obsolete.pdf

McNamara S, Schneider P, Love-Koh J, Doran T and Gutacker, N (2023), "Quality-Adjusted Life Expectancy Norms for the English Population", *Value Health*, 2023, 26(2): pp163-169.

National Audit Office (2018), *Adult Social Care At A Glance*. https://www.nao.org.uk/wp-content/uploads/2018/07/Adult-social-care-at-a-glance.pdf

The King's Fund (2022), "The NHS budget and how it has changed", https://www.kingsfund.org.uk/projects/nhs-in-a-nutshell/nhs-budget

Office for Budget Responsibility (2021), "Long-term economic determinants: May 2021". https://obr.uk/docs/dlm_uploads/Long_term_economic_determinants_March_2021_EFO.xlsx

Office for Budget Responsibility (2023), *Economic and Fiscal Outlook, March 2023*. https://obr.uk/efo/economic-and-fiscal-outlook-march-2023/

Office for National Statistics (2021), "National Life Tables: UK". https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/datasets/nationallifetablesunitedkingdomreferencetables

Office for National Statistics (2022a), "Adult smoking habits in the UK: 2021". https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/adultsmokinghabitsingreatbritain/2021

Office for National Statistics (2022b), "Principal projection – England population in age groups", https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/tablea24principalprojectionenglandpopulationinagegroups

Office for National Statistics (2022c), "Principal projection – Wales population in age groups", https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/tablea25principalprojectionwalespopulationinagegroups

Office for National Statistics (2022d), "Principal projection – Scotland population in age groups", https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/tablea26principalprojectionscotlandpopulationinagegroups

Office for National Statistics (2022e), "Principal projection – Northern Ireland population in age groups", https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/tablea27principalprojectionnorthernirelandpopulationinagegroups

Office for National Statistics (2022f), "Dataset: Adult smoking habits in Great Britain, 2021". https://www.ons.gov.uk/file?uri=/peoplepopulationandcommunity/healthandsocialcare/drugusealcoholandsmoking/datasets/adultsmokinghabitsingreatbritain/2021/adultsmokinghabitsingreatbritain.xlsx

Office for National Statistics (2023), "Adult smoking habits in the UK: 2022". https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/adultsmokinghabitsingreatbritain/2022

Reed, H (2010), *The effects of increasing tobacco taxation: A Cost Benefit and Public Finance analysis*. Action on Smoking and Health. https://portal-uat.who.int/fctcapps/sites/default/files/kh-media/e-library-doc/2019/12/Reed-2010-CBA.pdf

Reed, H (2020), *The impact of smoking history on employment prospects, earnings and productivity: an analysis using UK panel data*. Action on Smoking and Health. https://ash.org.uk/uploads/LandmanEconomics-smoking-employment-earnings-technical-report.pdf

Reed, H (2021a), *The economic impact of a smokefree United Kingdom: technical report*. Action on Smoking and Health. https://ash.org.uk/uploads/EconomicImpactSmokeFreeUK-FINAL.pdf

Reed, H (2021b), *The costs of smoking to the social care system and related costs for older people in England: 2021 revision*. Action on Smoking and Health. https://ash.org.uk/uploads/Landman-Economics-CostsOfSmokingToSocialCaresystem-March2021.pdf

Reed, H (2023a). *Guide to the ASH Cost Benefit and Public Finances model of smoking, Version 2*. February 2023. https://ash.org.uk/uploads/CBPF-model-2023.pdf

Reed, H (2023b). *The impact of smoking, heavy drinking and obesity on employment prospects, earnings and productivity: analyses using UK panel data.* Action on Smoking and Health. [insert URL when ready]

World Bank (2017), *Tobacco Tax Reform*: *At the Crossroads of Health and Development*. https://documents1.worldbank.org/curated/en/824771507037794706/pdf/WP-P154568-TobaccoTaxReform-PUBLIC.pdf

Appendix: Detailed methodology for calculation of lost productivity due to smoking-related early deaths

a) DHSC's Local Tobacco Control Profiles data are used to produce the England-wide smoking attributable mortality rate per 100,000 population, age 35 years and over. If available, this is combined with similar data for Scotland, Wales and Northern Ireland to produce an overall UK figure; if not, the England-wide mortality rate is used as a proxy for the UK mortality rate.
b) The mortality rate from step (a) is applied to estimates from Public Health England of the number of smokers aged 35+ to give a gross figure for the estimated number of smoking-attributable deaths. This figure is scaled up from England to the UK (using information on adult smoking prevalence and population size in Scotland, Wales and N Ireland compared to England)
c) The distribution of all deaths in the UK is calculated across age and sex based on data from the National Life Tables published by ONS.
d) The gross number of smoking-attributable deaths (step b) is disaggregated by sex and age (35-89 years) according to the distribution calculated in step (c)
e) Employment rates (%) for the UK, stratified by sex and age group, are calculated from ONS Labour Market Statistics.
f) The estimates from steps (d) and (e) are combined to produce an estimate of smoking-attributable deaths across the UK as a whole in the different age/sex categories for people in employment only .
g) For each age/sex category, the number of years of potential productivity remaining is calculated based on analysis of employment rates for smokers and non-smokers by age group using micro-data from the Understanding Society panel survey. (the technical specification is known as a hazard model). This data analysis is used to produce an estimate of average remaining years in employment for non-smokers in employment by age.
h) Outputs from step (g) are combined with outputs from step (f) to produce an actuarial table of years of potential productivity lost due to smoking-attributable early deaths for each age/sex category.
i) The distribution of earnings from employment and self-employment in the UK (combined) is derived from Family Resources Survey data and broken down for each age/sex category using summary quantile points of the distribution (e.g. within-quintile means). Note that using multiple quantile points isn't necessary for the productivity analysis but *is* necessary for accurate modelling of the tax effects of productivity losses due to early death because of the progressivity of the tax system – see Section 3.1 of this report for more details on this.
j) The output from step (h) is combined with the output of step (i) to produce a gross estimate of lost labour income due to early deaths from smoking, stratified by sex and age group.
   A discounting table is produced using the years of remaining potential productivity from step (g) and the assigned discounting factor (3.5% by default) to calculate an age-, year- and sex-stratified discounting value.