Understanding the impact of tobacco tax increases and tobacco industry pricing on smoking behaviours and inequalities

Study Protocol

Background

Health and economic impacts of tobacco

Smoking is the leading preventable cause of death, disease and health inequalities in the UK and places a considerable burden on NHS resources and the UK economy. Around 1 in 5 deaths, and over 500,000 hospital admissions per year among UK adults aged 35 years and older are attributable to smoking(1-4). The total annual cost to the NHS is estimated at £5.2 billion.(5) This does excludes the cost of treating diseases caused by passive smoking, estimated at £23 million each year for children alone.(6) Smoking also poses significant costs to the economy through time off sick, smoking breaks and higher death rates for smokers of working age. In total, smoking is estimated to cost society approximately £15.6[1] billion each year.(7-9) With 12.5 million smokers in the UK, any public health intervention that reduces tobacco use or prevents uptake will lead to significant benefits through reduced premature mortality and morbidity and consequently lower NHS costs and increased economic output.

Following the publication of the white paper 'Smoking Kills' by the UK Government in 1998(10), there were significant advances in tobacco control policies and a corresponding reduction in adult smoking prevalence. However, smoking rates have recently plateaued at around 20%(11) and the implementation of policies did not decrease the gap in prevalence between the most and least disadvantaged groups.(12) Current estimates show that smoking rates remain significantly higher amongst low socio-economic status (SES) groups (33% in routine and manual compared to 14% in professional and managerial occupations(11)).

The importance of tobacco tax and price

Raising the price of tobacco, through tobacco tax increases, is the most effective and cost-effective public health intervention for reducing tobacco use.(13) Additionally, because the least well off and the young are the most price-sensitive,(13) tobacco tax increases have also been shown to be the most effective public health intervention for reducing tobacco use in these harder to reach groups and thus for reducing inequalities in smoking.(12, 14, 15) Low SES smokers are, for example, more likely than high SES smokers to cite the cost of smoking as the trigger for making a quit attempt.(16) Price also plays a key role in decisions to take up smoking, with increases in the price of cigarettes shown to reduce the number of adolescents who start smoking, with a greater impact on preventing the transition to regular smoking in adulthood.(17-19) The tobacco industry (TI) is of course aware of the importance of price and its internal documents show not only that pricing and price promotions are among its most important marketing tools, but that low-priced brands and price promotions are developed to target young smokers and to keep smokers who would otherwise quit in the market when prices rise.(20-23) Studies have shown how the TI uses price promotions to reduce the success of tobacco control interventions.(24) In the US, where data on TI marketing spend is available, it is clear that price promotions are becoming the industry's favoured form of marketing.(25) Although data on TI marketing spend are not available in the UK, research shows a growth in price promotions, for example through the use of price-marked packs.(26, 27) While the scope for the TI to use price promotions in the UK is constrained by marketing legislation, pricing remains a key means through which the TI can market its products and influence the effectiveness of tobacco tax increases. Hence, while there is strong evidence that raising the price of tobacco through tobacco tax increases is

[1] Total for England, Wales and Scotland. No study has calculated costs for Northern Ireland.

the most effective public health intervention for reducing tobacco use and inequalities in smoking,(12, 14, 15) little research has addressed the extent to which its effectiveness is influenced by TI pricing strategies and the effect this has on smokers' behaviour and socio-economic inequalities in smoking.

Tobacco industry pricing strategies

When tax increases are announced in the Budget each year, tobacco companies can do one of three things: increase prices on top of tax increases so that both the price and tax increase are passed onto consumers (a practice known as over-shifting), absorb the tax increase so it is not passed onto consumers (under-shifting) or simply pass the tax increase onto consumers in full (fully-shifting).(25) Over-shifting will enhance the public health impact while under-shifting will undermine the public health impact of the tax increase. A recent study by our research team provides the first evidence on TI pricing strategies in the UK manufactured cigarette market.(28). It also showed how the price gap between the more expensive brands and the cheapest brands is increasing because of differences in how the TI is shifting the annual tax increases across these price segments.(28) Between 2006 and 2009, although on average the industry was over-shifting taxes, at the point each year when the government put taxes up, it under-shifted taxes and cut prices on its cheapest, so called 'ultra-low price' brands, while over-shifting taxes on its more expensive products. Consequently the real price of many of the cheapest brands has remained the same or fallen since 2006 such that the cost of smoking for those using these brands has not changed and the price gap between the most and least expensive cigarettes has increased. For example, the cost of a 20 pack of manufactured cigarettes in December 2004 ranged from £3.95 to £5.10 and by December 2010 this changed to £3.56 and £8.50.[2] The incentive for smokers to downtrade from expensive to cheap cigarettes has therefore increased and will increase further if the current pricing strategy continues.

UK smokers' behavioural responses to price increases

When faced with a tobacco tax and price increase, smokers may do nothing, quit, reduce consumption or engage in price-minimising behaviours by switching to one of a number of cheaper sources of tobacco. Dependant on their previous product choice the latter might include cheaper legal products (eg ultra-low price cigarettes or roll-your-own (RYO) tobacco), non-domestic legal (NDL) or illicit tobacco. The availability of cheap products is therefore likely to undermine the intended public health impacts of tobacco tax increases. Recent research from the International Tobacco Control Survey (ITC) showing that the availability of low cost cigarettes in a market reduces the effect of cigarette price increases in promoting smoking cessation(29) suggests this is the case.

The growing availability of cheap cigarettes in the UK consequent to the industry's pricing strategy outlined above is therefore a major public health concern. It has particular implications for the young and low SES groups who are the most price sensitive. Additionally, this pricing strategy and the consequent growing gap in price between expensive and cheap products likely plays a role in the widening inequalities in smoking in the UK. The same concerns apply to illicit tobacco which is also more frequently used by lower SES groups.(30-33)

Lower priced tobacco products in the UK

Cheap legal tobacco products. The cheapest legal (UK-duty paid) tobacco products available are ultra-low price manufactured cigarette brands and RYO tobacco, a cheaper alternative to manufactured cigarettes. Our research shows that the use of both forms increased in Great Britain (GB) between 2001 and 2008 with use greatest among low SES smokers and in areas with high smoking rates.(36) By 2008, 35% of smokers used one of these two forms of cheap legal tobacco with the largest increase occurring amongst 16-24 year olds, from 16% to 29%.(34)

[2] Prices obtained from Price Checker in 2004 and Nielsen in 2010.

Tax avoidance and Tax evasion. Tobacco on which no UK duties has been paid (non-UK Duty Paid or NUKDP) can be acquired either legally (tax avoidance) – by purchasing NDL products in duty-free shops or from low-tax jurisdictions (eg other EU countries, the majority of which have lower tobacco duties) for personal consumption, or illegally (tax evasion) – by purchasing illicit products (**Table 1**). Enormous effort is being made to control NUKDP tobacco use in the UK. HM Revenue and Customs (HMRC) data show that the market share held by NUKDP (NDL and illicit product combined) has declined substantially and that illicit represents a substantially greater problem than NDL. For example, the market share of NDL cigarettes declined from 9% in the 2002/03 tax year to 3% in 2011/12, compared with a decline from 18% to 7% for illicit cigarettes. The market share of NDL and illicit RYO tobacco has also declined during this period (16% to 6% and 55% to 35% respectively).(35)

Tax avoidance. Travellers returning from other EU countries can legally purchase tobacco for personal use with guidelines outlining what is deemed reasonable personal use.(36) A recent study using ITC data from the mid-2000s across Europe found similar levels of tax avoidance (specifically cross-border shopping) as HMRC at that time and lower levels in the UK compared to those in mainland Europe. It also showed that tax avoidance was more common among higher educated and higher income groups consistent with their greater propensity to travel.(37)

Tax evasion. There are different forms of tax evasion, including purchase of genuine TI product that has entered the illicit market, counterfeit and illicit whites (**Table 1**). The decline in illicit tobacco use in the UK over the last 10 years as a result of government strategies(38) has been accompanied by an apparent shift in the nature of the illicit market, possibly in response to these strategies. For example, major seizures (over 100,000 cigarettes) in the UK have changed from predominantly smuggled genuine product to counterfeit and illicit whites, although seizures are not necessarily representative of the illicit tobacco market as a whole and evidence suggests they are increasingly unrepresentative.(39)

In contrast to tax avoidance, tax evasion is substantially more common in lower SES groups.(30, 32, 33) Moreover, despite population declines in illicit use, our research shows that use remains prevalent in highly disadvantaged groups.(31) The young are also more likely to use illicit.(32)

Table 1: Definitions of non-UK duty paid products and related behaviours

	PRODUCT DEFINITIONS	
BEHAVIOURS	**Non UK Duty Paid Tobacco (NUKDP)*:**	**Product sub-categories**
Tax avoidance: purchase (for personal consumption) of legal product on which no UK duties have been paid	Non-domestic legal (NDL) product: legal product on which no UK duties have been paid.	Duty free: products exempt from duties and bought for personal consumption. Cross-border sales+: products with duties paid outside the UK, e.g. in other, lower tax EU countries and imported for personal consumption.
Tax evasion: purchase of illegal product on which no duties have been paid.	Illicit product: illegal product on which no UK duties have been paid.	Genuine product: genuine TI brands which have entered the illicit market. This may occur via large scale smuggling^ or bootlegging+ of legitimately manufactured products. Counterfeit: Products bearing a trademark of a tobacco manufacturer which are manufactured by a third party without the consent of that manufacturer. Illicit whites: cigarettes manufactured for the sole purpose of being smuggled into and sold illegally in another market.

Sources: *****The two subcategories of product in this column are known collectively as non-UK duty paid (NUKDP): product on which UK duties have not been paid. **^**Large scale smuggling: the illegal transportation, distribution and sale of large consignments of legitimately manufactured tobacco products, usually with no tax being paid. Tobacco companies and criminal networks are often involved

in this activity. **+** Bootlegging: illegal import of small quantities of legitimately manufactured products (eg products purchased in a country with a low level of taxation) by individuals and gangs for sale illegally.

The complicity of the TI in illicit tobacco

There is overwhelming evidence of the TI's historical involvement in the global illicit tobacco trade.(39-42) In the UK in the 1990s, for example, tobacco companies were accused of facilitating smuggling by deliberately over-supplying their brands to countries where there was no demand for them.(43) Although the nature of the illicit tobacco market has since changed substantially and the TI now claims it has addressed the problem, emerging evidence suggests they have continued to be involved in illicit trade and failed to control their supply chain(44-46), despite signing legal agreements to address both these issues.(39) For example, in the UK, HMRC estimated that in 2011 the aggregate supply of certain brands of RYO to some countries exceeded legitimate demand by 240 per cent.(47) Similarly, massive TI overproduction of cigarettes in Ukraine has been shown to fuel the illicit market in Europe;(44) a finding supported by our recent pan-European survey showing that illicit tobacco use was greatest in those living in countries which shared a land or sea border with Ukraine, Russia, Moldova or Belarus.(30) Furthermore, Philip Morris International's (PMI) own data suggest that in 2010 around a quarter of illicit cigarettes in Europe were genuine PMI brands.(39) The industry's own documents also suggest ongoing involvement in illicit to at least 2010, post-dating the legal agreements.(41, 46)

Despite these historical instances of involvement in the illicit trade and recent evidence of complicity, the TI continues to use the threat of increases in illicit tobacco use to argue against key tobacco control policies including tax increases.(48-51) While these arguments are intuitive and price is one driver of illicit tobacco use, it is not the main driver – supply side issues such as levels of corruption and TI complicity are more important and are key to controlling illicit.(52) Nevertheless, the industry has used these arguments extensively in the UK,(39, 50) despite evidence that much of the price increases are directly attributable to industry price increases rather than tax increases,(51, 53) that no association between tobacco prices and illicit tobacco use was observed across countries in Europe in a recent survey(30) and that levels of illicit tobacco in the UK have been declining despite continued tax increases.(36)

The need for better data on the illicit market and its relation to tobacco price increases

The industry's ability to misuse the illicit tobacco argument is enhanced by the dearth of timely, accurate and publicly available data on illicit use and the fact that the TI increasingly controls much of the data on illicit(39). HMRC estimates of illicit are based on annual sales and consumption data, do not allow analysis of changes in relation to tax changes and TI pricing or provide brand-specific data and are frequently published too late to be policy relevant. Seizure data are increasingly unrepresentative of the illicit market, tending to over-represent illicit white and counterfeit.(39) Subsequently growing reliance is placed on TI data obtained via empty pack surveys, a system of collecting discarded cigarette packs to determine their authenticity. Yet empty pack surveys can only measure NUKDP, being unable to distinguish which of this is legal and which illicit and growing evidence suggests industry empty pack surveys may be designed to increase the likelihood of finding non-domestic/illicit packs.(39) Industry methodologies are rarely published and our work shows how recent industry empty pack surveys significantly overestimate NUKDP/illicit compared with independent data.(39, 50) These issues underline the need for independent, timely data on the size and nature of the illicit market and its relationship with tax increases.

3 RATIONALE FOR CURRENT STUDY

The increased use of cheap legal tobacco products coinciding with the widening price gap between expensive and cheap manufactured cigarettes in the UK and the relatively high (although declining) use of illicit raises concerns that tax increases in the UK may not be as effective as assumed, particularly in low SES groups. An additional concern is that the

government's willingness to increase tobacco taxes is constrained by fear that tax and price rises will fuel the illicit tobacco trade, an argument exploited by the TI. There is a clear need, therefore, for greater understanding of the effectiveness of tobacco tax increases, the extent to which their public health impact is undermined by tobacco industry pricing and whether the threat of the illicit trade is a genuine concern that needs to be considered when setting tobacco duties.

Research in this area is limited and the evidence gaps can be split into 3 interrelated issues: RYO Pricing Strategies: First, no studies have examined TI pricing of RYO tobacco in the UK despite its growing market share (29% of smokers used RYO by 2008, with rates varying from 20% in Scotland to 57% in the South West of England, increases from 15% and 32% respectively in 2001)(34) Furthermore, the work on manufactured cigarette pricing dates only to 2009. As TI pricing strategies may evolve over time reflecting market, economic and policy developments and should be considered when setting tobacco duties, up to date data on RYO and cigarette pricing is essential.

TI Pricing Strategies and SES Inequalities: Second, evidence on the impact that TI pricing has had on levels of cheap legal cigarette use in the UK, differences in smoking outcomes (including quit attempts and success) among those using expensive and cheap cigarettes and the extent to which this explains inequalities in smoking is limited. Our work to date used repeat cross-sectional data to examine cheap cigarette use in the UK and could therefore not directly determine the impact that tax and industry price changes had on smokers' behaviour.(34) Evidence from the ITC study using data from around 5 -10 years ago across four countries including the UK suggested that the use of price minimising behaviours inhibited cessation(54, 55) although impact varied by type of tobacco purchased. However, analysis was based on all four countries' data combined and given the rapidly evolving legal and illicit market in the UK, the higher use of illicit and RYO in the UK and the different pricing structures across the 4 countries involved, this analysis therefore gives limited insight into how UK smokers respond to TI pricing strategies. Further research is therefore needed to examine how UK smokers respond to TI pricing strategies including the extent to which they engage in price minimising behaviours, reduce consumption or quit, and whether these responses vary by SES. Additionally, despite evidence that the TI use low-price brands to target young people,(20) no study has directly linked recent trends in tax/price changes to young people's purchasing behaviour, in particular whether young people initially smoke cheap products but later transition to more expensive products which provide greater revenue for the TI.(28)

The TI threat of increased illicit tobacco use: Third, although the argument the TI most frequently uses to prevent tobacco tax increases is the claim that they will lead to an increase in the illicit tobacco trade,(48) no study has directly examined links between tax increases and trends in tax evasion or avoidance by smokers in the UK. The only relevant study used ITC data from 15 countries, including the UK, and evaluated trends in and characteristics of smokers purchasing NUKDP tobacco from 2002 to 2010 but it did not examine the use of NUKDP in relation to tax increases and did not look at trends in tax evasion separately from tax avoidance (despite evidence of their very different socioeconomic patterning.(30, 32, 33, 37) Furthermore, as the TI uses the illicit trade to argue against tobacco tax increases and other tobacco control measures using its own misleading data,(39, 48, 50) it is important that detailed assessments of the level and nature of illicit use in the UK are conducted independently of the TI. The only recent, independent studies estimating illicit use in the UK cover only England or regions therein and do not provide a measure of uncertainty with the estimates.(30, 32, 33) Some also do not break the data down by cigarettes and RYO.(32) Further independent studies are therefore essential.

Our work will address these remaining research gaps using datasets designed to examine these policy relevant public health issues. It aims to understand the drivers and impacts of price minimising behaviours, and how such behaviours impact on the most disadvantaged and the young. This will in turn increase the ability of tobacco taxation to reduce tobacco

use, particularly among lower SES groups. This work therefore has potential to produce significant public health gains and reduce health inequalities across the UK.

4. RESEARCH OBJECTIVES

Aim

This study aims to evaluate the public health effectiveness of tobacco tax increases in reducing tobacco use and inequalities in tobacco use in the UK and the extent to which this is influenced (undermined or enhanced) by TI pricing strategies.

Objectives

1. To provide up-to-date knowledge of TI pricing and the extent to which this modifies the intended public health impacts of tobacco taxation by examining:
a. how the TI segments manufactured cigarettes and RYO tobacco on price;
b. the extent to which the TI under-,over- or fully- shifts tobacco tax increases to consumers, whether this varies by product and price segment and over time, and what proportion of price increases by segment are explained by TI price increases versus tax increases.

2. To explore the impact of tobacco tax increases, as moderated by TI pricing, on smokers' behaviour by examining:
a. the impact of the price gap (the difference in price between the most and least expensive products) and price changes (annual tax increase modified via TI pricing) on quitting or switching between price/product segments;
b. the impact of the price gap and price changes on consumption;
c. whether these behaviours differ by smokers' previous product/price choice;

3. To explore the impact of tobacco tax increases, as moderated by TI pricing, on inequalities in smoking by examining:
a. the characteristics (socio-economic, geographic etc) of smokers in each product/price segment;
b. whether behaviour choices (quitting, switching between price segments and reducing consumption) differ by smokers' SES;
c. the proportion of change in smoking inequalities over time attributable to cheap (legal) tobacco use.

4. To explore whether cheap (legal) products are a means of market entry for the young by examining:
a. the age of smokers in each product/price segment;
b. trends in youth usage of cheap products;
c. whether young people initiate smoking via cheap products later upgrading to more expensive products.

5. To increase understanding of trends in and the nature of tax avoidance and tax evasion by examining:
a. trends in the proportion of smokers engaging in tax avoidance and evasion, their SES and other characteristics, where they acquire their tobacco and trends therein;
b. whether tax/price increases, particularly larger tax increases, are linked to tax avoidance and/or evasion;
c. which brands are most frequently acquired via tax avoidance and evasion and from which sources.

6. To synthesise findings and develop recommendations to improve the effectiveness of tobacco taxation as a public health intervention.

Study data

Price data. We will use brand-specific price data from two sources: Price Checker (2002-2005) and Nielsen (2006-2014). Price Checker, a supplement to the magazine Retail Newsagent, was the main source of UK price data until October 2005 when it ceased publication. From November 2006, Nielsen began to publish price data for the UK. Nielsen monitors weekly sales from a nationwide network of electronic point of sale checkout scanners and represents sales in over 74,000 stores. Their sales figures, in most months, account for 94% of cigarettes released for consumption (based on HMRC figures). Nielsen is one of the main sources of market data worldwide and is consistently cited as the source of cigarette price data used in financial analyst (eg Citigroup), marketing (eg Key Note) and media reports (eg The Grocer).

International Tobacco Control (ITC) Study. The ITC Project is coordinated by the University of Waterloo , Ontario, Canada, under the oversight of Professor Fong (McNeill is PI for the ITC England survey), www.itcproject.org.. It involves parallel prospective cohort surveys of adult smokers and recent ex-smokers, aged 18 plus (cohorts replenished in cases of loss to follow-up) carried out in 20 countries. The design features and data collection methods of this survey have been published elsewhere. Briefly, the ITC UK survey has been carried out nearly annually since 2002, and involves around 2,000 respondents in each wave (see flowchart in Figure 1). Using random-digit-dialling to identify eligible households, and the next-birthday method to select a respondent in each household, a 10-minute computer-assisted recruitment survey screens for eligibility, ascertains consent and willingness to participate in follow-up. The baseline survey is carried out by telephone approximately one week later. For the UK sample, cooperation rates have averaged 76% per wave and retention rates 74%. We already have 8 waves of data covering the period 2002-2010. Wave 9 was carried out in 2013 and a 10th wave will be carried out in 2014. We will be able to utilise both additional datasets during the course of the study. The longitudinal nature of this study makes it particularly useful for objectives 2 to 6.

Smoking Toolkit Study (STS). The STS (www.smokinginengland.info) is an ongoing monthly cross-sectional survey designed to give timely data on a representative sample of adults (aged 16 plus) living in England. Households are selected each month and the interviewer carries out a face-to-face interview with one adult per household. Starting in 2006, this survey has collected data from around 2000 adults each month (approximately 400 of these will be smokers) using a random location sample design rather than a probability design. We will use STS data collected from 2006 to 2015 (see flowchart in Figure 2). Full access to the data has been approved. Although cigarette smokers and recent ex-smokers were initially followed up by postal questionnaire three and six months later, funding constraints led to the discontinuation of this follow up element and this will not therefore feature in our analyses. The young age of this sample, the detailed data on source of purchase and timeliness of the data make this survey particularly useful for objectives 4 and 5.

Outcome measures

Tobacco use and smokers' behaviour. The ITC surveys ask respondents whether they are current or recent ex-smokers, whether they smoke manufactured cigarettes or roll-your-own (RYO) tobacco, how much they consume each week, what brand they usually smoke, whether they have made quit attempts and the success of these attempts. Responses to these questions will enable us to derive the smokers' behaviour outcome measures for the statistical models in Objectives 2 to 4: whether they have quit smoking, and, for current smokers, their consumption and whether they smoke expensive or cheap products. Changes in these behaviours over time (eg if consumption has declined or smokers have

downtraded to cheaper tobacco products) will be assessed by adding Markov structure to our statistical models (see below). Changes from previous waves as well as changes made within the last year can be assessed.

Allocation of brands to price segments and categorisation: to date, the brands in the ITC dataset have not been allocated to price segments. As part of the initial cleaning of the UK ITC dataset we will therefore use the literature review and price data (objective 1) to allocate brands to price segments. Based on our previous work we anticipate five segments: premium, mid-price, economy, ultra-low price, and RYO although final allocations will be determined following the literature review and price analysis (objective 1*)*. For the analyses in objectives 2 to 4, we anticipate pooling these segments into a smaller number of price categories, most likely: expensive manufactured brands (premium, mid, economy); cheap manufactured brands (ULP); and RYO. Once again, final allocations will be determined at the time based on our initial findings and the objective in question.

Tax avoidance and evasion

ITC respondents are asked detailed questions about their last tobacco purchase: where purchased (13 sources are given for the respondent to choose from), brand purchased and price paid. STS respondents are asked where they have bought tobacco in the last 6 months and are given a similar list of 13 sources to select from; they are also asked the price paid the last time they bought cheap tobacco in the UK but are not asked to name the brand smoked.

Tax avoidance. We will define respondents in both surveys as engaging in tax avoidance when respondents state sources as either a duty-free shop or outside of the country (including international purchases over the internet).

Tax evasion. Based on our recent work, we will define an ITC respondent as engaging in tax evasion if their latest pack was: (1) bought from an independent source (eg door to door or in the street) or (2) its price was substantially lower than the known market price for that brand at the time of purchase based on Nielsen and Price checker data (unless acquired from a non-domestic legal source - ie from a duty-free shop or outside of the UK as this constitutes tax evasion). Similar but not identical indicators of tax evasion can be obtained from the STS. Smokers will be defined as engaging in tax evasion if in the last 6 months they have (1) purchased tobacco from one of the following four sources: pub (somebody who comes round selling cigarettes cheap), people who sell cheap cigarettes on the street, people in the local area who are trusted source of cheap cigarettes or cheap from friends, or (2) (as STS does not collect brand data) if the reported price of the latest purchase was substantially below the lowest price of cigarettes/RYO in the UK at that time. Our initial analysis of ITC data, comparing prices of genuine and illicit brands will be used to determine how we should define “substantially below” for both of these definitions to ensure we capture all illicit use. If necessary a range will be used to examine the impact of the definition on findings but based on similar previous work we do not anticipate a problem with this.

Explanatory variables collated from other data sources

To control for the impact of non-tax tobacco control measures on smoking behaviour in our analyses we will use a tobacco control score we have previously developed and used in evaluations of other public health interventions. This score quantifies tobacco control activity in England each month from 2002 until 2010 using scoring assigned by the Tobacco Control Scale developed by Joossens and Raw to each tobacco control intervention. Each month, scores for each policy were summed to derive a total Tobacco Control Score. As we move to use post-2010 data, the score will be updated.

Statistical and related analysis

Objective 1. We will conduct a comprehensive review of the literature on brand segmentation and cigarette prices covering the period 2008-2014 for manufactured cigarettes and RYO tobacco (**Obj 1a**). The review will include the academic literature, market reports (Euromonitor, KeyNote and Mintel), industry analyst reports on the UK and European markets, tobacco manufacturer annual reports, and TI and retail journals (Tobacco Journal International; Retail Newsagent, The Grocer, Wholesale News and Talking Retail). For manufactured cigarettes this will build directly on our previous literature review and enable identification of any changes in pricing strategy over time (eg in response to specific legislative changes including the point of sale display ban) and whether any brands have been shifted between price segments or removed from the market. For RYO, we will provide the first literature review on industry pricing strategy. We will specifically explore whether the literature details any price-based targeting of smokers by socio-economic status (SES) and age. Finally, to inform the allocation of brands to price segments, as explained further below, we will record the number of price segments and the names of each brand identified in each segment at any point in time, adding these details to our previous compiled list which covers the period 2002-9.

We will then analyse 2008-2014 Nielsen data on brand-specific price and sales to explore trends in the price, volumes and revenue of cigarettes and RYO tobacco by price segment and, most importantly, the extent to which the TI is under- or over-shifting tobacco tax increases by segment (**Obj 1b**). The literature review above will be used to allocate brands to price segments. Where the literature does not specify which price segment a brand lies in, we will use price data to do this using our previously developed methodology. To do this, we will calculate the weighted average retail selling price (the average of brand-specific prices weighted by market sales) for each price and product segment. Tax paid per pack of cigarettes or RYO tobacco will be calculated based on the weighted average retail selling price within each price segment. Average net of tax revenue per pack of cigarettes or RYO tobacco will then be calculated by subtracting the tax paid from the weighted average price. Results will be presented graphically in real terms using the UK consumer price index. To examine the extent to which the TI transfers tobacco tax increases onto smokers (**Obj 1b**), real price increases net of tax will be examined by price segment and for individual brands with significant market shares between 2008 and 2014. Finally we will use the same data to determine what proportion of the price change by product and price segment is attributable to tax increases versus industry pricing (**Obj 1b**).

Objective 2. We will use all available ITC survey data (2002 onwards) to examine whether the price gap (the gap between the most and least expensive products) and changes in price in each price segment following each annual tobacco tax increase impact on decisions to quit or switch between price/product segments (**Obj 2a**). To model this relationship we will use a mixed effects multinomial regression with smokers' behaviour choices as the outcome variable and the price gap and change in price of manufactured cigarettes and RYO as explanatory variables. As explained above, the final outcome variable categories will be determined following the objective 1 analysis but we anticipate them including: quit, smokes an expensive brand of cigarette, smokes cheap legal product. Impacts of the price gap and price changes on consumption (**Obj 2b**) will be determined using a mixed effects Poisson regression with consumption as the outcome variable, price gap and change in price of manufactured cigarettes and RYO as explanatory variables. All models will also include the following individual-level covariates potentially associated with smokers' behaviour and which may be predictors of attrition in the survey: education, age, gender and marital status (single respondents are more often lost to follow-up). Other covariates we will include are government office region of residence (GOR)[i] and the number of adults and phone lines in the household (to adjust for the stratified sampling design and unequal probability of selection) and other tobacco control policies that may also influence smoking behaviour. The latter will be done using our previously developed tobacco control score as outlined

above. As replenishment samples are representative of the population at the time of data collection rather than those lost to follow-up, we will assess the influence of 'time-in-sample' on the outcome variables by including it as an explanatory variable. The models will also have a random effect for smoker to account for correlated responses within smokers over time. There are a number of ways we can deal with tax evasion and avoidance in these models – either controlling for "source" of purchase in the analysis or first determining whether each purchase of a brand is legal, tax avoidance or evasion; final decisions will be taken at the time.

To explore whether these behaviours differ by smokers' previous product/price choice (**Obj 2c**), which will tell us whether changes in price are causing people to change the tobacco products they smoke, both the Poisson and multinomial models will include Markov structure (a type of transition model). The Markov structure allows for the influence of past smoking behaviour on current smoking behaviour and involves having past smoking behaviour as covariate(s) in the model. We will explore whether the influence of price on smoking behaviour varies depending on the smokers' previous product choice by including an interaction between past smoking behaviour and the price covariates.

Objective 3. To determine which smokers use which product/price type (**Obj 3a**) and the extent to which this varies by SES, we will use ITC data collected in the most recent surveys (2010 onwards) in a multinomial regression with product/price segment as the outcome variable and smoker's characteristics, including age, gender, GOR[i] and SES, as explanatory variables. We will also include covariates to adjust for the sampling design, time-in-sample and purchase source as described above. We will then examine whether the behaviour choices in response to price changes in Objective 2 (quitting, switching between product categories and reducing consumption) differ by SES (**Obj 3b**) by using the models described for Objective 2 and including interactions between SES, price gap/price change and past smoking behaviour covariates.

Finally to explore what proportion of the increase in smoking inequalities over time is attributable to the availability of cheap legal tobacco products (**Obj 3c**), we will use the same data in a mixed effects logistic regression Markov model with quit (yes/no) as the outcome variable and price gap, previous product choice and their interactions with SES as explanatory variables. Covariates to adjust for predictors of attrition, the sampling design, time-in-sample, and other tobacco control policies will be included in the model. We will then simulate new scenarios to determine the extent that inequalities would have improved had the price gap and the proportion using cheap products not changed over time.

Objective 4. To explore whether cheap tobacco is a means of market entry for the young we will use data collected from both ITC surveys (2002 onwards) and 2006-2015 STS surveys and first compare the age of smokers in each product/price segment (**Obj 4a**). We will then examine trends in use of cheap products (cheap manufactured, RYO) among young people over time using summary statistics (**Obj 4b**). Finally we will apply a mixed effects logistic regression model to the ITC data with cheap product use (yes/no) as the outcome variable, age as an explanatory variable and a random effect for smoker. We will examine whether the relationship between cheap product use and age varies among smokers by including a random effect to represent the variability in this relationship from smoker to smoker (**Obj 4c**). The other covariates included will be as for the models in Objective 2 in order to account for determinants of attrition, the sample design and the influence of time-in-sample, and other tobacco control policies. To explore the association between age and cheap product use using STS data (**Obj 4c**), we will use a logistic regression model with cheap product use (yes/no) as the outcome variable, age as an explanatory variable and include other

covariates in the model that are potentially associated with cheap product use and may vary among the STS surveys due to differential nonresponse.

Objective 5. We will use both ITC and STS data to examine trends in and the nature of tax avoidance and tax evasion. *ITC data:* To explore trends in tax avoidance and the characteristics of smokers engaging in this behaviour (**Obj 5a**), we will analyse ITC data from 2002 onwards using a mixed effects logistic regression model with engaging in tax avoidance (yes/no) as the outcome variable, smoker as a random effect and age, gender, SES and GOR[i] as covariates to explore the characteristics of smokers. We will include survey date as an explanatory variable to measure the long-term trend and check for non-linearity in the shape of this trend. To explore whether trends in tax avoidance vary by SES we will include in the model an interaction between SES and survey date. We will also include covariates that, in addition to those already in the model, may predict attrition, unequal probability of selection or time-in-sample. This analysis will be repeated using tax evasion (yes/no) as the outcome variable.

To explore whether larger tax/price increases are linked to tax avoidance and evasion (**Obj 5b**), we will use the same data in a mixed effects logistic regression model with Markov structure and have tax avoidance and evasion (yes/no) in separate models as the outcome variable(s), annual tax increases as moderated by TI pricing (the weighted average price of cigarettes) as an explanatory variable and smoker as a random effect. The Markov structure, essentially a covariate indicating whether the smoker responded yes to tax avoidance/evasion behaviour in the previous survey and an interaction between this covariate and the weighted average price of cigarettes, will enable us to investigate whether the influence of large tax/price increases on tax avoidance behaviour differs depending on smokers' tax avoidance history. Predictors of attrition and covariates to adjust for the sampling design and time-in-sample, as described under Objective 2, will be included in the model.

Using self-reported information collected from each respondent on the name of the brand last purchased and where from, we will explore which brands are most frequently acquired via tax avoidance and evasion (**Obj 5c**). For each year, we will summarise this information to identify which brands are most frequently purchased using tax avoidance or evasion and from where and determine how this has changed over time.

STS data: To explore trends in tax avoidance & evasion and the characteristics of smokers engaging in these behaviours (**Obj 5a**), we will analyse 2006-15 STS data using a logistic regression model with tax avoidance (yes/no) and evasion (yes/no) as outcome variables in two separate models. Similar to the ITC model, we will include the following variables to investigate the long term trend: smokers' characteristics and whether trends vary by SES: survey date, age, gender, SES, GOR[i] and an interaction between SES and survey date. We will look at trends by source of cheap cigarettes or RYO tobacco by repeating the above analysis for each source. We will explore whether large tax/price increases are linked with tax avoidance/evasion by fitting a logistic regression model with tax avoidance/evasion (yes/no) as the outcome variable(s) and annual tax increases as moderated by TI pricing (the weighted average price of cigarettes) as an explanatory variable, adjusting for covariates that are potentially associated with tax avoidance/evasion and may vary among the STS surveys due to differential nonresponse.

Objective 6:
We will synthesise all key findings and policy recommendations from the project into a brief research report and work with a knowledge exchange expert at the University of Bath's

Institute of Policy Research to develop an accompanying policy briefing. This plan builds on a model we have previously used to effectively disseminate policy relevant work to key stakeholders and users (eg see http://www.bath.ac.uk/ipr/our-publications/policy-briefs/policy-brief-smokefree-legislation.html). We see this stage as essential not only to ensure research findings are used by public health practitioners, advocates and policy makers, but also because the division of the work into objectives and focused papers is always somewhat artificial. In reality the findings from objectives 1 to 5 address inter-related issues and will be mutually reinforcing. Consequently the synthesis report will be essential to fully understanding our findings and drawing appropriate policy recommendations from the research.

We will establish a stakeholder group for the duration of the project comprising smokers from our UKCTAS Smoker's Panel and those working in the field, notably in NGOs. We will specifically seek their input on interpretation and dissemination. In addition, we will hold a broader Smokers' Panel event on our study, feeding the main study findings to the panel to explore their interpretation and getting their input on draft dissemination materials, notably the synthesis report. We will also explore with them whether a briefing for smokers would be a useful addition to our dissemination materials. In addition, we intend to explore the possibility of one of the smoker representatives becoming involved in dissemination events and media coverage; something they have usefully contributed to in the past.
Finally, we will endeavour to do some basic modelling of alternative tax/regulatory scenarios as part of objective 6 although any detailed and lengthy modelling of alternative regulatory scenarios will have to be undertaken as a separate piece of work.

Figure 1

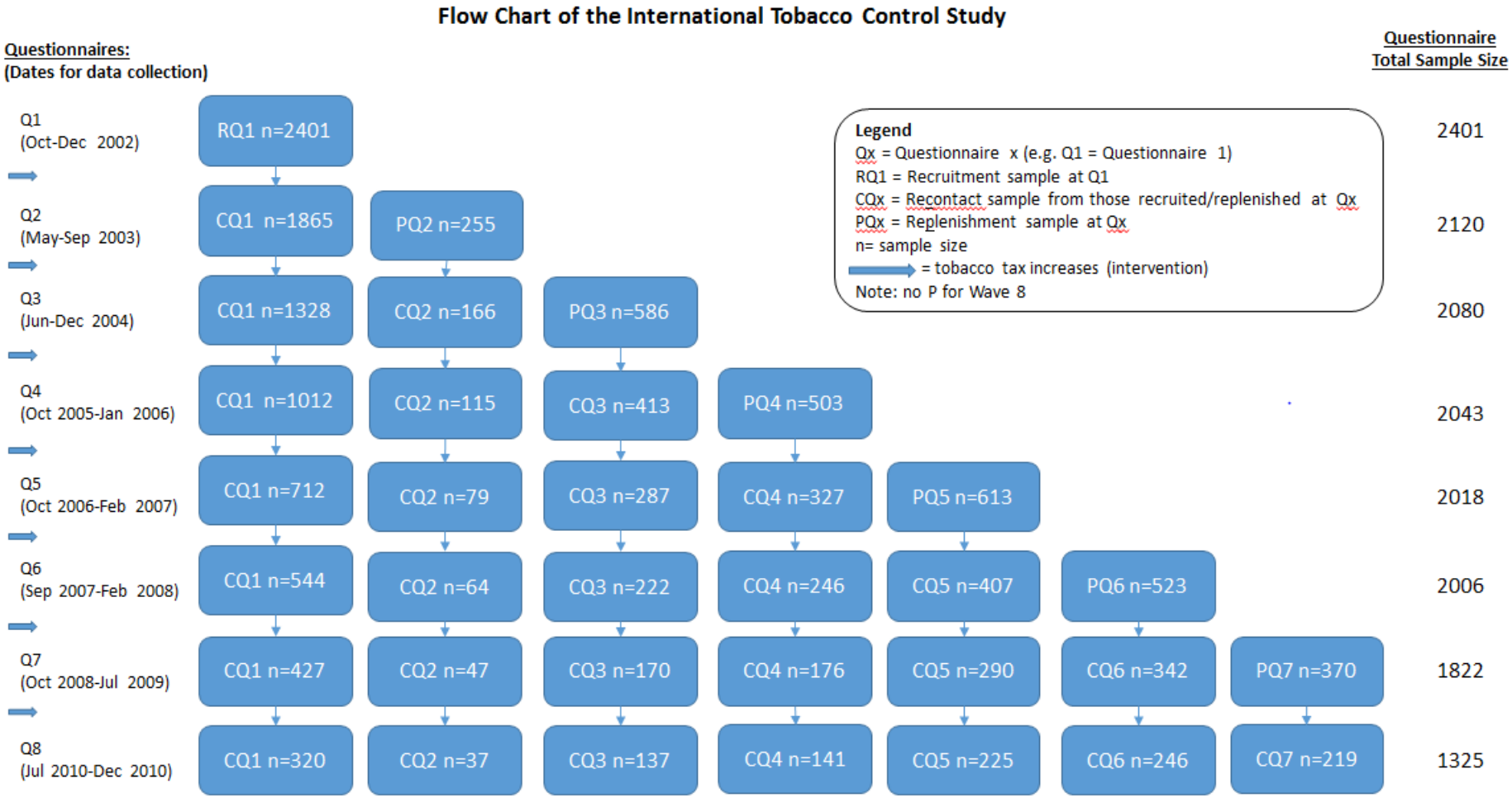
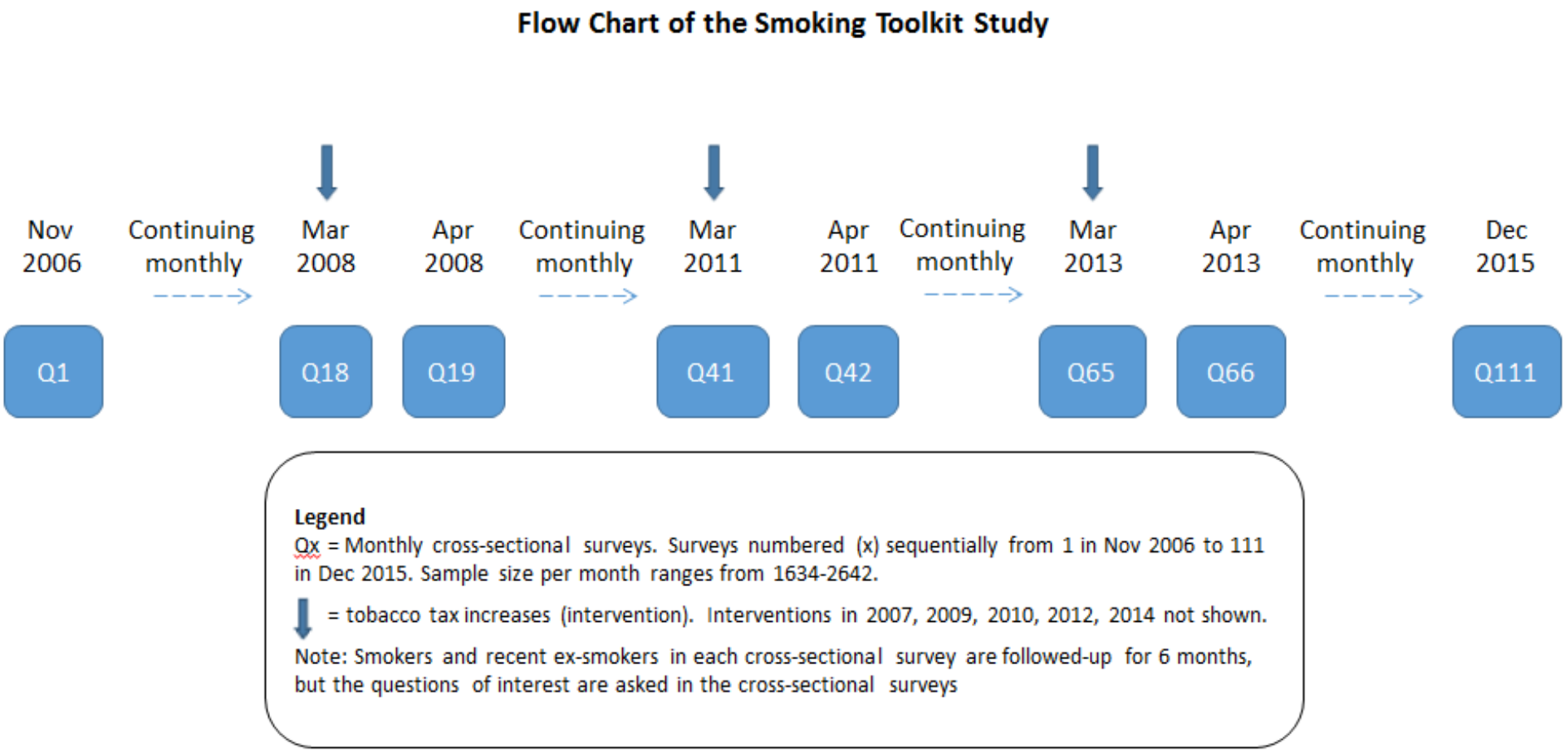

Flow Chart of the International Tobacco Control Study
Questionnaires:
(Dates for data collection)
Questionnaire Total Sample Size
Q1 (Oct-Dec 2002)
Q2 (May-Sep 2003)
Q3 (Jun-Dec 2004)
Q4 (Oct 2005-Jan 2006)
Q5 (Oct 2006-Feb 2007)
Q6 (Sep 2007-Feb 2008)
Q7 (Oct 2008-Jul 2009)
Q8 (Jul 2010-Dec 2010)
RQ1 n=2401
CQ1 n=1865
PQ2 n=255
CQ1 n=1328
CQ2 n=166
PQ3 n=586
CQ1 n=1012
CQ2 n=115
CQ3 n=413
PQ4 n=503
CQ1 n=712
CQ2 n=79
CQ3 n=287
CQ4 n=327
PQ5 n=613
CQ1 n=544
CQ2 n=64
CQ3 n=222
CQ4 n=246
CQ5 n=407
PQ6 n=523
CQ1 n=427
CQ2 n=47
CQ3 n=170
CQ4 n=176
CQ5 n=290
CQ6 n=342
PQ7 n=370
CQ1 n=320
CQ2 n=37
CQ3 n=137
CQ4 n=141
CQ5 n=225
CQ6 n=246
CQ7 n=219
2401
2120
2080
2043
2018
2006
1822
1325
Legend
Qx = Questionnaire x (e.g. Q1 = Questionnaire 1)
RQ1 = Recruitment sample at Q1
CQx = Recontact sample from those recruited/replenished at Qx
PQx = Replenishment sample at Qx
n= sample size
= tobacco tax increases (intervention)
Note: no P for Wave 8

Figure 2


Flow Chart of the Smoking Toolkit Study
Nov 2006
Continuing monthly
Mar 2008
Apr 2008
Continuing monthly
Mar 2011
Apr 2011
Continuing monthly
Mar 2013
Apr 2013
Continuing monthly
Dec 2015
Q1
Q18
Q19
Q41
Q42
Q65
Q66
Q111
Legend
Qx = Monthly cross-sectional surveys. Surveys numbered (x) sequentially from 1 in Nov 2006 to 111 in Dec 2015. Sample size per month ranges from 1634-2642.
= tobacco tax increases (intervention). Interventions in 2007, 2009, 2010, 2012, 2014 not shown.
Note: Smokers and recent ex-smokers in each cross-sectional survey are followed-up for 6 months, but the questions of interest are asked in the cross-sectional surveys

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