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Final Report

A systematic review of the effects of price on the smoking behaviour of young people

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Smoking is a significant contributor to preventable illness and premature death. It has also been shown to be a major contributor to social inequalities in health. The uptake of smoking among young people and the perpetuation of smoking into adult life is a concern for the UK Government. Deterring non-smokers starting to smoke and encouraging young smokers to quit is a serious public health issue that has long term consequences in terms of future health gains and associated costs to the NHS and the wider economy. A range of interventions have been proposed, developed, evaluated and implemented to deter smoking among young people. Conventional economic theory suggests that young people are more sensitive than adults to price in determining their consumption behaviour. The aim of this study was to systematically review the evidence on the effects of price as an economic instrument to target youth smoking.

The majority of studies assessing the impact of price on smoking behaviour are best described as econometric analyses of observational survey data. There is huge variation in the surveys used and the empirical methods adopted, coupled with concerns about the overall quality and representativeness of most of the surveys employed. Most of the studies also failed to report adequate detail about the surveys, price (or tax) data and about the empirical methods used. Bearing in mind these shortcomings, the overall findings of the review suggest that price is an effective instrument in modifying the smoking behaviour of young people. The evidence suggests that increases in price reduce smoking participation and prevalence, as well as the level of smoking. Increased price also induces reductions in smoking initiation and increases in quit rates. There is, however, heterogeneity in the size of the effect for each of these outcomes, with a range of estimated effects reported. The results support the notion that price should be viewed as a legitimate instrument to be used alongside other policies aimed at reducing cigarette consumption among young people.

Executive summary

Background

Smoking has been identified as the single greatest cause of preventable illness and premature death in the UK accounting for 87,000 deaths a year in England alone. It is also a major contributor to health inequalities, being disproportionately concentrated in socio-economically disadvantaged groups.

While the prevalence of smoking in Great Britain declined substantially in the 1970s and early 1980s, the rate of decline continued more slowly until the early 1990s. More recently smoking prevalence has resumed a slow decline and in 2006 it was estimated that around 22% of the adult population smoked. This is against a backdrop of sustained increases in the real price of cigarettes, averaging over 5% annually since the early 1990s.

The uptake of smoking among young people and the perpetuation of smoking into adult life remains a concern for the UK Government. Youth and young adulthood (aged 25 or less) represent critical stages in the development of smoking habits that directly affects health in later years. Deterring non-smokers from taking up smoking and encouraging smokers to quit within this age group will have huge benefits in terms of future health gains and the associated reduction in costs to the NHS and wider economy. A range of interventions have been proposed, developed, evaluated and implemented to deter smoking among young people. Conventional economic theory suggests that young people are likely to be more sensitive than adults to cigarette price and accordingly, price offers a potential economic instrument to target youth smoking.

Aims

The primary aim of this review was to examine the impact of price on cigarette smoking in young people aged 25 years or under. Where the data allowed, the specific focus was on estimated price elasticity effects, and where sufficient evidence was available, differential effects by stage of smoking behaviour and by socio-demographic or socio-economic group were also assessed. A further aim was to identify potential criteria for assessing the methodological quality of empirical studies evaluating the impact of price on smoking behaviour and where possible to use the included studies as an exemplar of how such criteria might be applied in practice.

Methods

A systematic review was conducted. Literature searches were undertaken to identify published and unpublished studies assessing the effect of price on cigarette smoking. Twenty databases were searched from inception to June 2007. Searches were not limited by study design or language. Eligible studies were those assessing the impact of price on smoking behaviour in young people aged 25 years or under: either by focusing on young people or by presenting the data separately for young people and adults. Data from each study were extracted by one reviewer and independently checked for accuracy by a second reviewer. Due to heterogeneity between studies in terms of sources of data, outcomes and modelling methods, formal meta-analysis was considered inappropriate and a narrative synthesis was undertaken. The studies were grouped according to whether they used longitudinal, repeated cross-sectional or cross-sectional data and within these groupings described in relation to the type of controls they employed, in particular policy variables such as restrictions of sales to young people, and indoor air regulations. Where available the differential impact of price by sub-groups and evidence on the impact of cross-border purchasing of cigarettes on price elasticity estimates were also assessed. Smoking

outcomes were categorised into participation, prevalence, levels of smoking, smoking initiation and smoking cessation. We distinguish between smoking participation and smoking prevalence as the former refers to individual-level analyses of the probability of smoking, and the latter to aggregate state or country-level analyses of the proportion of smokers.

Key findings

A total of 45 studies met the inclusion criteria. The literature was dominated by studies from the USA, with only one study based in the UK. Thirty-four studies were specific to young people and 11 studies included adults and young people but reported findings separately. The vast majority of studies were econometric analyses of survey data; therefore the evidence base is derived almost exclusively from the secondary analysis of observational data. In the absence of experimental evidence, the attribution of outcomes to policy instruments is sensitive both to the quality and reliability of the survey data and the empirical approach to modelling. The heterogeneity across studies in both the use and interrogation of data, attests to the challenges in deriving causal impacts of price on smoking outcomes and caution is warranted when interpreting the findings.

Details about the surveys and price or tax data that formed the basis of analyses were rarely described in detail. Further, the representativeness, with respect to all young people, of many of the surveys was questionable. Although several studies claimed that the surveys were representative, they were specific to sub-groups of young people, such as school children or college students. It was often unclear, even where a survey was representative, whether the sub-sample of data used in the estimation retained representativeness. These caveats are important to the interpretation and ability to generalize the findings to a national population of young people.

Thirty-three studies reported estimated price effects as an elasticity (this provides a measure of the percentage change in smoking outcome for a 1% change in price). Overall, the results of the review suggest that price is an effective instrument in reducing cigarette smoking among young people. However, heterogeneity in the estimated size of this effect across studies and for each outcome was found. This is perhaps not surprising given the wide variability in the sources of data used, and empirical techniques employed and possible real differences in effects.

Smoking participation

While there is fairly consistent evidence across studies of a negative effect of price on smoking participation, the magnitude of this effect is less clear. Better quality evidence from longitudinal studies suggests a 10% increase in price is associated with between a 1.1% and 2.4% decrease in smoking participation. Evidence from repeated cross-sectional studies suggests a more elastic response, implying a decrease of between 1.3% and 7.7% for a 10% increase in price. There was little evidence to suggest a difference in price response by age of young person, while results across gender suggest males are more responsive to price than females. Evidence from two studies suggests that black ethnic groups are more price responsive than whites.

Smoking prevalence

Limited evidence was found on the price elasticity of smoking prevalence. All three studies suggested that price had a negative impact on smoking. Evidence from the strongest study suggests a modest response to price for school-aged children, implying a 10% increase in price is associated with between a 1.3% and 2.4% decrease in smoking prevalence.

Level of smoking

There is consistent evidence across the majority of studies of a negative effect of price on the quantity of cigarettes smoked by smokers. The single longitudinal study suggests a 10% increase in price is associated with a 7.3% decrease in the quantity of cigarettes smoked (elasticity: -0.731). Evidence from five repeated cross-sectional studies suggests a more inelastic effect implying up to a 6% decrease in quantity smoked for a 10% increase in price (elasticity range: -0.567 to -0.022). Studies based on surveys of older rather than younger young people suggest a greater response to price for the former. Evidence from two studies suggests that price may have a greater impact on males than on females. Two studies provide evidence to suggest that white ethnic groups are responsive to price but black ethnic groups are not. There was some evidence to suggest that cross-border shopping reduced the price responsiveness of young people.

Moreover, price was also found to be negatively related to the total quantity of cigarettes smoked which takes into account both the effect of price on participation and on the level of smoking by smokers. Better quality evidence from the single longitudinal study suggests a 10% increase in price is associated with a 8.4% decrease in the total quantity of cigarettes smoked (elasticity: -0.844). Evidence from the five repeated cross-sectional studies suggests a more inelastic effect implying between a 3.3 and 6.5% decrease in quantity smoked for a 10% increase in price. There was some evidence to suggest that this price response is greater for older rather than younger young people and that males are more responsive than females. Conflicting evidence on the price responsiveness across ethnic group was found. Mixed evidence of the effect of cross-border purchasing of cigarettes on the price responsiveness of young people was found.

Smoking initiation

Overall, the evidence suggests that price is effective in deterring young people from starting to smoke. Three of the four longitudinal studies using more than two waves of data reported an elastic response to price implying a 10% increase in price is associated with between a 6.5 and 9% decrease in smoking initiation. A single longitudinal study which included controls for state level anti-smoking sentiment found a lower response to price, suggesting a reduction of 1% in smoking initiation for a 10% price increase.

Smoking cessation

Based on the two available longitudinal studies, price appears to be effective in encouraging young people to quit smoking but has a more moderate effect in encouraging sustained smoking cessation among young people.

Implications for policy

The results of this systematic review suggest that price is effective in reducing smoking among young people, although, the magnitude of this effect is less clear. However, it is important to consider the reliability of this evidence given its non-experimental nature and the problems in attributing outcomes directly to policy intervention.

The review findings raise questions about the high price responsiveness of young people frequently assumed in the literature. Price potentially acts to reduce cigarette consumption through three mechanisms. First, a higher price might reduce cigarette initiation and hence prevent individuals from starting to smoke. Secondly, a higher price might induce smokers to attempt quitting which is likely to translate into increased cessation rates and thirdly, price might influence the level of consumption by encouraging smokers to reduce their daily intake. The findings of this review lend some support to these assertions, in that overall,

smoking initiation, quantity smoked and quit attempts, appear to be responsive to price, albeit at different levels of effect. Whilst smoking participation also appears to be responsive to price, the overall effect appears to be lower than the commonly cited USA consensus estimate of around -0.7.

Although some ambiguity remains over the magnitude of effects, the results of this systematic review - bearing in mind the caveats relating to the nature of the evidence - suggest that the economic instrument of price is likely to be effective in reducing cigarette smoking among young people. This has important implications for informing cigarette taxation policy if such policies are to be aimed at curtailing the future public health burden of smoking and the associated costs placed on the NHS. Taxation should be viewed as a legitimate instrument to be used alongside other policies aimed at reducing cigarette consumption. Evidence on the responsiveness to price across social groups is lacking, and further research is required to inform future Government targets aimed at reducing the social distribution of smoking.

Implications for research

Current evidence on the effect of price is dominated by studies undertaken in the USA; only one study was identified from the UK. Similarly, evidence on the impact of cross-border purchases of cigarettes was limited to the USA and the extent to which this evidence is transferable to the UK population, where the relative cost of cigarettes is greater and smuggling is a significant problem, is not clear, and is an important area for future research. Due to the concentration of evidence from USA studies, the majority of price data were derived from the Tax Burden on Tobacco, often using a weighted average price across all sales of cigarettes measured at state level. It is questionable whether an average across all sales is the most relevant price to apply to studies of young people who tend to be more brand-conscious than older smokers.

Limited evidence on the price elasticity of smoking by socio-economic or demographic group was found. Where information was available, this was restricted to effects by age (younger and older young people), gender and ethnic groups. Consideration of the effects on groups from different socio-economic backgrounds should be a priority area for future research, as an aid to understanding the social patterning of smoking among young people and the effectiveness of price in reducing inequalities in smoking behaviours.

The evidence included in this review was limited by a lack of detailed reporting; a problem commonly found in much medical research. Reporting guidelines for trials (CONSORT) and for observational studies (STROBE) have been developed and have the potential to improve the quality of reporting and consequently the quality of research. To date, no such guidelines exist for the reporting of econometric studies and development remains a priority for the future.

Our review was also limited by the lack of specific checklists or tools to assess the methodological quality of econometric studies. Consequently, we attempted to identify relevant criteria that could be applied in a systematic way, for example, in relation to survey design and the source of price data, and approaches to empirical modelling. However, the development of a reliable tool or checklist for the assessment of econometric studies remains a priority for future research and will require consensus on the appropriate criteria to be included.

1. Background

Smoking has been identified as the single greatest cause of preventable illness and premature death in the UK accounting for 87,000 deaths a year in England.[1] It is also a major contributor to health inequalities, exhibiting a strong social gradient and being disproportionately concentrated in socio-economically disadvantaged groups.[2]

While the prevalence of smoking in Great Britain declined substantially in the 1970s and the early 1980s, the rate of decline continued more slowly until the early 1990s. Prevalence rates then levelled out at around 27%, with higher rates among men than women.[3] More recently, smoking prevalence has resumed a slow decline and in 2006 it was estimated that around 22% of the adult population smoked.[4] This is against a background of sustained increases in the real price of cigarettes, averaging over 5% annually since the early 1990s.[5]

There are demographic trends in smoking and one factor that has been identified as being responsible for the levelling out of the decline in prevalence was the high uptake of smoking among young adults despite a reduction in prevalence in some other groups.[6] Since the early 1990s smoking prevalence has been higher among those aged 20 to 24 compared to other age groups. Of current and ex-smokers it is estimated that approximately two-thirds started smoking before the age of 18 and almost two-fifths started before the age of 16.[4] Similar findings have been reported in the USA.[7, 8] The uptake of smoking among young people and the perpetuation of smoking into adult life is a particular concern for the UK government. Smoking earlier in life is associated with longer durations of smoking, smoking more heavily and an increased chance of dying from a smoking related disease.[9]

Encouraging young people to adopt healthy lifestyles has received particular policy attention.[10] Youth and young adulthood (aged 25 or less) represent critical stages in the development of smoking habits that directly affects health in later years. Deterring non-smokers starting to smoke and encouraging smokers to quit within this age group is a serious public health issue that will have huge benefits in terms of future health gains and the associated reduction in costs to the NHS and the wider economy. Reducing smoking among young people will also impact on the success of Government PSA targets to reduce both the level and social distribution of smoking. Currently the target for adult smoking is a reduction in prevalence to 21% or less by 2010, including a reduction in prevalence among routine and manual groups to 26% or less.[1]

A range of interventions have been proposed, developed, evaluated and implemented to deter smoking among young people. These include policy level interventions such as changes to cigarette pricing. Conventional economic theory suggests that young people are more sensitive than adults to price in determining their consumption behaviour (see Appendix 1 for a summary). A higher price potentially acts to reduce cigarette consumption through three mechanisms. First, a higher price might reduce cigarette initiation and hence prevent individuals from starting to smoke. Secondly, a higher price might induce smokers to quit increasing cessation rates and thirdly, price might influence the level of consumption by encouraging smokers to reduce their daily intake.

While some empirical research supports the notion that young smokers are sensitive to price changes and that the size of this response is greater than that for adults,[8, 11] other research has challenged this view.[12] Others still have explored the potential for price to influence different stages of young people's smoking decisions such as initiation, experimentation, habit forming and cessation.[13] Exploring the influence of price is important in understanding behavioural responses to economic incentives and how they compare to other interventions aimed at encouraging smoking cessation and deterring the uptake of smoking. It also has relevance for informing taxation policy.

Evidence about the effects of price on the cigarette consumption patterns of young people has been accumulating over recent years, mostly from the secondary analysis of survey data. This report presents the results of a systematic review of empirical studies focusing on reported price elasticities of smoking participation, prevalence, level of consumption and starting and quitting behaviour. Recent work has attempted to synthesise evidence on smoking behaviour but has concentrated on an adult population.[14] Since the vast majority of cigarette consumption is by adults, inference from a general population cannot be assumed to extend to young people.[8] Accordingly a review of studies specific to young people is required to assess the strength of evidence on the price responsiveness of youth smoking.

2. Objectives

The primary aim of this systematic review was to examine the impact of price on cigarette smoking in young people aged 25 years or under. Where the data allowed, the specific focus was on estimated price elasticity effects and where sufficient evidence was available, differential effects by stage of smoking behaviour and by socio-demographic or socio-economic group as defined by the PROGRESS[15] criteria (place of residence or area deprivation indicator, race/ethnicity, occupation, gender, religion, educational level, income) were also assessed.

A further aim was to identify criteria that might be used to assess the methodological quality of empirical studies evaluating the impact of price on smoking behaviour and if possible to apply these criteria to the studies included in the review.

3. Methods

3.1 Search strategy

Search strategies were devised to identify published and unpublished studies assessing the effect of price on cigarette smoking. The following bibliographic databases and resources covering medicine, economics and social sciences were searched to locate articles and other forms of publication on tobacco and pricing: MEDLINE; MEDLINE In-Process; EMBASE; Cumulative Index to Nursing and Allied Health Literature (CINAHL); Health Management Information Consortium (HMIC); PsycINFO; BIOSIS Previews; ECONLIT; Database of Abstracts of Reviews of Effects (DARE); NHS Economic Evaluation Database (NHS EED); Health Technology Assessment database (HTA); Science Citation Index (SCI); Social Science Citation Index (SSCI); ISI Technology & Science Proceedings (ISTP); Cochrane Library (CDSR & CENTRAL); Public Affairs Information Service (PAIS); Internet Documents in Economics Access Service (IDEAS); Sociological Abstracts (SocAbs); National Technical Information Service (NTIS); Robert Wood Johnson Foundation website.

Individual search strategies were developed for each electronic database and were based on previous searches[16] using those parts of the strategies which related to the issue of price.

All databases were searched from inception to June 2007 and strategies were not limited by study design or language. The strategies are listed in Appendix 2.

To identify any existing checklists or tools for the assessment of econometric studies we searched the Cochrane Library, the Campbell Library and NHS EED. We searched collections of systematic reviews to locate any existing tools that had been used previously to assess the quality of econometric studies. We also contacted experts in the field; experts in the conduct of econometric studies and experts with an interest in the systematic review of econometric studies.

Citations from the literature search were downloaded into an Endnote Library. Two reviewers independently screened all titles and abstracts. Full paper manuscripts of any titles/abstracts that were considered relevant by either reviewer were obtained. The relevance of each study was assessed according to the criteria set out below. Any discrepancies were resolved by consensus and if necessary a third reviewer was consulted.

3.2 Inclusion criteria

Study design
All types of study design were eligible for inclusion. Original scoping searches suggested that most studies assessing the impact of price on the use of tobacco have applied econometric methods to large-scale surveys. Simulation studies, where the smoking responses to changes in price are not based on observed data were excluded.

Participants
Young people aged 25 or under were eligible. Studies involving participants of any age where results were presented separately for young people were also included.

Intervention
Change in cigarette price and/or tax on cigarettes. Studies including interventions other than price and/or tax but where information on prices and/or tax was separately available were also included.

Outcomes
Any measure of behaviour related to cigarette smoking was of interest, including smoking initiation, participation and prevalence, cigarette consumption or demand (quantity smoked), and quitting.

3.3 Data extraction

Data from each study meeting the inclusion criteria were extracted by one reviewer and independently checked for accuracy by a second reviewer. Disagreements were resolved through consensus and if necessary a third reviewer was consulted. The data extracted included: bibliographic details, objectives, whether specific to young people, country of study, source and description of survey and price data, participant details (setting and other contextual information), details of intervention (price or tax), smoking outcomes and outcome definitions (participation, prevalence, quantity smoked, smoking initiation and smoking cessation), details of modelling approach (including theoretical model underpinning analyses, empirical model including dependent and explanatory variables, estimation method used, tests of model assumptions, control for cross-border purchases), results (including price elasticity estimates of the outcomes listed above, other reported price elasticity estimates, tax elasticity estimates of the above outcomes, other effects of price for studies where elasticity estimates were not reported).

Differential impact of price by sub-group as defined by the PROGRESS criteria[15] was also extracted. Since the cost of acquiring cigarettes rather than price might be more relevant to young people than a general population, information about the impact of cross-border trade and barriers to access on estimated price effect was also extracted. Where studies considered the effect of price on brand switching to lower cost cigarettes this information was also extracted.

3.4 Quality assessment

A search for existing guidelines or tools to assess the methodological quality of econometric studies revealed no such tools exist. Therefore in an attempt to assess quality we considered criteria thought to contribute to the overall quality of econometric studies. These were based on a consensus among the authors of what constituted good practice in undertaking econometric analyses and included information on the source and type of both survey and price data, together with information about the approach to empirical modelling. The latter related to unit of analysis (individual, area level, country level), approach to analysis (longitudinal, repeated cross-sectional, cross-sectional), measures and type of smoking outcome (survey measures, whether self-reported), adequacy of sample size, evidence of theoretical model, appropriateness of empirical model, adjustment for confounders and anti-smoking sentiment, control for cross-border purchases, test of model assumptions and sensitivity analyses performed.

Details about the type and source of survey and price data were very limited which presented problems for quality assessment. The almost exclusive reliance on surveys and econometric methods, the lack of standardisation in reporting of the studies and approaches to analysis rendered the application of quality criteria difficult and unhelpful in terms of distinguishing better from poorer quality studies. Instead, we considered the type of data used for analysis. Longitudinal data, with their potential to track smoking behaviour across individuals and over time were considered to be the most reliable; followed by repeated cross-sectional data (which also allow time variation in price data). The least robust data were considered to be cross-sectional (restricted ability to observe variation in price from other impacts on smoking). Greater emphasis was attached to estimates derived from longitudinal analyses and least to estimates from cross-sectional analyses.

3.5 Data synthesis

The large degree of heterogeneity between studies in terms of the sources and uses of data, outcomes and modelling methods together with a general lack of reported sampling variability associated with the estimated elasticities rendered a formal meta-analysis inappropriate. Instead, a narrative synthesis was carried out focusing on estimates of price elasticities for the main outcomes of interest. Elasticities provide a simple and intuitive interpretation of the effect of changes in price to changes in outcome and can be easily compared across studies. For example, a price elasticity of smoking prevalence of -0.2 implies a 10% increase in price is associated with a 2% reduction in smoking prevalence (see Appendix 3). Studies reporting price or tax effects, but not in the form of elasticity estimates, are considered separately.

Effects are synthesised for each outcome: smoking initiation, participation and prevalence, cigarette consumption or demand (quantity smoked), and quitting. Smoking participation (studies based on individual-level as the unit of analysis) and prevalence (aggregate state or country-level analyses) are considered separately. Within each category of outcome the effects are considered according to the type of data: longitudinal, repeated cross-sectional and cross-sectional. For smoking initiation we place greater emphasis on studies using longitudinal survey data collected prospectively, and cross-sectional surveys where information relevant to smoking initiation is retrospectively constructed from the age respondents stated they began smoking.

Ecological studies using aggregate rather than individual level data are also discussed separately. Within each grouping we summarise elasticity estimates by providing the mean effect across relevant studies together with the median and range. This is in the spirit of summary data presented in recent reviews on the demand for cigarettes and alcohol.[14, 17] Point estimates for each study are presented in summary tables and in the data extraction tables.

Within each category, studies that controlled for policy variables likely to be confounded with price are given greater emphasis. For USA based studies, policy variables are largely represented by state fixed effects, indices of state anti-sentiment towards cigarette smoking and policies restricting smoking in public places and restrictions on youth access to cigarette purchases. Again, we provide summary price elasticity estimates across relevant studies.

There is debate over the appropriate use of controls representing clean indoor air regulations, restrictions on youth access to cigarettes, anti-smoking sentiment and/or the use of state dummy variables. By including various permutations of these variables, a number of studies presented price elasticity estimates derived across multiple model specifications, and did not provide direct guidance on a preferred model. Instead, a mean effect taken across model results was often discussed in study summaries and we have extracted this information. Where results across multiple specifications were presented without guidance on a preferred result or a mean effect provided, we have calculated the average effect. For studies reporting results by sub-group such as gender or age, to obtain an overall estimate to synthesise along with other study results, we have calculated an average estimate together with the reported sub-group results.

4. Findings

A total of 7,829 citations were identified from the literature searches. Of these 79 papers were obtained, from which 45 studies met the inclusion criteria and are included in the review. Studies were excluded because they did not assess price effects (n=14), did not report results for young people (n=11), failed to report cigarette smoking (n=1), were duplicate publications (n=6), were not empirical studies (n=1) or were simulation studies (n=1). Excluded studies are listed in Appendix 4. Figure 1 summarises study selection.

Data extraction tables for included studies are presented in Appendix 5.

Below we present descriptive findings on survey and price data followed by a synthesis of the main findings on the impact of price on smoking outcomes according to data type.

4.1 Description of studies

Thirty-eight of the 45 studies were based on data from the USA. One study used data from both the USA and Canada,[18] three used data from Canada[19-21] and single studies used data from Australia,[22] Sweden[23] and the UK.[24] Appendix 6 provides details of the source of survey data used in the studies.

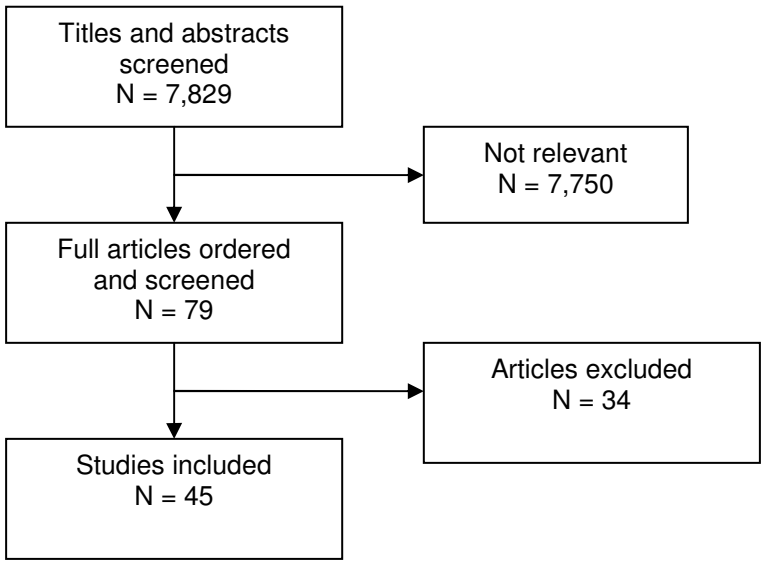

Figure 1: Process of study selection

Forty-four studies utilised survey data and one[25] used administrative data. A range of different sources were used for obtaining price data. Thirty-three studies reported price elasticity estimates[8, 12, 13, 18, 19, 21, 22, 24, 26-50] and three reported tax elasticities.[51-53] Seven studies reported price estimates[20, 23, 54-58] and two tax estimates.[25, 59]

School-based surveys were used in 23 studies,[8, 12, 18, 20, 29, 30, 32, 33, 38-40, 43-49, 53, 54, 56-58] a general non-institutionalised population in five studies,[33, 34, 36, 37, 50] household surveys in four studies,[21, 24, 42, 52] and two studies each used national surveys,[28, 50] surveys of youths[26, 41] and general college/university surveys.[31, 55]

Studies from the USA made use of a further eight survey units, including a survey of children to mothers of the National Longitudinal Survey of Youth;[27] a survey of 15-year-olds and over;[19] teenagers (derived from a household survey);[35] a census of teen mothers giving birth;[39] a sample of smokers and previous smokers where all participants had been identified as smokers in a previous study;[23] a population survey;[13] a home survey of school children;[51] and a survey of US children.[59] One study did not state the survey unit used.[22] One study used an administrative dataset drawn from the Centres for Disease Control and Prevention in the USA which used disaggregated state-level data.[25]

The studies using school-based surveys were all from the USA, with the exception of one using both USA and Canadian data[18] and one using Canadian data.[20] These 23 studies used the findings from six different surveys including The Monitoring the Future project, a nationally representative survey of high-school students aged 13 to 18 years, which was used in 11 studies.[29, 30, 33, 39, 45-49, 56, 58] The National Education Longitudinal Survey, a nationally representative sample of 14-year-olds first surveyed in 1988, with up to four follow-up surveys to 2000, was used in four studies.[8, 32, 38, 54] The National Youth Risk Behavior Survey (YRBS), a nationally representative sample of students aged 15-18 years, was used in four studies.[12, 39, 40, 53] The Study of Smoking and Tobacco Use Among Young People,[43, 44, 57] a nationally representative random sample comprising high school students from public, private and parochial high schools was used in three studies. School-based surveys of 15 year old students in communities across two countries over two years conducted as part of the COMMIT (Community Intervention Trial for Smoking Cessation) project was used in one study and The Ontario Student Drug Use Survey which sampled 15-19 year-olds using a region-by-grade stratified design which was subsequently changed to a stratified single-stage school board cluster was used in one study.[20]

The remaining studies used a variety of different surveys. Analyses using nationally representative samples included six based on the National Health Interview Survey (NHIS)[33, 34, 36, 37, 42, 50] a multistage probability sample of the civilian non-institutionalised population, one based on The Cancer Control Supplement from the NHIS,[36] another based on the Cancer Risk Factor Supplement[34] and one the smoking history analysis.[33] Further nationally representative samples included: The Harvard College Alcohol Study, a survey of colleges and universities;[31, 55] Cycle III of the US Health Examination Survey,[41] a sample of youths aged 12-17; The National Longitudinal Survey of Youth,[26] a nationally representative sample of youths aged 12-21 years and the Current Population Survey.[52] Two further studies used the Second National Health and Nutrition Examination Survey (NHANES2)[28, 50] which is an annual survey of the civilian non-institutionalised population.

Household surveys undertaken outside of the USA and used in five different studies were the British General Household Survey;[24] Canada's National Population Health Survey;[21] The Canadian Tobacco Use Monitoring Survey (CTUMS) of those aged 15 plus;[19] and a Swedish unnamed survey.[23] Two Australian surveys using a random sample of the Australian population were utilised in one study.[22] These were the National Health Survey (NHS 1990) (used for the main analyses) and the National Drug Strategy Household Survey (NDSHS 1998 used for sensitivity analyses).

Studies from the USA mainly used price data from The Tax Burden on Tobacco, an annual report from the Tobacco Institute. Other sources included average price of premium brand cigarettes,[58] Add Health data,[51] real cigarette price,[40] price data from barcode scanning,[13] inter-city cost of living index,[31] federal and state cigarette taxes as a percentage of retail price,[25] and the average price of premium-brand cigarettes across all stores in a community.[58]

The one UK based study[24] used national income and expenditure accounts. The Swedish study[23] used the average price of 20 cigarettes deflated by the consumer price index and the

Australian study used time-series data on cigarette prices from an unpublished Australian Bureau of Statistics source.[22] The three Canadian studies used the annual price indices and personal income data from the CANSIM database (Statistics Canada's key socio-economic database);[19] the retail price of a carton of cigarettes;[21] and taxes in Canada.[20] The joint US and Canadian study used price data from The Tax Burden on Tobacco and nominal Canadian tax-inclusive prices from the Canadian Non-Smokers Rights Association.[18] Appendix 7 provides further details about the source of price data for each study.

4.2. Price elasticity estimates

Thirty three studies reported price elasticity estimates. Of these, nineteen studies reported price elasticity estimates for participation;[8, 12, 13, 18, 19, 29-32, 35-39, 41-44, 48] three studies reported prevalence estimates;[12, 33, 39] thirteen studies reported elasticity estimates for the level of smoking by smokers[13, 29, 31, 32, 35-37, 39-42, 44, 48] and fifteen studies reported price elasticity estimates for the total level of smoking.[13, 24, 28, 29, 31, 32, 35-37, 39, 41, 42, 44, 48, 50] A further seven studies reported elasticity estimates for the probability of commencing smoking[21, 22, 26, 27, 34, 45, 49] and two studies provided evidence on the price elasticity of smoking cessation.[46, 47] All studies directly estimated price elasticities with the exception of three studies that estimated tax elasticities[a] which were subsequently transformed to price elasticities.[8, 12, 36] Appendix 8 provides further details of the outcomes investigated in the studies.

The majority of studies were recent being based on surveys from 1990 onwards. One study used data commencing in the 1960's,[41] ten studies used data from the 1970's onwards[24, 28, 33, 37, 42, 45-48, 50] and five studies from the 1980s onwards.[8, 27, 34, 36, 38]

Price data were described as being derived from a weighted average of sales of cigarette packs in 14 studies. Five studies described price derived from simple average of cigarette packs,[18, 33, 35, 37, 49] and a single study was based on the typical price of a pack of cigarettes.[31] Three studies described price derived from national accounts,[24] price adjusted for quality,[22] and scanned sales data.[13] In seven studies, the derivation of prices was not sufficiently well described to determine.[19, 21, 30, 38-41] In three studies price elasticity estimates were derived from observed changes in cigarette taxes rather than price per se.[8, 12, 36]

The majority of studies used individuals as the unit of analysis. The exceptions were studies based on individual level survey data aggregated to either area or country level. One study[12] used data from two versions of the Youth Behavioural Risk Survey (YBRS) based on aggregated statistics, one measured at a local level (US Cities) and one at the state level. One of the datasets analysed in a US study[39] included data on the smoking behaviour of young mothers (to 19 years) during pregnancy. The study aggregated the data into US state by age by year cells and analysed the cell mean rate of smoking. Using the percentage of smokers as the outcome of interest, another study[33] analysed two aggregate country level time series datasets derived from a survey of school children and a general population survey. Similarly, another analysed country level data.[24] All analyses with the exception of two[33] [24] had large sample sizes. Relative to other studies, samples were small in two of the datasets used in one study.[12]

All studies included one or more of a standard set of controls (for example, gender, age, income, ethnicity), with the exception of one study that simply regressed outcome on price.[33] Sixteen studies[8, 12, 18, 21, 27, 29-31, 39, 40, 44-48, 50] specified either individual policy variables or an index indicating clean indoor air regulations; twelve studies[8, 18, 27, 29-32, 39, 43, 44, 49, 50] used individual variables or an index for restrictions on youth access to cigarettes, and ten studies[8, 18, 21, 27, 29, 30, 35, 41, 43, 44] had variables or an index representing other policies aimed at

[a] To convert a tax elasticity to a price elasticity, an estimate of the pass-through rate of taxes to prices is required together with an estimate of the tax as a proportion of total price.[8]

controlling cigarette consumption. Six studies[12, 37-39, 48, 49] conditioned on state level fixed effects in an effort to control for state level attitudes and policies towards cigarette use and two studies used a variable to indicate whether a state was a tobacco producing state.[26, 45] A list of the major variables used in each study is presented in Appendix 9.

Only seven studies described in detail a theoretical economic model of smoking behaviour used to inform an empirical model.[13, 26, 28, 34, 38, 40, 60] Few studies described tests of model assumptions, although there were some exceptions.[22, 24, 26-28, 38, 43-45, 48, 50] The majority of studies did however perform sensitivity analyses around the main results.

The full range of elasticity results for included studies are presented in the data extraction tables in Appendix 5. The reporting of results varied across studies. Some authors report single results[19, 21, 36, 37, 42, 45, 50] whilst others report multiple results, or results from multiple models, within which there is an expressed preference for a given value or model.[12, 18, 26, 28, 32, 35, 38-41, 43, 44, 48] Others report multiple findings but express a preference for an average of these findings,[31, 46, 49] whilst a number of studies report multiple results with no indication of preference. Where this is the case we have calculated an average elasticity value across multiple specifications[47] or across either gender or age categories[8, 13, 22, 24, 27, 29, 30, 34] to produce an overall summary measure comparable to other studies. Individual results by age and gender categories are also included.

4.2.1. Participation

This section synthesises evidence on the price elasticity of smoking participation. The elasticity of smoking participation represents the extent to which changes in price lead to changes in the probability of smoking. For example, an elasticity of -0.2 implies that a 10% increase in price is associated with a 2% decrease in smoking participation.

Nineteen studies reported price elasticity estimates for participation[8, 12, 13, 18, 19, 29-32, 35-39, 41-44, 48] Sixteen studies directly estimated price elasticities and three studies estimated a tax elasticity of participation[b] which was subsequently transformed to a price elasticity. [8, 12, 36] One study[39] provided participation estimates based on two surveys (Monitoring the Future and National Youth Behavioural Survey) and is treated as two separate studies in the summary that follows – hence 20 studies in total. Table 1 summarises the elasticity estimates across the studies.

The majority of the surveys were cross-sectional (n=10), or repeated cross-sectional (n=8), and the remaining two were longitudinal. The studies using longitudinal and repeated cross-sectional surveys were able to exploit smoking behaviour and variation in prices over time. One survey was described as cross-sectional but data were collected over a four year period and hence price variation over time was introduced.[41] All but two studies used survey data from the USA.[18, 19]

The studies used a number of methods to estimate the price elasticity of participation. The majority used either two-part models[c] (separate models for participation and demand conditional on smoking) or models solely for participation. All used probit, logit (or logistic) or linear probability regressions to estimate the impact of price on participation. There were two notable exceptions who estimated participation simultaneously with conditional demand[38] or

[b] To convert a tax elasticity to a price elasticity, an estimate of the pass-through rate of taxes to prices is required together with an estimate of the tax as a proportion of total price.[8]

[c] A two-part model estimates participation as a first stage and the quantity smoked by smokers (conditional demand) as a second stage. This approach allows the estimation of a price elasticity for participation, the quantity smoked by smokers, and overall demand (quantity smoked over all individuals).

estimated an ordered probit model for a categorical measure of the number of cigarettes smoked daily from which a price elasticity of participation was obtained.[8]

Table 1: Participation: overall price elasticity estimates

Author	Publication Year	Overall Elasticity	Basis of elasticity estimate
Emery et al[35]	2001	-0.83	Participation elasticity for `current' smokers
Harris & Chan[13]	1999	-0.575	Average across elasticities for age groups: 15 to 17; 18 to 20; 21 to 23.
Chaloupka & Pacula[30]	1999	-0.765	Average across elasticities for young men and young women
Lewit & Coate[42]	1982	-0.74	
Lewit et al[41]	1981	-1.43	
Ross & Chaloupka[44]	2004	-0.351	
Chaloupka & Grossman[29]	1996	-0.588	Average across price only model and model including all policy variables
Tauras & Chaloupka[48]	1999	-0.112	Year and state fixed effects and index of clean indoor air regulations
Gilleskie & Strumpf[38]	2000	-0.24	
DeCicca et al[8]	2002	-1.35	Average taken across results for 8th, 10th and 12th grade students
DeCicca et al[32]	2006	0.082	Model including state anti-smoking sentiment. Authors preferred model.
Farrelly et al[37]	2001	-0.30	
Carpenter & Cook[12]	2007	-0.56	
Evans & Farrelly[36]	1998	-0.575	
Powell et al[43]	2005	-0.315	
Lewit et al[18]	1997	-0.49	Model including covariates
Gruber[39]	2000	-0.311	
Gruber[39]	2000	-0.126	
Dienner et al[19]	2007	-0.77	
Chaloupka & Wechsler[31]	1995	-0.617	Average across the three model results presented for the full sample

Gruber[39] presented participation elasticities across two separate survey datasets and is included as two studies in the summary

Table 2 summarises the studies overall and broken down by characteristics of the survey data and approaches to modelling. The table illustrates the wide heterogeneity in the sources of data and analysis techniques. The overall mean elasticity across all twenty studies is -0.548 (median: -0.568) suggesting that a 10% increase in price leads to a 5.5% reduction in the probability of smoking. The mean, however, masks variation across studies. The standard deviation of the mean is large (0.38) as is the range of estimates: -1.43 to 0.082. The findings are synthesised according to whether the studies are longitudinal (i.e. cohorts), repeated cross-sectional or, cross-sectional.

Longitudinal

Two studies using longitudinal data, collected via school-based surveys, reported elasticities for participation of -0.240[38] and -0.112.[48] The mean elasticity across the two studies is -0.176.

One[48] assessed the impact of clean indoor air laws and cigarette price on young people's cigarette consumption. Price was found to reduce both the number of people smoking and the frequency with which they smoked. Restrictions on smoking in public places and private worksites were also found to be effective in reducing smoking. The second[38] investigated the impact of price based on a dynamic behavioural model of smoking which accounted for past smoking decisions and found that price had a non-linear effect on smoking behaviour, with large increases having a stronger influence on young people smoking than smaller increases. They further found that price increases have a greater effect on the incidence of higher smoking intensities.

Table 2: Participation: summary elasticities by study characteristics

Category	Variable	Price Elasticity				
		n	Mean	Median	Min	Max
Overall		20	-0.548	-0.568	-1.43	0.082
Data	*Price variable*					
	Average across packs	4	-0.621	-0.677	-0.83	-0.3
	Weighted average across packs	5	-0.287	-0.315	-0.74	0.082
	Typical price	1	-0.617	-0.617	-0.617	-0.617
	Taxes*	3	-0.828	-0.575	-1.35	-0.56
	Not stated	5	-0.575	-0.311	-1.43	-0.126
	Other	2	-0.533	-0.533	-0.575	-0.49
	Price variation					
	US States	7	-0.583	-0.575	-1.35	0.082
	US States and time	9	-0.492	-0.311	-1.43	-0.112
	Sub-US State level	2	-0.596	-0.596	-0.617	-0.575
	Canadian provinces and time	1	-0.77	-0.77	-0.77	-0.77
	Canadian provinces and US states and time	1	-0.49	-0.49	-0.49	-0.49
Model						
	Theoretical model specified?	2	-0.408	-0.408	-0.575	-0.24
	Yes	18	-0.564	-0.568	-1.43	0.082
	No					
Analysis						
	Approach to analysis	10	-0.670	-0.596	-1.43	0.082
	Cross-sectional	8	-0.489	-0.525	-0.77	-0.126
	Repeated cross-sectional	2	-0.176	-0.176	-0.24	-0.112
	Longitudinal					
	Unit of analysis	20	-0.548	-0.568	-1.43	0.082
	Individual					
	Method:	3	-0.597	-0.56	-0.74	-0.49
	Probit	10	-0.477	-0.575	-0.77	0.082
	Logit	3	-0.556	-0.126	-1.43	-0.112
	Linear probability model	2	-0.831	-0.831	-1.35	-0.311
	Ordered probit	1	-0.24	-0.24	-0.24	-0.24
	Joint estimation	1	-0.83	-0.83	-0.83	-0.83
	Not stated					
	Model controls:	20	-0.548	-0.568	-1.43	0.082
	Standard set of controls	5	-0.440	-0.56	-0.617	-0.126
	Indoor air regulations	3	-0.565	-0.588	-0.617	-0.49
	Youth restrictions	5	-0.890	-0.765	-1.43	-0.315
	Other policy variables					
		5	-0.614	-0.490	-1.35	-0.112
	Index for clear air regulations	8	-0.453	-0.333	-1.35	0.082
	Index for youth restrictions	3	-0.557	-0.490	-0.83	-0.351
	Index for other policy variables					
	Heterogeneity:	20	-0.548	-0.568	-1.43	0.082
	Covariates only	6	-0.275	-0.27	-0.56	-0.112
	Fixed state effects					
	Tests of model assumptions?	4	-0.254	-0.277	-0.351	-0.112
	Yes	16	-0.622	-0.582	-1.43	0.082
	No					
	Sensitivity analysis?	17	-0.530	-0.560	-1.43	0.082
	Yes	3	-0.650	-0.77	-0.83	-0.351
	No					

* Models estimates on taxes, results transformed to price elasticities

Both studies conditioned on a comprehensive set of controls. In addition to controlling for state level anti-smoking sentiment by including state fixed effects, one[48] further conditioned on an index of clean indoor air restrictions. The other[38] also used state fixed effect and jointly modelled the decision to smoke with the quantity smoked for smokers together with school drop-out to account for sample attrition.

One[48] presented multiple sensitivity analyses to assess the potential trade-off between bias arising from omitted variables in models with a small number of controls and from multicollinearity in models with highly correlated controls. A comparison across models with different combinations of individual variables for clean indoor air laws or a summary index, with and without state fixed effects, was undertaken. The range of participation elasticities across all models was -0.121 to -0.082 (mean = -0.110). The study estimate reported here (-0.112) refers to the strategy using an index of indoor air laws including state fixed effects. Seven follow-up periods were included, each at two yearly intervals, and hence the data included individuals observed from school age to beyond their 25th birthday (modal age of survey participants was 23 years). In contrast, the longitudinal element of the survey used in the other study[38] is restricted to youths aged 14 to 18 years. The age difference across the surveys might explain the larger elasticity reported in one (-0.240)[38] compared to the other[48] (-0.112).

Repeated cross-sectional

Seven studies reported price elasticities of smoking participation using data from repeated cross-sectional surveys.[12, 18, 19, 29, 30, 37, 39] This includes a study[39] which reported two sets of results and is therefore treated as two studies, so in effect eight studies contributed data. The mean price elasticity of participation across the studies was -0.489 (median: -0.525) with a range of -0.77 to -0.126.

Four of the studies specified state fixed effects to capture the impact of state anti-smoking sentiment.[12, 37, 39] The mean elasticity across the four studies was -0.324 (minimum: -0.56; maximum: -0.126). One[39] investigated the impact of price and other public policies on youth smoking participation by drawing separately on data from Monitoring the Future and the National Youth Risk Behavioural Survey. Respective elasticity estimates were -0.311 and -0.126. Using a nationally representative sample of US adults, another[37] investigated the effect of cigarette price increases by gender, age, income and ethnicity and reported a smoking participation elasticity for young adults of -0.30. Focusing specifically on high school teens, one study[12] assessed the effects of state cigarette taxes on the consumption of cigarettes and reported a price elasticity of teen smoking participation of -0.56. In assessing the impact of state level anti-smoking sentiment and tax on smoking behaviours, this study[12] estimated a tax elasticity of participation and converted this to a corresponding price elasticity. Models were estimated with, and without, state fixed effects and with and without a direct measure of state anti-smoking sentiment (developed by DeCicca et al[32]). Both state fixed effects and the direct measure of anti-smoking sentiment reduced the absolute size of the tax participation elasticity. Including the measure of anti-smoking sentiment had a negligible impact in models which already contained state fixed effects. The results imply that omitting state level attitudes towards smoking might overstate the magnitude that price has on smoking behaviour.

Six studies included variables representing clear indoor air restrictions, youth access restrictions and/or other policy variables.[12, 18, 29, 30, 39] The mean participation elasticity across these studies is -0.473 (median: -0.525), with a range of -0.765 to -0.126. Two studies have been described above.[39] [12] Another[30] investigated the responsiveness of youth smoking to price and tobacco control policies and whether there were differences across gender and ethnic status and found that young men were more responsive to price than young women and young black men were more price responsive than young white men. The price elasticity

of participation averaged across their sample of men and women was -0.765 (men: -0.93; women: -0.60). Another[18] examined the effect of cigarette price, limits on public smoking, laws regulating access to tobacco by young people and exposure to anti-tobacco messages on smoking participation amongst ninth-grade students. The price elasticity of smoking participation was substantially higher for males (-1.02) than females (-0.06) with an overall estimate of -0.49.

One study[29] examined the effectiveness of tobacco control policies together with price, using a strategy which estimated a model containing price together with a set of standard control variables. To this, either a single policy variable representing a smoking restriction or a youth access variable, or another policy variable (e.g. an indicator of whether cigarette taxes are earmarked for tobacco control policies) was entered. Lastly, all policy variables were included simultaneously with the controls and price variable. The price elasticity of participation in the model excluding policy variables was -0.799 and in the model with all policy variables -0.376. The latter model would appear a more sensible specification but might suffer from problems of multicollinearity, although the authors did not explicitly test for this.

One study examined the impact of retailer compliance with youth retail access laws in Canadian provinces and cigarette price on youth smoking participation.[19] Price had a greater effect on youth participation compared to quantity demanded and men were less responsive to price than women. As the compliance rate of retailers increased, youths appeared to move away from retail sources and towards social sources for their cigarettes.

Cross-sectional

Ten studies used cross-sectional survey data.[8, 13, 31, 32, 35, 36, 41-44] Three of the studies used recent data (1988 onwards), and one[41] data from 1966 to 1970. The average price participation elasticity across all ten studies was -0.670 (median: -0.596) with a range of -1.43 to 0.082.

Four of the ten studies specified policy variables including clean indoor air regulations, and youth access restrictions.[8, 31, 41, 43] The average participation elasticity reported across these studies was -0.928 (median: -0.984) with a range of -1.43 to -0.315. With one exception[31] (elasticity = -.617) all studies focused on young people under 18 years of age.

Five studies made use of an index, rather than individual variables, to represent indoor air regulations and youth access restrictions.[8, 32, 35, 43, 44] The mean elasticity across these studies was -0.553 (median: -0.351; range: -1.35 to 0.082). One study[8] estimated a tax elasticity of participation and converted this to a price elasticity (-1.35). Another[44] considered individual policy variables but rejected these in favour of a single index and a measure of retailer's compliance with clean indoor air regulations (elasticity: -0.351). One[32] developed a measure of state sentiment towards cigarette consumption, based on attitudes towards anti-smoking and found after controlling for state anti-smoking sentiment, that the price of cigarettes had a weak and statistically insignificant effect on smoking participation (elasticity: 0.082). In another[35] smoking participation for both current and established smokers was considered and a price elasticity of -0.83 for the former and -1.53 for the latter was found.

Of the remaining studies[13, 36, 43, 44] one[13] considered the probability of being a current smoker and found an overall elasticity estimate of -0.575 (averaged across three age groups). Young people were also found to be more responsive to the price of premium brand cigarettes compared to discount brands. Another study[36] found young smokers were more likely to quit as a result of higher prices but were also the group most likely to switch to smoking cigarettes with a higher tar and nicotine content. One study[42] found the decision to begin smoking by men to be price elastic (elasticity: -0.74) and greater than for women

(-0.136). A further study considered peer influences on youth smoking behaviour when estimating price effects and reported a price elasticity of participation of -0.315.[43] Peer effects appeared to play a significant role in youth smoking decisions.

Cross-border purchasing

Two of the studies using repeated cross-sectional surveys[29, 30] and four studies using cross-sectional surveys[31, 41, 42, 44] investigated the impact of cross-border purchasing of cheaper cigarettes on estimated price elasticities of participation.

Three studies constructed a variable representing the difference between own state price and the price in the neighbouring state (if less than own price) to include in their models.[30, 41, 44] Four studies considered a restricted sample of individuals not residing in proximity of a state border where prices in the neighbouring state were cheaper than the state of residence.[29, 31, 41, 42] For three studies, the main results reported above refer to models that included control for cross-border purchases.[30, 42, 44] For studies that presented results using a restricted and unrestricted (full) sample, one[29] found the participation elasticity for the full sample was -0.376 compared to -0.602 for the restricted sample. Using repeated cross-sectional data, one[31] also reported a more elastic participation response to price increases for the restricted sample (-0.733) compared to the full sample (-0.617), while another[41] reported a more inelastic response (-0.97 on the restricted sample, compared to -1.47 on the full sample).

Findings by PROGRESS criteria

Table 3 presents the participation elasticity estimates according to age, gender and ethnicity (the only sub-groups for which separate results are available). The average estimate across studies relating to youths under 18 years of age is slightly higher than the corresponding estimate relating to young adults greater than 18 years of age. The difference is not, however, statistically significant. Using cross-sectional data, one study[13] found a greater elasticity of participation for the below 18 year age group. The results according to gender suggest males are more responsive to price changes than females although this finding was not consistent across all four studies with a single cross-sectional study suggesting females are more responsive than males.[31] The mean elasticity of participation for males is -0.918 compared to -0.491 for females. Across three cross-sectional studies (including the use of two surveys in one[39]) black ethnic groups appear more responsive to prices than their white counterparts (mean elasticity of participation -1.323 versus -0.275)

4.2.2. Prevalence

The elasticity of smoking prevalence represents the extent to which changes in price lead to changes in the proportion of smokers in a given population. For example, an elasticity of -0.2 implies that a 10% increase in price is associated with a 2% decrease in smoking prevalence.

Three studies reported prevalence elasticity estimates.[12, 33, 39] Two studies directly estimated price elasticities,[33, 39] and one study estimated a tax elasticity which was subsequently transformed to a price elasticity.[12]

Table 3: Participation: Sub-group summary elasticity estimates

Author	Publication Year	Study Age range	Overall elasticity	Age ≤ 18	Age >18	Female	Male	White	Black
Emery et al[35]	2001	14 to 22	-0.83						
Harris & Chan[13]	1999	15 to 23	-0.575	-0.831	-0.447				
Chaloupka & Pacula[30]	1999	13 to 18	-0.765	-0.765		-0.60	-0.93	-0.64	-1.11
Lewit & Coate[42]	1982	20 to 25	-0.74		-0.74	-0.136	-1.276		
Lewit et al[41]	1981	12 to 17	-1.43	-1.43					
Ross & Chaloupka[44]	2004	mean 16	-0.351						
Chaloupka & Grossman[29]	1996	14 to 18	-0.588	-0.588					
Tauras & Chaloupka[48]	1999	modal age 23	-0.112						
Gilleskie & Strumpf[38]	2000	14 to 18	-0.24	-0.24					
DeCicca et al[8]	2002	13 to 18	-1.35	-1.35					
DeCicca et al[32]	2006	18	0.082	0.082					
Farrelly et al[37]	2001	18 to 24	-0.30		-0.30				
Carpenter & Cook[12]	2007	14 to 18	-0.56	-0.56					
Evans & Farrelly[36]	1998	18 to 24	-0.575		-0.575				
Powell et al[43]	2005	14 to 18	-0.315	-0.315					
Lewit et al[18]	1997	15	-0.49	-0.49		-0.06	-1.02		
Gruber[39]	2000	14 to 18	-0.311	-0.311				-0.277	-0.327
Gruber[39]	2000	15 to 18	-0.126	-0.126				0.092	-2.53
Dienner et al[19]	2007	15 to 18	-0.77	-0.77		-0.979			
Chaloupka & Wechsler[31]	1995	18+	-0.617		-0.617	-0.682	-0.446		
Mean			-0.548	-0.591	-0.536	-0.491	-0.918	-0.275	-1.323
Median			-0.568	-0.56	-0.575	-0.60	-0.975	-0.277	-1.11
Min			-1.43	-1.43	-0.74	-0.979	-1.276	-0.64	-2.53
Max			0.082	0.082	-0.30	-0.06	-0.446	0.092	-0.327

All studies were based on individual level repeated cross-sectional survey data from the USA aggregated to either area or country level. One study[12] used data from two versions of the Youth Behavioural Risk Survey (YBRS) based on aggregated statistics, one measured at a local level (US Cities) and one at the state level. One study[39] used data relating to the smoking behaviour of young mothers (to 19 years) during pregnancy. The data were aggregated into US state by age by year cells and analysed the cell mean rate of smoking. Using the percentage of smokers as the outcome of interest, one[33] analysed two aggregate country level time series datasets derived from a survey of school children and a general population survey. Ordinary least squares regression was used on either an untransformed outcome variable,[12, 39] or a log-transformed outcome.[33]

The overall mean elasticity across the studies is -1.45. The mean, however, masks large variation in reported price elasticities, with a standard deviation of (1.89) and a range of -4.74 to -0.131.

Two studies included standard controls together with variables representing clean indoor air restrictions and/or restrictions on youth access to cigarettes,[12, 39] and a single study specified state fixed effects.[12] The mean elasticity across the studies is -0.36 (range: -0.49 to -0.25). One[12] used controls for age, ethnicity, clean indoor air ratings in public places, and state unemployment rates together with year and state fixed effects. The reported prevalence elasticities for the two datasets were: local level dataset: -0.243; state level dataset: -0.131, each significant at the 10% level or less. Sample sizes were not large but appear adequate (97 local level dataset and 181 state level dataset). One[39] controlled for age, ethnicity, clean indoor air regulations (four variables) and an index covering restrictions on youth access to cigarettes. Price elasticities for prevalence for 13-16 year olds were -0.240; for 17-18 year olds -0.376 and for 13 to 18 years olds -0.353. Elasticity estimates for white mothers were -0.433 and for black mothers 0.671.

No controls were used in one study[33] and sample sizes were very small (22 and 14 observations in the two surveys used). The prevalence elasticity for the school data was -1.41 and for the general population survey -4.74. Significant negative elasticities were obtained for sub-sets of females (-2.98), and black and Hispanic ethnic groups (-9.11 and -2.01 respectively).

4.2.3. Quantity smoked: Level of smoking for smokers

Price elasticity of the quantity of cigarettes smoked by smokers is also termed the price elasticity of conditional demand. The elasticity represents the extent to which changes in price lead to changes in the quantity of cigarettes smoked among smokers. For example, an elasticity of -0.2 implies that a 10% increase in price is associated with a 2% decrease in the quantity of cigarettes smoked by smokers. In the following section we further consider studies that report total quantity smoked, representing the overall level of consumption across the population of both smokers and non-smokers.

Thirteen studies reported elasticity estimates for the amount smoked for individuals who smoke.[13, 29, 31, 32, 35-37, 39-42, 44, 48] All studies directly estimated the price elasticity for quantity smoked, with the exception of a single study that used tax as the source of variation in cigarette prices but converted the corresponding elasticity to a price elasticity.[36] One study[39] provided elasticity estimates based on three surveys and is treated as three separate studies in the synthesis that follows – hence 15 studies in total. Table 4 summarises the elasticity estimates across the studies.

The majority of the surveys were cross-sectional (n=8) or repeated cross-sectional (n=5). There was a single longitudinal survey and a survey based on repeated cross-sectional data

which was aggregated to represent US state by year by age cell means.[39] All surveys were carried out in the USA.

Table 4: Quantity smoked: Overall price elasticity estimates

Author	Publication Year	Conditional demand elasticity	Total demand	Basis of elasticity estimate
Katzman et al[40]	2002	-0.28		Overall result for buyers and bummers of cigarettes
Emery et al[35]	2001	-0.87	-1.7	Conditional demand and total demand for 'current' smokers
Harris & Chan[13]	1999	-0.231	-0.806	Average across results for individual age groups: 15-17; 18-20; 21-23
Lewit & Coate[42]	1982	-0.20	-0.89*	
Lewit et al[41]	1981	-0.01	-1.44*	Conditional demand derived from unconditional and participation elasticities
Ross & Chaloupka[44]	2004	-0.199	-0.722	
Chaloupka & Grossman[29]	1996	-0.561	-1.148	Average across price only model and model including all policy variables
Tauras & Chaloupka[48]	1999	-0.731	-0.844	Year and state fixed effects and index of clean indoor air regulations
DeCicca et al[32]	2006	0.022	0.014	Model including state anti-smoking sentiment. Authors preferred model.
Farrelly et al[37]	2001	-0.25	-0.55	Average taken across results for 8th, 10th and 12th grade students
Evans & Farrelly[36]	1998	-0.223	-0.798	Total demand derived as sum of participation and conditional demand elasticities
Gruber[39]	2000	-0.124	-0.477	Total demand derived as sum of participation and conditional demand elasticities
Gruber[39]	2000	-0.02	-0.331	Total demand derived as sum of participation and conditional demand elasticities
Gruber[39]	2000	-0.526	-0.652	Total demand derived as sum of participation and conditional demand elasticities
Chaloupka & Wechsler[31]	1995	-0.847	-1.464	Average across the three model results presented for the full sample
Townsend et al[24]	1994		-0.395*	Average across results for men and women and age groups: 16-19; 20-24
Wasserman et al[50]	1991		0.86*	
Chaloupka[28]	1991		-0.06*	

* Estimates derived directly from models of unconditional demand.

Table 5 presents the survey question used to measure the quantity of cigarettes smoked. There is wide variability in the form of the question used. Studies also differed in how this information was used. For example, to create a 'continuous' measure for the level of smoking, studies often used the mid-point of each category.[29 39]

Table 5: Quantity smoked by smokers: measures of cigarette consumption

Measures of cigarette consumption	Number of studies
Number of cigarettes smoked per day	3
Number of days smoked in last 30 days	1
Average smoked on each of previous 7 days	1
Categorical measure of number of cigarettes per day	5
Categorical frequency of smoking in past 30 days	1
Average number smoked per day	1
Categorical average daily consumption	1
Categorical measure of packs per day	1
Continuous measure	1

The studies used a number of methods to estimate the price elasticity of smoking demand. The majority of studies were estimated using the two-part model (a model of participation and quantity smoked for smokers), with the demand part of the model estimated

predominantly using ordinary least squares (OLS) on an untransformed measure of smoking (n=7) or on a log-transformed measure of smoking (n=3). A single study used a generalised linear model,[44] a further study simply stated using a two-part model[35] and the three studies (presented together)[39] did not state the exact estimation method, but appeared to be OLS with instrumental variables.

Table 6 summarises the overall study findings and broken down by characteristics of the survey data and approaches to modelling. As for smoking participation, there is wide variation in sources of data and techniques used for analysis and unsurprisingly large differences across studies in estimates of the elasticity of demand.

The overall mean elasticity across all fifteen studies is -0.337 (median: -.231) suggesting that a 10% increase in price leads to a 3.4% reduction in the level of smoking. The mean, however, masks variation across studies. The standard deviation of the mean is large (0.30) as is the range of estimates: -0.87 to 0.022. The findings are synthesised according to whether the studies are longitudinal, repeated cross-sectional or, cross-sectional.

Longitudinal

One study used longitudinal data from a school-based survey where approximately 2,400 students were followed-up biennially for up to seven occasions to assess the impact of cigarette prices and clean indoor air laws on cigarette consumption in young adults.[48] The survey contains individuals tracked over time to beyond 24 years of age (modal age of sample was 23 years).

The overall elasticity of demand for smokers was reported to be -0.731. This was derived from a model including a standard set of controls, an index for clean indoor air regulations, and US state fixed effects to control for state level anti-smoking sentiment. Separate regressions for models with individual controls for clean indoor air laws (six indicators); an indoor air index (derived from the six individual variables) and at most one clean indoor air indicator were used together with the standard controls. Models were estimated with and without state fixed effects. In total 12 model specifications were used. The range of demand elasticities for smokers across all models was -0.744 to -0.513 (mean = -0.677). The model that used an index for indoor air regulations was preferred.

Repeated cross-sectional

Four studies analysed repeated cross-sectional data, relying on variation in price across states and time.[29, 37, 39, 40] One study[39] reported results separately for a school-based survey and a national survey of risk behaviours in youths (aged 14 to 18) and this is treated as two separate studies, so five studies in total. The mean elasticity of demand across these studies is -0.327 (median: -0.28; minimum: -0.561; maximum: -0.02).

Two studies[39 37] specified state fixed effects to capture the impact of state anti-smoking sentiment. In one[39] an elasticity of -0.02 was reported for the national survey and for the youth survey -0.526. Neither result was statistically significant. The other study[37] evaluated the effects of increases in cigarette prices by gender, income, age and ethnicity. Results were presented separately for adults and young adults aged 18 to 24 years and suggest that young adults were more responsive to price than older individuals (over 40 years). The elasticity for the quantity smoked was -0.25 ($p<0.05$).

Of the five studies, four (including two presented in the same publication[39]) included variables representing clear indoor air restrictions, youth access restrictions and/or other policy variables.[29, 39, 40] The mean elasticity for quantity smoked across these studies was -0.347 (median: -0.403), with a range of -0.561 to -0.02.

Table 6: Quantity smoked by smokers: summary elasticities by study characteristics

Category	Variable		Price Elasticity			
		n	Mean	Median	Min	Max
Overall		15	-0.337	-0.231	-0.87	0.022
Data	*Price variable*					
	Average across packs	3	-0.560	-0.561	-0.87	-0.25
	Weighted average across packs	4	-0.277	-0.200	-0.731	0.022
	Typical price	1	-0.847	-0.847	-0.847	-0.847
	Taxes*	1	-0.223	-0.223	-0.223	-0.223
	Not stated	5	-0.192	-0.124	-0.526	-0.01
	Other	1	-0.231	-0.231	-0.231	-0.231
	Price variation					
	US States	5	-0.294	-0.20	-0.87	0.022
	US States and time	8	-0.313	-0.265	-0.731	-0.01
	Sub-US State level	2	-0.539	-0.539	-0.847	-0.231
Model	*Theoretical model specified?*					
	Yes	2	-0.256	-0.256	-0.28	-0.231
	No	13	-0.349	-0.223	-0.87	0.022
Analysis	*Approach to analysis*					
	Cross-sectional	8	-0.320	-0.212	-0.87	0.022
	Pooled cross-sectional	5	-0.327	-0.28	-0.561	-0.02
	Longitudinal	1	-0.731	-0.731	-0.731	-0.731
	Aggregate	1	-0.124	-0.124	-0.124	-0.124
	Unit of analysis					
	Individual	14	-0.352	-0.241	-0.87	0.022
	Aggregate**	1	-0.124	-0.124	-0.124	-.124
	Method:					
	OLS	7	-0.167	-0.223	-0.28	0.022
	OLS (ln quantity)	3	-0.713	-0.713	-0.847	-0.561
	GLM	1	-0.199	-0.199	-0.199	-0.199
	'Two-part model'	1	-0.87	-0.87	-0.87	-0.87
	Not stated***	3	-0.233	-0.124	-0.526	-0.02
	Model controls:					
	Standard set of controls	15	-0.337	-0.231	-0.87	0.022
	Indoor air regulations	6	-0.393	-0.403	-0.847	-0.02
	Youth restrictions	2	-0.704	-0.704	-0.847	-0.561
	Other policy variables	2	-0.286	-0.286	-0.561	-0.01
	Index for clear air regulations	2	-0.465	-0.465	-0.731	-0.199
	Index for youth restrictions	5	-0169	-0.124	-0.526	0.022
	Index for other policy variables	2	-0.535	-0.535	-0.87	-0.199
	Heterogeneity:					
	Covariates only	15	-0.337	-0.231	-0.87	0.02
	Fixed State effects	4	-0.382	-0.388	-0.731	-0.02
	Tests of model assumptions?					
	Yes	2	-0.465	-0.465	-0.731	-0.199
	No	13	-0.317	-0.231	-0.87	0.022
	Sensitivity analysis?					
	Yes	13	-0.306	-0.231	-0.847	0.022
	No	2	-0.535	-0.535	-0.87	-0.199

* Models estimates on taxes, results transformed to price elasticities
** Data aggregated such that the unit of analysis represents US state by year by age cell means
*** Precise method not stated but appears to be OLS

In a study evaluating the effectiveness of tobacco control policies in discouraging cigarette smoking among young people, various strategies for estimating youth cigarette demand were presented.[29] These are described in the earlier section on participation. The price elasticity of the quantity smoked in a model excluding policy variables was -0.651 and in a model with all policy variables, -0.470. The latter model would appear a more sensible specification, but might suffer from problems of multicollinearity, although the authors did not explicitly test for this.

One study[39] included one or more indices of policy controls rather than specifying individual policy variables. Similarly, another[40] studied the impact of price and other restrictions on teenage smoking decisions and found that overall, the price elasticity of demand for smokers was -0.280 ($p<0.05$). Higher prices were also found to induce a substitution away from buying towards 'bumming' cigarettes, and that the number of days smoked in the past 30 was more responsive to price for 'bummers' compared to buyers of cigarettes.

Cross-sectional

Eight studies used cross-sectional data.[13, 31, 32, 35, 36, 41, 42, 44] The overall mean elasticity of demand across the studies was -0.320 (median: -0.212) with a range of -0.87 to 0.022.

Two studies specified policy variables for clean indoor air regulations, youth access restrictions or other policy variables.[31, 41] The average participation elasticity reported across the two studies was -0.429. One[41] used data from a survey undertaken between 1966 and 1970 to assess the impact of excise tax, radio and television anti-smoking messages and bans on cigarette advertising on the demand for cigarettes by teenagers (price elasticity = -0.01). Similarly, the other[31] investigated the impact of several tobacco control policies among young adults based on a survey of college and university students (price elasticity = -0.847).

Three studies made use of indices to represent policy variables.[32, 35, 44] The mean elasticity across these studies was -0.349 (median: -0.199) with a range of -0.87 to 0.022. One[44] rejected the use of individual policy variables on the basis of collinearity and instead used an index to represent the number of clean indoor air laws in a state together with a measure of retailer's compliance with youth access laws. The conditional demand elasticity was estimated to be -0.199. Another study[32] developed a measure of state anti-sentiment towards cigarette consumption, based on attitudes towards smoking. Controlling for state anti-smoking sentiment, price had a weak and insignificant effect on the demand for cigarettes. The reported elasticity from this 'preferred' model was 0.022, compared to an estimate of -0.302 from a model without state anti-sentiment. A third study[35] examined the relationship between smoking experiences and adolescent price sensitivity and reported a price elasticity of conditional demand of -0.87 for current smokers, and -0.68 for established smokers.

Of the remaining studies,[13, 36, 42] one[42] found men more price elastic than women (elasticity -0.171 versus -0.025; overall elasticity -0.20), while another[36] found an similar overall elasticity estimate of -0.223. A further study[13] considered cigarettes smoked per day and reported an overall elasticity of -0.231. There was a greater response to price for smokers of premium rather than discount cigarettes.

Aggregate level

A single study used data on the smoking behaviour of young mother's during pregnancy.[39] Individual level data were aggregated to represent US state by year by age cell means. Variables for price, ethnicity, clean indoor air regulations and youth access restrictions were

regressed on the cell mean quantity of smokers. The overall price elasticity of demand for smokers was estimated to be -0.124 (significant at the 5% level).

Cross-border purchasing

One of the studies using repeated cross-sectional data,[29] and four using cross-sectional data[31, 41, 42, 44] investigated the impact of cross-border purchasing of cheaper cigarettes on estimated price elasticities of the quantity smoked for smokers.

Two studies[41,44,] constructed variables representing the difference between own state price and the price in the neighbouring state (if less than own price) to include in the models. Four studies considered a restricted sample of individuals not residing in proximity of a state border where prices in the neighbouring state were cheaper than the sate of residence.[29, 41, 42, 31] For two studies the main results reported above refer to models that included control for cross-border purchases. [42, 44] For studies that presented results using a restricted and unrestricted (full) sample, one[29] found the demand elasticity of smokers for the full sample was -0.561 compared to -0.652 for the restricted sample. A second[41] also found a more elastic response to price on the restricted sample (-0.45 compared to -0.01 on the full sample) while a third[31] found a more inelastic response to price increases (-0.703 on the restricted sample, compared to -0.847 on the full sample).

Findings by PROGRESS criteria

Table 7 provides the results of elasticity estimates by age, gender and ethnicity (the three criteria on which the studies reported). The average estimate across studies of youths less than 18 years of age is approximately half the corresponding estimate for young adults greater than 18. The difference is not, however, statistically significant. Using cross-sectional data, one study[13] provides estimates for both age groups and reports a greater elasticity for the quantity smoked for the over 18 age group. The results across gender suggest males are more responsive to price changes than females. The mean elasticity of participation for males is -0.679 compared to -0.296 for females.[31 42] The three surveys used in one study[39] provide evidence across ethnic groups. For the two repeated cross-sectional surveys, a positive elasticity estimate for black ethnic groups was found. For the single aggregate survey, black mothers appear to be more responsive to price changes than white mothers.

4.2.4. Quantity smoked: Total level of smoking

The price elasticity of the total quantity of cigarettes smoked is also termed the price elasticity of demand. The elasticity represents the extent to which changes in price lead to changes in the total quantity of cigarettes smoked in a given population and takes into consideration rates of participation and conditional demand. For example, an elasticity of -0.2 implies that a 10% increase in price is associated with a 2% decrease in the total quantity of cigarettes smoked in a population.

Fifteen studies reported price elasticity estimates for total demand.[13, 24, 28, 29, 31, 32, 35-37, 39, 41, 42, 44, 48, 50] Total demand can be estimated from the separate components (participation and conditional demand) of the two-part model. Elasticity estimates were derived in this way for the majority of studies. Five studies, however, directly calculated elasticity estimates for total demand that did not report results for conditional demand.[24, 28, 41, 42, 50] All studies estimated price elasticities with the exception of a single study[36] that estimated a tax elasticity which was subsequently transformed to a price elasticity. One[39] provided estimates based on three separate surveys and is treated as three separate studies in the summary that follows – hence 17 studies in total. Table 4 summarises the elasticity estimates across the studies. Given the large overlap between the total demand studies and the participation and conditional demand studies, we do not provide a breakdown of elasticity estimates by

characteristics of the data and empirical approaches to modelling. It is worth noting, however, that as observed for studies of the quantity smoked for smokers, there is wide variation in sources of data and techniques used in analyses. The overall mean elasticity across all studies is -0.671 (sd 0.62) with a range of -1.7 to 0.86.

Longitudinal

A single study utilized longitudinal data.[48] Details of the study are described in the sections on participation and conditional demand. A total demand elasticity of -0.844 was reported and derived from a model controlling for year and state fixed effects and an index of clean indoor air regulations. Due to the longitudinal follow-up period used to construct the data, observations on the sample of school children as they age beyond their 25th birthday are included in the analysis.

Repeated cross-sectional

Including two surveys reported in one publication,[39] five studies analysed repeated cross-sectional data to derive total demand elasticities.[29, 37, 39, 50] The mean elasticity across the five studies is -0.364 (median: -0.550; range: -1.148 to 0.86).

Three studies controlled for state fixed effects to reflect anti-smoking sentiment at the state level (mean: -0.511; minimum: -0.652; maximum: -0.331).[37, 39] One[37] reported an overall demand elasticity of -0.55 and the other[39] reported estimates of -0.331 and -0.652 using two separate school-based surveys.

Four studies included variables representing clean indoor air restrictions, youth access restrictions and/or other policy variables, either as individual variables or as an index. [29, 39, 50] The mean elasticity across the four studies is -0.318 (range -0.652 to 0.86). In a study of the impact of price on smoking decisions and whether the impact differed by gender an overall elasticity of demand of 0.86 was found.[50] This was not statistically significant from zero, or the author's estimate of the corresponding price estimate for adults (-0.23). The model controlled for youth access restrictions together with an index of clean indoor air regulations. In a study to assess the effectiveness of tobacco control policies in discouraging cigarette smoking among young people, various strategies for estimating youth cigarette demand were presented.[29] These are described in the section on participation. The price elasticity of the total quantity smoked in a model excluding policy variables was -1.450 and in a model with all policy variables, -0.846. The latter model is likely to represent a more accurate reflection of the price elasticity of demand, but might suffer from problems of multicollinearity, although the authors did not explicitly test for this.

Cross-sectional

Nine studies presented analyses of cross-sectional data.[13, 28, 31, 32, 35, 36, 41, 42, 44] The mean elasticity across the nine studies was -0.874 (median: -0.806; range -1.7 to 0.014). Two studies controlled for policy variables,[31, 41] (mean: -1.45; range -1.46 to -1.44) and three studies for indices of policy variables (mean: -0.803; range -1.7 to 0.014).[32, 35, 44] One further controlled for a constructed variable representing state sentiment towards smoking (-0.014).[32] The mean elasticity across the remaining four studies[13, 28, 36, 42] was -0.639 (range: -0.89 to -0.06).

Table 7: Quantity smoked: Sub-group summary elasticity estimates

Author	Study Age range	Quantity smoked by smokers Elasticity						
		Overall elasticity	Age ≤ 18	Age >18	Female	Male	White	Black
Katzman et al[40]	14 to 18	-0.28	-0.28					
Emery et al[35]	14 to 22	-0.87						
Harris & Chan[13]	15 to 23	-0.231	-0.165	-0.265				
Lewit & Coate[42]	20 to 25	-0.20		-0.20	-0.025	-0.171		
Lewit et al[41]	12 to 17	-0.01	-0.01					
Ross & Chaloupka[44]	mean 16	-0.199						
Chaloupka & Grossman[29]	14 to 18	-0.561	-0.561					
Tauras & Chaloupka[48]	modal 23	-0.731						
DeCicca et al[32]	18	0.022	0.022					
Farrelly et al[37]	18 to 24	-0.25	-0.25					
Evans & Farrelly[36]	18 to 24	-0.223	-0.223					
Gruber[39]	<= 19	-0.124	-0.124				-0.076	-0.539
Gruber[39]	14 to 18	-0.02	-0.02				-0.181	0.691
Gruber[39]	15 to 18	-0.526	-0.526				-0.775	4.393
Chaloupka & Wechsler[31]	18+	-0.847		-0.847	-0.566	-1.186		
Townsend et al[24]	16 to 24							
Wasserman et al[50]	12 to 17							
Chaloupka[28]	17 to 24							
Mean	-0.337		-0.214	-0.437	-0.296	-0.679	-0.344	1.515
Median	-0.231		-0.194	-0.265	-0.296	-0.679	-0.181	0.691
Min	-0.87		-0.561	-0.847	-0.566	-1.186	-0.775	-0.539
Max	0.022		0.022	-0.20	-0.025	-0.171	-0.076	4.393

*Average across Hispanic (-1.0) and African-Americans (-0.86).

** Derived from prevalence and conditional demand results.

Table 7 (cont.): Total quantity smoked: Sub-group summary elasticity estimates

Author	Study Age range	Total quantity smoked elasticity						
		Overall Elasticity	Age ≤ 18	Age >18	Female	Male	White	Black
Katzman et al[40]	14 to 18							
Emery et al[35]	14 to 22	-1.7						
Harris & Chan[13]	15 to 23	-0.806	-0.996	-0.712				
Lewit & Coate[42]	20 to 25	-0.89*		-0.89	-0.302	-1.401		
Lewit et al[41]	12 to 17	-1.44*	-1.44					
Ross & Chaloupka[44]	mean 16	-0.722						
Chaloupka & Grossman[29]	14 to 18	-1.148	-1.148					
Tauras & Chaloupka[48]	modal 23	-0.844						
DeCicca et al[32]	18	0.014	0.014					
Farrelly et al[37]	18 to 24	-0.55	-0.55				-0.44	-0.93*
Evans & Farrelly[36]	18 to 24	-0.798	-0.798					
Gruber[39]	<= 19	-0.477	-0.477				-0.509	0.132
Gruber[39]	14 to 18	-0.331	-0.331				-0.458	0.364**
Gruber[39]	15 to 18	-0.652	-0.652				-0.683	1.863
Chaloupka & Wechsler[31]	18+	-1.464		-1.464	-1.248	-1.632		
Townsend et al[24]	16 to 24	-0.395*	-0.40	-0.40	-0.91	0.12		
Wasserman et al[50]	12 to 17	0.86*	0.86					
Chaloupka[28]	17 to 24	-0.06*		-0.06				
Mean		-0.671	-0.538	-0.705	-0.82	-0.971	-0.523	0.357
Median		-0.722	-0.55	-0.712	-0.91	-1.401	-0.484	0.248
Min		-1.7	-1.44	-1.464	-1.248	-1.632	-0.683	-0.93
Max		0.86	0.86	-0.06	-0.302	0.12	-0.44	1.863

*Average across Hispanic (-1.0) and African-Americans (-0.86).

** Derived from prevalence and conditional demand results.

Aggregate level studies

One study[39] used data on the smoking behaviour of young mothers during pregnancy, and aggregated the repeated cross-sectional data to represent year by state by age cell means. An elasticity of total demand of -0.477 was found. Similarly, another study[24] using aggregated UK data from the General Household Survey analysed a time series of the quantity of cigarettes smoked against price, controlling for annual disposable income per head, health publicity effects including the social acceptability of smoking and smoking restrictions. Men and women in lower socio-economic groups appeared more responsive to changes in price than those in higher groups. The elasticity of total demand for young women was -0.91 and men 0.12, with a average across gender of -0.395.

Cross-border purchasing

Two of the studies using repeated cross-sectional data[29, 50] and five using cross-sectional data[28, 31, 41, 42, 44] investigated the impact of cross-border purchasing of cheaper cigarettes on estimated price elasticities of the total quantity smoked. For two of the studies the main results reported above refer to models that included control for cross-border purchases.[28, 44] Both of the studies using repeated cross-sectional data and three using cross-sectional data[31, 41, 42] estimated price elasticities on a restricted sample of individuals not residing in proximity of a state border where prices in the neighbouring state were cheaper than the state of residence. One[29] found the demand elasticity of smokers for the full sample was -0.846 compared to -1.254 for the restricted sample. In contrast four studies reported similar elasticities of total demand across both the full and restricted samples.[50 41 42 31]

Findings by PROGRESS criteria

Table 7 provides the results of elasticity estimates by age, gender and ethnicity (the criteria assessed in the studies). The average estimate across studies focused on youths less than 18 year olds is less than the corresponding estimate based on young adults greater than 18 (-0.538 versus -0.705). The difference is not, however, statistically significant. Using cross-sectional data, one study provides estimates for both age groups and reports a greater elasticity for the quantity smoked for the over 18 year age group (-0.996 versus -0.712)[13]. The results of another study[24] using aggregate country-level data suggest no difference between the two age groups. The results across gender suggest males are slightly more responsive to price changes than females. The mean elasticity for males is -0.971 compared to -0.82 for females. This result is consistent across two studies[31 42] but not across a third.[24] Using repeated cross-sectional data one study[37] provides evidence for a greater price responsiveness of black ethnic groups (Hispanics and African-Americans) compared to white. This contrasts with the findings of another study[39] which suggest black ethnic groups do not respond to prices (a positive elasticity for black ethnic groups was found).

4.2.5. Smoking initiation

This section synthesises evidence on the price elasticity of the decision to start smoking, where the elasticity represents the extent to which changes in price impact on smoking initiation. For example, an elasticity of -0.2 implies that a 10% increase in price is associated with a 2% decrease in the hazard (probability of starting in a given period conditional on not starting in a prior period) of starting to smoke.

Seven studies reported elasticity estimates for the probability of starting smoking.[21, 22, 26, 27, 34, 45, 49] Five studies used longitudinal data and two[22 61] cross-sectional data. Five of the seven studies were based on survey data from the USA, one study was from Canada[21] and a further study from Australia.[22]

A number of methods were used to estimate price elasticities. One study was based on modelling smoking initiation using logistic regression;[21] four studies used discrete-time hazard models for the probability of smoking commencement[26, 27, 45, 49] and two used a split-population duration analysis.[22, 34] One[22] modelled the age at commencing smoking rather than the hazard of smoking.

Five of the seven studies of smoking commencement used prospective longitudinal data where individuals were followed-up over time and their smoking habits observed.[21, 26, 27, 45, 49] One study, however, only used two periods of data.[21] Two studies retrospectively constructed the time when an individual started to smoke based on cross-sectional surveys that directly asked the age at which an individual commenced smoking.[22, 34]

Tables 8 and 9 summarise the elasticity estimates across the studies overall and by sub-groups corresponding to the PROGRESS criteria.

Longitudinal

Four of the five studies based on prospective longitudinal data used multiple waves of data to estimate discrete-time hazard models of the probability of smoking initiation.[26, 27, 45, 49] The mean price elasticity of smoking initiation was -0.597 (median: -0.683) with a range of -0.912 to -0.111. One study used only one baseline and single follow-up.[21]

In an attempt to control for US state sentiment towards cigarette smoking and other policies operating at a state level, a single study specified US state fixed effects and reported an elasticity of -0.111.[49] Two studies included variables for whether a state was a major producer of tobacco and the average elasticity across these two studies is -0.779 (range: -0.912 to -0.646).[26, 45]

Two studies controlled for policy variables representing clean indoor air regulations, youth access restrictions and/or other policy variables aimed at smoking restrictions.[45, 49] A further study utilized indices to represent the above policy variables.[27] The mean elasticity across the three studies is -0.492 (minimum: -0.72; maximum: -0.111).

Table 8: Starting and quitting: Overall price elasticity estimates

Author	Publication year	Overall elasticity	Basis of elasticity estimate
Starting			
Cawley et al[26]	2003	-0.912	
Tauras et al[49]	2001	-0.111	Average across fixed effects results
Cawley et al[27]	2006	-0.72	Average across male and females
Douglas[34]	1998	-0.41	Average across age 12 and age 20 starting elasticities
Tauras[45]	2005	-0.646	Daily uptake
Kidd & Hopkins[22]	2004	0.125	Age at starting smoking: average for male and female
Zhang et al[21]	2006	-3.4	Smoking initiation
Quitting			
Tauras[46]	2004	0.35	Average: 8 specifications of the hazard model
Tauras & Chaloupka[47]	1999	1.155	Average: 4 specifications for males and 4 for females

One study[49] which investigated the role of price, policy variables and state fixed effects on smoking initiation a school-based survey of 8th and 10th grade students who were tracked over time from ages of approximately 14 to 20 years. Ten model specifications were used, ranging from a model of cigarette price and socio-demographic variables to a model that additionally included seven tobacco control policy variables. Intermediate models contained only one of the seven policy variables or an index of youth access restrictions. The average

reported elasticity of initiation (for any level of smoking) across the models was -0.271 (range: -0.191 to -0.340). Including state fixed effects reduced the reported average elasticity to -0.111 (range: -0.083 to -0.119). Effects were significant at the 10% level. Corresponding estimates for smoking at least 1 to 5 cigarettes per day and separately for at least half a pack per day revealed a greater response to price than any level of smoking. Using the same data set but with a longer follow-up period, another study[45] further investigated the impact of price and policy variables on smoking uptake. Together with socio-economic and demographic variables, controls reflecting the presence of state-level restrictions on public indoor smoking were used. In addition indicators of whether a survey respondent lived in a tobacco-producing state or Utah (which contains many Mormons whose beliefs ban tobacco use) were included. Due to collinearity, fixed state effects were excluded. The reported elasticity of daily smoking initiation was -0.646. Elasticity estimates for moderate uptake (half a pack per day) and heavy uptake (a pack or greater a day) were also provided at -0.576 and -0.412 respectively. Due to the extended follow-up, the mean age of the sample was 24 years and included observations on individuals beyond age 25 years.

One study[26] also included an indicator of whether a state is a tobacco producer. Data came from a cohort of youths aged 12 to 16 in 1996 with follow-up in 1998, 1999 and 2000. Smoking initiation from non-smoking to any smoking and frequent smoking (at least 15 cigarettes in past 30 days) revealed price elasticities of -0.946 and -1.61 respectively.

In a similar study[27] the Children of the NLSY, 1979 Cohort (CoNLSY) were used. Baseline data in 1986 together with six biennial follow-ups were used in the analysis (approximate age of respondents was 10 to 20 years). The elasticity of initiation to any level of smoking was five time greater for males (-1.2) than for females (-0.24). The average across the two estimates is -0.72. For stricter definitions of smoking initiation (> once a week or > 5 to 6 times a week), price effects were not significant and price elasticity estimates were not reported.

Another study[21] was limited to two waves (1994/95 and 1996/97) of a Canadian health survey in which non-smokers in the first wave were selected and observed to be smoking or not in the second wave. Variation in prices was largely determined by tax cuts between the waves in five Canadian provinces. The reported elasticity of 3.4, implies a 1% cut in prices led to a 3.4% increase in the smoking initiation rate.

Different definitions for smoking initiation were presented across studies. For example, in the studies by Cawley[26, 27] definitions for initiation ranged from 'whether the respondent has ever smoked a cigarette' to 'the transition from being a non-smoker to smoking any cigarettes'. Differences in definitions of smoking initiation are likely to account for some of the reported differences in elasticity estimates across studies. Cawley et al (2003)[26] reported different elasticity values for less stringent initiation (defined as the transition from being a non-smoker to smoking any cigarettes - elasticity value -0.912) compared with more stringent initiation (defined as the transition from being a non-smoker to a frequent smoker - elasticity value -1.55). In another study[45] higher elasticity estimates for moderate uptake (defined as the transition from smoking 1-5 per day to smoking 10 or more per day), -0.576, compared with heavy uptake (defined as the transition from smoking 10 per day to smoking 1 or more packs per day), -0.412, were reported. Whilst in another[49] the elasticity for 1 to 5 cigarettes/day was -0.811 and the elasticity for ½ pack/day was -0.955.

Cross-sectional

Two studies provided evidence on the price elasticity of smoking initiation using retrospective information on the age of starting to smoke derived from cross-sectional data.[22, 34]

One study[22] investigated smoking initiation among young adults who had started smoking between the ages of 18 to 26. Using a split-population hazard model the reported elasticity of the age of starting to smoke was 0.11 for males and 0.14 for females. Only the female result was significant (10% level). The mean across genders is 0.125 implying a 10% increase in prices would lead to a 1.25% increase in the age at starting to smoke. The second[34] also used respondent recalls of the age at starting to smoke from a US survey. The reported age at smoking initiation of survey respondents corresponds to the mid 1950s onwards which raises the issue of both the relevance of the study results to contemporary tobacco policy and the degree of recall bias. The elasticity of smoking initiation is reported to be -0.57 at age 12 and -0.15 at age 20 years (average: -0.41).

Findings by PROGRESS criteria

Table 9 provides the results of elasticity estimates by age and gender (the only criteria assessed). A single study provided evidence on smoking initiation by age finding a greater elasticity for young people under the age of 18 years.[34] Using longitudinal data, one study[27] found males were more price responsive than females in decisions to start smoking, whilst another, using cross-sectional evidence,[22] that females were more likely than males to delay smoking onset as price increases.

4.2.6. Quitting smoking

This section synthesises evidence on the price elasticity of the decision to quit smoking. The elasticity represents the extent to which changes in price impact on smoking cessation. For example, a price elasticity of 0.2 implies that a 10% increase in price is associated with a 2% increase in the probability of quitting.

Two studies provided evidence on the price elasticity of smoking cessation.[46, 47] Both studies used the same US school-based survey, exploited variation in prices across both US states and time, and derived prices based on a sales weighted average across packs. Semi-parametric Cox specifications of the hazard were used to model durations to smoking cessation. Due to the length of follow-up of survey respondents (high school seniors followed-up biennially for up to seven waves), observations on individuals quitting smoking at ages greater than 25 were included in the analyses.

Tables 8 and 9 summarise the elasticity estimates across the studies overall and by sub-groups corresponding to the PROGRESS criteria.

Longitudinal

Both studies specified variables representing policies on clean indoor air restrictions together with price and presented multiple model specifications to assess the degree of collinearity between the included policy variables. The major difference in the studies was the empirical approach to the definition of a quit. While one[47] modelled the hazard of the first quit, the other[46] modelled multiple quit attempts. The first[47] reported an average elasticity to the first quit across four specifications for females of 1.19 (range 1.17 to 1.21) and across four specifications for males of 1.12 (range 1.07 to 1.15). The average across both genders is 1.155. Recognising the addictive nature of smoking and the withdrawal associated with smoking cessation, the second[46] extended the analysis to model multiple quit attempts within each individual. Cigarette price was found to have a positive and significant impact on the quitting hazard in all eight model specifications; the average elasticity of quitting was 0.350 with a range across the models of 0.269 to 0.466.

Table 9: Starting and quitting: sub-group summary elasticity estimates

Author	Publication year	Study Age range	Overall elasticity	Age ≤ 18	Age >18	Female	Male
Starting							
Cawley et al[26]	2003	12 to 20	-0.912				
Tauras et al[49]	2001	mean 15	-0.111				
Cawley et al[27]	2006	10 to 20	-0.72			-0.24	-1.2
Douglas[34]	1998	12 to 20	-0.41	-0.57	-0.15		
Tauras[45]	2005	high school	-0.646				
Kidd & Hopkins[22]	2004	10 to 24	0.125			0.14	0.11
Zhang et al[21]	2006	18 to 26	-3.4				
Quitting							
Tauras[46]	2004	not stated	0.35				
Tauras & Chaloupka[47]	1999	modal age 32	1.155			1.17	1.15
*Starting**							
Mean			-1.033				
Median			-0.683				
Min			-3.4				
Max			-0.111				
Quitting							
Mean			0.616				
Median			0.35				
Min			0.343				
Max			1.155				

* Descriptive statistics excluding Kidd as this study analysis represents age to starting.

4.3. Tax elasticity estimates

Three US studies reported tax elasticity results.[51-53] One[51] used both longitudinal and cross-sectional data, whilst the other two[52 53] used cross-sectional data.

One[51] examined the effects of a number of tobacco control policies, including state excise taxes, using two sources of data: longitudinal data from a home survey of school children and cross-sectional data from a school-based survey. Longitudinal data yielded an overall participation elasticity of -0.09 for experimental smoking and 0.01 for regular smoking (-0.09 and 0.05 with policy variables). These effects were not significant. The cross-sectional data yielded an overall participation elasticity of -0.04 for experimental smoking and -0.07 for regular smoking. When policy variables were included in the model, the elasticity estimates decreased in absolute size or became positive. Similarly, taxes were also found not to have a significant negative effect on smoking initiation or escalation. The majority of the results were either non-significant, positive or both. Tax did have a significant negative effect for some sub-groups, impacting upon participation rates of heavy regular smokers and experimental smoking by black ethnic groups.

Another[52] analysed cross-sectional data to assess the effect of various tobacco control measures on youth cigarette demand. In a model treating tax and smoking regulations as endogenous, they reported a participation tax elasticity of -0.22 ($p<0.01$) for males aged 16 to 24. Males aged < 24 years were considered to be more responsive to tobacco tax rates than older males. Increases in taxes were associated with an increased use of snuff amongst men aged 16 to 24.

Primarily concerned with risk behaviour amongst adolescents, another study[53] utilised school-based cross-sectional data to investigate the extent to which government policies influenced smoking participation by adolescents. The results suggest that, among youths who smoke, cigarette taxes did not have a significant deterrent effect, but laws limiting vending machine access did. The reported participation tax elasticity was -0.19, implying a 10% increase in tax equates to a -1.9% decrease in participation.

4.4. Non-elasticity results

Nine studies did not report elasticity estimates,[20, 23, 25, 54-59] all but two of which[20, 23] were US-based studies. A summary of the results relating to the price and tax effects of these studies is presented here. One study used longitudinal data,[54] two used repeated cross-sectional data[20, 56] and six used cross-sectional data.[23, 25, 55, 57-59]

4.4.1. Effect of price

Three studies[23, 54, 57] investigated the effect of cigarette price on the uptake, or initiation of smoking, one using longitudinal data[54] and two cross-sectional.[23, 57] In the study using longitudinal data the primary focus was on how the determinants of smoking onset including price, peer influences, state of residence and academic success, varied by race and ethnicity. Higher cigarette price, after controlling for state fixed effects, were not found to reduce the hazard rate of starting to smoke amongst white youths. However, among Hispanic youths a 20% increase in the price reduced the hazard rate from 17.3% to 13.2%. Importantly, a youth's state of residence was found to be a powerful determinant of starting to smoke.

Similarly, the two studies using cross-sectional data also investigated the determinants of smoking uptake.[23, 57] A Swedish study[23] focused on the age of initiation and found that men who started smoking did so at a younger age than women, and individuals started at an earlier age if both parents smoked. Public policies, including cigarette price, information campaigns, and laws and regulations, did not affect the age of smoking initiation. The

second study[57] examined the differential effects of cigarette price, clean indoor air and youth access laws on smoking uptake (defined in five stages from low risk cognition smokers to addicted/established smokers) amongst high school students. Higher cigarette prices reduced the probability of being in a higher stage of smoking uptake. The price effect was more pronounced in the later stages of smoking uptake, suggesting that the further students are in their smoking uptake progression, the more sensitive they are to price.

Two studies assessed the impact of price on the frequency of smoking and amount smoked, one through the use of repeated cross-sectional data[56] and the other through cross-sectional data.[55] The former also investigated the differential effects of cigarette price on the intensity of youth smoking.[56] Living in a medium, or a high price area was associated with higher thresholds between smoking intensity at all levels. Individuals living in a high-price area were 30% less likely to cross the threshold into smoking one pack or more per day, demonstrating the effectiveness of higher prices for controlling youth smoking. The other study[55] assessed the impact of price and control policies on cigarette smoking among college students using three models. Cigarette price was found to have a significantly negative association with smoking by college students providing supporting evidence that higher cigarette price discourage smoking participation, and the level of smoking, amongst young adults. When clean air restrictions and other tobacco control policies were represented as a single index, the amount, and frequency, of cigarettes smoked were both statistically significantly negatively affected by stronger restrictions, suggesting that a combination of policies is important.

A Canadian study[20] used repeated cross-sectional data from 1977 to 2001 to examine the relationship between price decreases and trends in smoking prevalence, and amount smoked, amongst youths aged 13-19 years of age. For all daily smoking students, the mean number of cigarettes smoked per day showed a significant discontinuity effect, with an increase followed by a shallow decrease then a shallow, but negative, subsequent trend. The results suggested that the early 1990s cigarette price decrease, and the effective reduction in price prior to that, may have played a role in increasing youth smoking.

Another study[58] used cross-sectional data to examine the differential associations of cigarette retail marketing practice on youth smoking uptake. The uptake measure was based upon three survey questions, from which six categories were defined for the level of uptake smoking (1 - “never smoker” to 6 - “current established smoker”). Although the study was not primarily concerned with price, there were significant price effects in moving from “puffer” to “non-recent experimenter”, while the effects of price were equal across the remaining stages of uptake.

4.4.2. Effects of tax

One study using cross-sectional data assessed the association between cigarette tax and initiation.[59] Three models were developed, with the third model adjusting for a wide range of variables, including gender, peer and parental smoking and state poverty level. Results suggest that higher taxes are associated with lower odds of smoking, although there was variation between the models. For experimental smoking, higher taxes were associated with lower odds of smoking across all models, whereas for established smoking there was only an impact in the model that made the least level of covariate adjustment.

A second study using cross-sectional data from an administrative dataset, rather than a survey, assessed the effectiveness of tobacco policies, including tax, in reducing tobacco use.[25] The study found a weak effect of taxes on smoking, for both boys and girls. Higher per-capita income at the state level was considered likely to be a more powerful deterrent to smoking, especially among boys. Indoor smoking restrictions were also found to be effective deterrents (again, especially for boys). Minimum age requirements deter youth smokers for both sexes, whereas the cross-price effects between smoking and smokeless tobacco were found to be insignificant.

5. Implications for policy, practice and research

A recent systematic review of population tobacco control interventions[16] has called for greater knowledge about the effects of price increases on adolescents and young people's smoking behaviour. Therefore, the review reported here represents an attempt to identify, appraise and synthesize all available evidence on this topic. The literature is dominated by studies from the USA, with only one study based in the UK. The majority of studies are best described as econometric analyses of observational survey data. The main findings of the review are summarised briefly below, and the implications for policy and future research are outlined.

5.1. The evidence-base

The price elasticity of smoking

Across the studies there was wide variability in the sources of data and empirical techniques used, in the reporting of data, methods and results. It is perhaps not surprising, therefore, to find large differences in estimated price elasticities for a given outcome. The disparate surveys and approaches to analysis render the synthesis of the evidence into a coherent message challenging. The results are best viewed as reporting across a broad range of findings obtained from differing surveys and methodologies rather than yielding definitive analytical answers.

Participation

While there is fairly consistent evidence across studies of a negative effect of price on smoking participation, the magnitude of this effect is less clear. Better quality evidence from the two studies using longitudinal data suggest an elasticity of around -0.18 (range: -0.240 to -0.112), implying a 10% increase in price is associated with between a 1.1% and 2.4% decrease in smoking participation. Evidence from the eight studies using repeated cross-sectional data suggest a more elastic response of around -0.49 (range -0.77 to -0.126) implying a decrease of between 1.3% and 7.7% for a 10% increase in price. Across all studies reporting participation results, the mean is -0.548. The mean, however, masks large variability in estimates with a range of -1.43 to 0.082.

One study reported that those aged 18 years or younger are more responsive to price than those over 18 years of age,[13] a finding supported by a comparison of the mean elasticity values for the two age groups (see Table 3). Three studies reported that males are more responsive to price than females[18, 30, 42] whilst one study found females to be more responsive.[31] Two studies found black ethnic groups to be more responsive to price than young white groups.[30, 39] Evidence about the effect of controlling for cross-border purchases of cigarettes was mixed. One study found that the impact of cross-border price differences were small and not significant.[41] A model based upon a restricted sample accounting for cross-border shopping produced similar results to the full sample findings implying no notable effect of cross-border purchases.[31] A further study suggested a greater response to price once controls for cross-border shopping were introduced.[29]

Prevalence

Limited evidence was found on the price elasticity of smoking prevalence. The three available studies suggest that price had a negative impact on smoking with elasticity estimates ranging from -4.74 to -0.131. Evidence from the strongest study[12] however, suggests a modest response to price (-0.131 using the local level dataset and -0.243 using

the state level dataset) for school-aged children, implying a 10% increase in price is associated with between a 1.3% and 2.4% decrease in smoking prevalence.

A single study found evidence of a gradient across age groups with older females being more responsive to price than younger females.[39] In the same study white females were found to be more responsive to price than black females.[39]

Quantity smoked: Level of smoking for smokers

There is consistent evidence of a negative effect of price on the quantity of cigarettes smoked by smokers. The evidence however, is less consistent on the magnitude of this effect. The single study using longitudinal data suggests an elasticity of -0.731, implying a 10% increase in price is associated with a 7.3% decrease in the quantity of cigarettes smoked. Evidence from the five studies using repeated cross-sectional data suggests a more inelastic effect of around -0.327 (range -0.567 to -0.022), implying between a 0 and 6% decrease in quantity smoked for a 10% increase in price. The mean response across all studies is similar at -0.337, however this mean masks greater variability in estimates with a range between -0.87 and 0.02.

Overall, studies based on surveys of older rather than younger young people suggest a greater response to price. This was confirmed in a single study that provided results separately for youths older and younger than 18 years of age.[13] In relation to gender, evidence from two studies suggests that males may be more influenced by price than females. [31, 42] Evidence on ethnicity is provided by a single study (using three separate surveys).[39] Better quality evidence from the two individual level repeated cross-sectional surveys suggests that white ethnic groups are responsive to price while black ethnic groups are not. One study using a restricted sample to account for cross-border issues reported findings similar to the full sample results, implying no notable effect of cross-border purchases.[31] The border phenomenon was found to be an unimportant issue in estimating youth cigarette demand in one study[41] and another found that state average price was not significant in the conditional demand equation.[44]

Quantity smoked: Total level of smoking

Price was found to be negatively related to the total quantity of cigarettes smoked. The single study using longitudinal data suggests an elasticity of -0.844, implying a 10% increase in price is associated with an 8.4% decrease in the total quantity of cigarettes smoked. Evidence from the five studies using repeated cross-sectional data suggests a more inelastic effect of around -0.511 (range -0.652 to -0.331), implying between a 3.3 and 6.5% decrease in quantity smoked for a 10% increase in price. The mean response across all studies is similar at -0.671. This mean, however, masks greater variability in estimates with a range between -1.7 and 0.86.

Overall, studies based on surveys of older rather than younger young people suggest a greater response to price. However, this is not supported by the two studies that provided results separately for youths greater than, and less than, 18 years of age.[13, 24] Two studies suggest that price is a greater influence on cigarette consumption in males than in females[31, 42] whereas the sole UK study found the reverse.[24] Conflicting evidence was also found across ethnic groups, with one study suggesting white ethnic groups were less responsive than black ethnic groups[37] and a further study (using three datasets) finding the converse.[39] Four studies found no evidence to suggest that cross-border purchases of cigarettes impact on the price elasticity of total quantity of cigarettes smoked[31, 41, 42, 50] whilst a single study suggested the reverse.[29]

Smoking initiation

Evidence from studies using longitudinal data suggests that price is effective in deterring young people from starting to smoke. Three of the four studies[26, 27, 45] find an elastic response to price (range: -0.91 to -0.65) implying a 10% increase in price is associated with between a 6.5 and 9% decrease in smoking initiation. A single study which included dummy variables for each state to control for state level anti-smoking sentiment and other policies related to attitudes towards smoking, found a lower response to price, suggesting a reduction of 1% in smoking initiation for a 10% price increase.[49] The results suggest that appropriate controls for state-level anti-smoking sentiment are crucial in determining price effects.

There was limited evidence of a greater response to price for younger than for older young people, obtained from respondent recall of the age of starting to smoke and is likely to be subject to reporting bias.[34] In relation to gender, evidence from two studies suggests that males are more responsive to price than females.[22, 27]

Quitting smoking

Based on the two available studies using longitudinal data price appears to be effective in encouraging young people to quit smoking. Evidence from one study on the price elasticity for a single quit suggests a 10% increase in price is associated with a near 12% increase in the probability of a quit.[47] A second study, recognising that young people who stop may return to smoking and make subsequent quits, modelled multiple quit attempts.[46] The findings suggest that quitting is less responsive to price with the corresponding elasticity implying a 3.7% increase in the probability of quitting for a 10% increase in price. Across the two studies, while price appears effective in encouraging quit attempts it is less effective in sustaining quits among young people.

Other results

Evidence from the three studies reporting tax elasticity estimates[51-53] suggests mixed findings in relation to the impact of tax on smoking. Results based on a longitudinal survey suggest no tax effect on smoking participation (0.01 and 0.05 with other policy variables).[51] This contrasts with evidence estimated from three cross-sectional surveys suggesting a negative impact of tax on participation, ranging from -0.07 to -0.22 implying a 10% increase in tax is associated with between a 0.7% and 2.2% decrease in smoking participation.[51-53]

Amongst studies reporting results other than elasticity, findings varied. Price was found to be effective in decreasing smoking onset among Hispanic youths but not white youths.[54] Cigarette price, amongst other public policies, did not affect the age of smoking initiation[23] but higher cigarette prices were found to reduce the probability of being in a higher stage of smoking uptake[57] and discouraged youth from progressing to established smoking at most levels of smoking uptake.[58] Two studies concluded that a higher price influences the level of smoking among young people.[55, 56]

Higher state taxes were associated with lower odds of smoking experimentation and established smoking amongst adolescent boys and girls,[59] whereas higher taxes were found to be an ineffective deterrent in a further study.[25]

Findings by PROGRESS criteria

As can be seen from the evidence summaries provided in the preceding section very few studies explored price effects according to socio-demographic characteristics. The available evidence according to PROGRESS criteria is further considered in this section.

Three authors investigated price effect differences amongst ethnic groups as part of their research question,[30, 37, 54] though one did not report elasticity values.[54] A further study also reported results by ethnic group but this was not an explicit aim of the study.[39] Two participation studies[30, 39] reported that black ethnic groups were more responsive to price than white groups. For the level of smoking one study reported that Hispanic and African-American groups were more responsive to price than white groups,[37] whereas another study found that white groups were more responsive than black groups.[39] The reliability of these findings is uncertain due to the small number of studies involved and the lack of clarity surrounding samples used for the models.

Five studies explicitly explored the impact of price according to gender,[22, 24, 26, 30, 37] although two did not report elasticities.[26, 37] A further six studies reported gender results but this was not a specific study objective.[18, 19, 22, 27, 31, 42] Both males and females were found to be responsive to price, males generally more so than females.

Three studies[23, 24, 37] explicitly explored the impact of price according to age, although the majority of studies reported elasticities by varying age categories up to 25 years of age. For example, 11 participation studies presented elasticity results separately for those aged 18 years and under,[8, 12, 18, 19, 29, 30, 32, 38, 39, 41, 43] four studies for those over 18 years of age[31, 36, 37, 42] and another presented results for those aged 18 years and under and over 18 years of age.[13]

Few studies reported elasticity gradients across younger young people (less than 18 years of age). Amongst those that did, one[8] reported a strong age gradient for participation from -2.03 for 13-14 year olds to -0.72 for 17-18 year olds. A further study[34] found that the elasticity of starting to smoke declined with age, from -0.57 at age 12 to -0.15 at age 20. A study using three separate survey datasets generally found that elasticities increased from younger age cohorts to older cohorts (youths aged 17-19 years).[39]

Although income was used as a covariate in a number of studies the reporting of income effects was sparse and there was an absence of reported elasticities by specific income groups.

Results based on sub-group analysis should be treated with some caution. The findings relating to gender are the most consistent, followed by those for age, but the number of studies reporting results for sub-groups is small.

5.2. Strengths and weaknesses of the review

Rigorous systematic review methods were applied, including an extensive search to identify both published and unpublished studies. It is possible, however, we have failed to identify all relevant studies and new studies may have become available since June 2007, when the searches were undertaken.

The review aimed to address overall price effects on smoking behaviour, and according to various participant characteristics, stratified using the PROGRESS criteria.[15] The PROGRESS criteria were used in a previous review of population tobacco control interventions[16] and also in a review of school-based cognitive behavioural therapy programmes for preventing/reducing depression.[62] Differential effects were assessed in thirteen of the elasticity studies, but only in relation to age, gender and ethnicity. Importantly, exploration of differential effects was not necessarily an explicit study aim, and therefore, the data available in the studies are fairly limited.

Similarly, some studies did not focus explicitly on young people, and the information provided was fairly limited. The majority of studies used general surveys rather than surveys

specifically designed and sampled to capture estimates of youth smoking elasticities. Accordingly, there was a lack of standardisation in approaches to identifying the impact of price on smoking outcomes. These varied from simple regressions of smoking outcome on price only, using a small time series of data[33] to complex econometric approaches applied to individual-level longitudinal data.[38 46]

5.3. Limitations of the evidence and implications for future research

The included studies were almost exclusively econometric studies based on survey datasets. A broad range of surveys, often involving the same survey at different points in time was used across the included studies. Different age groupings for young people were selected, and many studies also included adults. Study settings differed and publication dates extended from the early 1980s through to 2007. Thirty-seven studies were published since 1998, two of them in the early 1980s and six in the period 1990-1997. The majority of surveys were of US citizens. Detail about the surveys and the data that formed the basis of subsequent analyses was generally lacking, though whether this was due to inadequate reporting by the authors, or publication restrictions, is unclear. Some authors used the same survey data in subsequent publications and made few amendments to their commentary.[45-49]

The representativeness of many of the surveys was questionable. Although several claimed to be representative, they were specific to sub-groups of youths, such as school children, college students, and pregnant young women. How representative these surveys are of the general population of young people is debatable. Secondly, although a survey might be representative, it was often unclear whether the sub-sample of data used in estimating price effects retained representativeness. These caveats are important to the interpretation and generalisability of findings to a national population of young people.

The various survey datasets were used in different ways. For example, one author made use of the Monitoring the Future (MTF) survey in five studies[45-49] and exploited the longitudinal component. In contrast, four other studies[29, 33, 39, 56] also used data from MTF, but treated it as repeated cross-sectional data. Yet another study[58] treated the MTF data as cross-sectional. This is also true for other surveys that were longitudinal in nature but in some studies was analysed as repeated cross-sectional or cross-sectional. Traditionally, systematic reviews seek to exclude multiple uses of the same dataset by an author, particularly randomised controlled trials based upon the same patient cohort. However, the studies included within this review have employed different outcomes, modelling approaches or cohorts within their analyses and were considered to represent individual studies, and analyses.

However, investigation of using different approaches and analyses of the same data sets presents a challenging research agenda. Deriving meaningful comparisons from such an investigation would require analysis of a large number of studies based upon a single source of survey data. Within this systematic review relative to the total number of studies, a minority of different studies focused upon the analysis of the same single survey, and accordingly it would be difficult to generalise any conclusions derived from such an investigation. Further exploration of this issue in the context of conducting systematic reviews is however important and should be considered in future reviews of econometric studies.

Current evidence on the effect of price is dominated by studies undertaken in the USA. Only one study was identified from the UK. In part, this is due to the ability to observe cross-sectional variation in price across US states derived from changes in state and local tax rates. This provides a source of variation in addition to changes over time not observed in the UK. Relying solely on historical variation in prices to identify changes in smoking behaviours severely restricts the ability of UK data to contribute to the evidence base and

contemporary policy. The extent to which evidence derived from young people in the USA is transferable to a UK population of young people is not clear, and is an area for future consideration.

Due to the concentration of evidence from the USA, the majority of price data were derived from the Tax Burden on Tobacco, often using a weighted average price across all sales of cigarettes measured at state level. It is questionable whether an average across all sales is the most relevant price to apply to studies of young people who tend to be more brand-conscious than older smokers. Analyses recording price at sub-state level were rare, though two studies included data measured at city level[31, 53] and one included an additional measure that sought out a community price of cigarettes in a local area.[57]

A minority of studies (nine) evaluated price and/or tax effects, but not in the form of elasticity estimates. Elasticities provide a simple and intuitive interpretation of the effect of a change in price to a change in outcome which can easily be compared across studies. To strengthen the evidence base, future research on the impact of price on smoking behaviour should endeavour to report effects in terms of price elasticities.

Of key importance is the extent and type of controls used in models investigating price effects. Successfully identifying the effect of price from the effects of other policy instruments that might simultaneously impact on young people is critically important. A number of approaches based largely on controlling for other policy initiatives (e.g. clear indoor air regulations, restrictions on sales to youths, whether a US state was a producer of tobacco, US state fixed effects) were used. These approaches, however, often necessitated the use of longitudinal data to successfully attribute smoking outcomes to price and these studies were in the minority. Identifying price effects independently from other smoking reduction policies is an area of research where further clarity is required. Research effort should focus on the analysis of longitudinal surveys exploiting the ability to track young people over time and throughout their smoking lifetime.

The attribution of smoking outcomes to price requires all potential confounding factors to be adequately represented in the analysis. Surprisingly, there seemed to be little consensus across studies in how best to control for confounders. In particular there appears to be debate over the appropriate use of controls for clean indoor air regulations, restrictions on youth access to cigarettes, anti-smoking sentiment and/or state dummy variables. In an attempt to address these issues, a number of studies provide price elasticity estimates derived across multiple model specifications, but often do not provide guidance on which model is preferred. Instead a mean effect taken across model specifications is often discussed in the study summaries.[31, 46, 49] Where different model specifications lead to substantially different price effects, it is debateable whether the mean is a useful summary for use in informing policy decisions. Greater investigation of each model specification, highlighting the strengths and weaknesses and providing guidance on a preferred set of controls would assist in determining the actual response to price for young people.

Another potential limitation is the reliance on individual self-reported data on cigarette consumption. Self-reported measures are likely to substantially underestimate actual smoking consumption.[63, 64] However, studies comparing self-reported smoking status with biochemical measures suggest that self-reports are more accurate for identifying smoking participation.[65] For studies of smoking cessation, prolonged abstinence supported by biochemical evidence is a more relevant measure for evaluative purposes but might not be achievable in observational studies.[66] If reporting bias systematically varies across stage of smoking, then this is likely to lead to biased estimates of the impact of price. Obtaining more accurate measures of smoking behaviour in the context of survey designs remains challenging but is likely to be more relevant to the investigation of the smoking behaviour of young people than for adults.[65]

Limited evidence on the price elasticity of smoking by socio-economic or demographic group was found. Where information by PROGRESS criteria[15] was available, this was restricted to effects by age, gender and ethnic group. Moreover, for the latter the limited evidence available was from the US where the focus is on race, and the extent to which these findings translate to the UK is questionable. Evidence on price elasticities across socio-demographic groups remains a priority area for future research to gain a greater understanding of the social patterning of smoking among young people and the effectiveness of price in reducing inequalities in smoking outcomes.

Evidence on the impact of cross-border purchases of cigarettes was limited to studies undertaken in the USA where variation in local and state level taxes lead to price differences. The extent to which findings in the USA are applicable to the UK context where recent evidence suggests that almost one in five cigarettes is smuggled is an area for future research.[67] Tobacco smuggling provides smokers with access to cut-price cigarettes which is likely to undermine price as a tobacco control mechanism. Other potential influences such as illicit sales within borders (for example, the sale of single cigarettes by newsagents and from vans) and social markets in cigarettes (from friends) are likely to further lead to subvert the effects of price and may have important implications for smoking-related inequalities in health.

5.4. Reporting guidelines and quality assessment

It has frequently been found that much medical research is reported poorly and a number of reporting guidelines such as CONSORT (Consolidated Standards of Reporting Trials),[68] QUOROM (meta-analyses of randomised trials),[69] STARD (Standards for Reporting of Diagnostic Accuracy Studies)[70] and STROBE (Strengthening the Reporting of Observational Studies in Epidemiology)[71] have been developed. Reporting guidelines have the potential to improve the quality of reporting and consequently the quality of research.[72] The costs of developing guidelines have been estimated to be in the region of £50,000.[72] To date, no such guidelines exist for the reporting of econometric studies, and although beyond the remit of this project, development remains a priority for the future.

Similarly, our search for specific checklists and tools to assess the methodological quality of econometric studies revealed no such tools exist. Consequently, we attempted to identify relevant criteria that could be applied in a systematic way, for example, in relation to survey design and the source of price data, and approaches to empirical modelling. However, it became clear during the review process that the identification and application of appropriate quality criteria represents a significant research agenda in its own right and the development of a reliable tool or checklist for the assessment of econometric studies remains a priority for future research. We found that the lack of standardisation in reporting of studies and approaches to analysis rendered the application of potential quality criteria difficult and not helpful in terms of distinguishing better from poorer quality studies.

Potentially useful criteria for future consideration include information on the source and type of both survey and price data, details of the unit of analysis, approach to analysis, measures and type of smoking outcome, adequacy of sample size, evidence of theoretical model, appropriateness of empirical model, adjustment for confounders and anti-smoking sentiment, control for cross-border purchases, test of model assumptions and sensitivity analyses performed. For survey data, consideration should be given to how representative the survey is to the population of interest and if there were any deviations from representativeness in the sample used for empirical modelling. The survey instrument used to define the study outcome and other key variables should be assessed. Approaches to modelling, including theoretical and empirical models, should be scrutinized, including the rationale for the approach adopted and the underlying assumptions. The relevance of included covariates should be considered together with any limitations of omitting from a model potential

confounding variables. Where results are reported with point estimates and confidence intervals, study limitations such as estimation bias should be assessed. Where multiple model specifications are reported, consideration of the overall main finding and likely error should be examined.

Future research should also assess whether it is quality that best describes the assessment of econometric studies or whether it is the likely robustness of the study based on type and source of data. Both will require detailed information obtained from study authors and survey sources to ensure that all relevant information is available for assessment. Poor and inconsistent reporting of such features within studies, was especially problematic within this systematic review. If quality criteria can be agreed then combining individual quality indices in a systematic and informative way and demonstrating how quality impacts on the size and variability of estimated effects would be a crucial research consideration. The generalisability of quality criteria to other reviews of econometric studies would also need to be considered.

Similarly, although there appears to be relatively few existing systematic reviews of econometric studies especially in the health field, those that are available may provide useful descriptions of criteria used to assess methodological quality.[73, 74] For example, a recent review seeking to identify effective measures of innovation (research and development, research utilization) attempted to assess the quality of econometric studies using the following three dimensions: quality of data, quality of the model, and the quality of results.[74] The quality of data criteria covered data source, data completeness, representativeness of sample and data description. There were four broad criteria for assessing model quality: type of analysis, model assumptions, model specification and the selection of variables. Statistical significance, estimation bias, and overall objectivity were used to assess quality of results. Each criterion was scored on a scale of one to three and summed across criteria and dimensions to obtain an overall study quality score.

Systematic reviews of econometric studies will continue to be limited until such time that reliable checklists or tools for assessing methodological quality and recommendations for reporting standards become readily available. The work of the Campbell & Cochrane Economics Methods Group is important in this respect as they are engaged in developing economic methods for research synthesis and in undertaking empirical research in the development and application of economic methods (http://www.med.uea.ac.uk/research/research_econ/cochrane/cochrane_home.htm).

5.5. Implications for policy

The uptake of smoking among young people and the perpetuation of smoking into adult life is a concern for UK government policy-makers.[1] A recent report suggests there are strong ethical arguments to support taxation as a legitimate instrument to be used alongside other policies aimed at reducing cigarette consumption.[75]

Conventional economic wisdom suggests that the smoking behaviour of youths and young adults is highly responsive to price and is greater than that for adults.[8] The results of this systematic review indicate that price is effective in reducing smoking among young people, however, the extent of this effect is less clear. Questions are also raised about the assumed high price responsiveness of young people, which has been frequently reported.[7, 12, 13] Price potentially acts to reduce cigarette consumption through three mechanisms. First, a higher price might reduce cigarette initiation and hence prevents individuals from starting to smoke. Secondly, a higher price might induce smokers to quit increasing cessation rates and thirdly, price might influence the level of consumption by encouraging smokers to reduce their daily intake. The findings of our systematic review lend some support to these assertions, in that overall smoking initiation, quantity smoked and quitting, appear to be responsive to price, albeit at different levels of effect. Whilst smoking participation also appears to be responsive

to price, the overall effect appears to be lower than the commonly cited USA consensus estimate of around -0.7.[32, 12]

Although some ambiguity remains over the size of effects, the results of this systematic review suggest that the economic instrument of price is effective in reducing cigarette smoking among young people. This has important implications for informing cigarette taxation policy. A tax policy which reduced smoking among young people could be supported on these immediate effects alone as well as the impacts on curtailing the future public health burden of smoking and the associated costs placed on the NHS. Evidence on the responsiveness to price across social groups is lacking, and further research is required to inform future Government targets aimed at reducing the social distribution of smoking.

Appendix 1: Price responsiveness of young people

A number of arguments have been used to suggest the youth smoking is more responsive to price compared to adults. These can be summarised as follows:

- Youths have a more limited expenditure compared to adults and hence, for a given level of consumption, a greater proportion of disposable income is spent on cigarettes. Accordingly, youths are more sensitive to fluctuations in prices and respond to increases by lowering consumption.

- Youths are at an earlier stage than adults in their smoking behaviour and are more likely to be experimenting with smoking and less likely to be addicted to nicotine. Accordingly, they are more able to adjust consumption levels and find it easier to quit smoking. This makes young people more responsive to changes in tobacco regulations and incentives, including responding to increases in cigarette price.

However, it has also been suggested that youth smoking is less responsive to increases in price:

- Young people discount the future more heavily compared to adults. As a consequence, they overvalue present satisfaction and undervalue future satisfaction. Accordingly, young people smoke more than is optimal in their youth. Only through the investment process as they age and mature, do people become more orientated toward future benefits and hence adjust downwards discount rates applied to the health benefits associated with reduced consumption of cigarettes.

- It has also been suggested that while young people are aware of the dangers attached to certain health behaviours (smoking, alcohol, risky sex) they may overstate the associated risks and therefore avoid participation altogether.[53]

- Research in social psychology suggests that peers have a powerful influence over youth smoking.[76] Peer-group influences might mediate the responsiveness of young people to price increases. This has been termed a social multiplier whereby the total observed impact of price changes on cigarette consumption consists of a direct and indirect effect,[43] the latter being caused through peer-effects which act to reinforce the direct effect. Should the peer-group jointly face an increase in the costs of smoking, young people might be more responsive than if they faced the increase in cost alone as peer pressure is likely to decline.

- It has, however, also been suggested that youth demand for cigarettes is a derived demand from the demand for peer acceptance. Accordingly, if youths are unable to substitute other inputs for cigarettes in the production of peer acceptance then they may be price inelastic and fail to adjust consumption when faced with price increases.

- Young people are more likely to experiment with cigarette consumption prior to becoming a regular smoker. During the stage of experimentation it is possible that cigarettes are cadged from friends or only smoke when obtained free of cost. This would render the consumption response inelastic. However, prices may be a useful mechanism for preventing experimenters from progressing to regular smokers.

Appendix 2: Search strategy

The core search strategy used for this review was as follows:

1. SMOKING/
2. Smoking Cessation/
3. TOBACCO/
4. "Tobacco Use Disorder"/
5. NICOTINE/
6. smoking.ti,ab.
7. (smokers or smoker).ti,ab.
8. tobacco.ti,ab.
9. cigarette$.ti,ab.
10. nicotine.ti,ab.
11. or/1-10
12. ((smok$ or anti-smok$ or tobacco or cigarette$) adj3 (legislat$ or government$ or authorit$ or law or laws or bylaw$ or byelaw$ or bye-law$ or regulation$)).ti,ab.
13. ((sale or sales or sponsor$) adj3 (restrict$ or limit$ or ban or bans or prohibit$)).ti,ab.
14. ((smok$ or tobacco) adj (policy or policies or program$)).ti,ab.
15. ((retailer$ or vendor$) adj3 (prosecut$ or legislat$)).ti,ab.
16. test purchas$.ti,ab.
17. ((sale or sales or retail$ or purchas$) adj3 (minors or teenage$ or underage$ or under-age$ or child$)).ti,ab.
18. (youth access adj3 restrict$).ti,ab.
19. ((tobacco or cigarette$ or smok$) adj4 (tax or taxes or taxation or excise or duty-free or duty-paid or customs)).ti,ab.
20. ((cigarette$ or tobacco) adj3 (price$ or pricing or cost$)).ti,ab.
21. point of sale.ti,ab.
22. vending machine$.ti,ab.
23. (trade adj (restrict$ or agreement$)).ti,ab.
24. (contraband$ or smuggl$ or bootleg$ or cross-border shopping).ti,ab.
25. or/12-24
26. 11 and 25

This strategy was designed for searching MEDLINE through the Ovid interface and was adapted as appropriate for all other databases searched, taking into account differences in indexing terms and search syntax for each database.

Full details of all databases searched and search strategies are provided below.

MEDLINE & MEDLINE In-Process: Ovid (http://gateway.ovid.com/athens)

The MEDLINE search covered the date range 1950 to 27 June 2007. The search was carried out on 27 June 2007 and identified 2323 records.

1. SMOKING/
2. Smoking Cessation/
3. TOBACCO/
4. "Tobacco Use Disorder"/
5. NICOTINE/
6. smoking.ti,ab.
7. (smokers or smoker).ti,ab.
8. tobacco.ti,ab.
9. cigarette$.ti,ab.
10. nicotine.ti,ab.

11. or/1-10
12. ((smok$ or anti-smok$ or tobacco or cigarette$) adj3 (legislat$ or government$ or authorit$ or law or laws or bylaw$ or byelaw$ or bye-law$ or regulation$)).ti,ab.
13. ((sale or sales or sponsor$) adj3 (restrict$ or limit$ or ban or bans or prohibit$)).ti,ab.
14. ((smok$ or tobacco) adj (policy or policies or program$)).ti,ab.
15. ((retailer$ or vendor$) adj3 (prosecut$ or legislat$)).ti,ab.
16. test purchas$.ti,ab.
17. ((sale or sales or retail$ or purchas$) adj3 (minors or teenage$ or underage$ or under-age$ or child$)).ti,ab.
18. (youth access adj3 restrict$).ti,ab.
19. ((tobacco or cigarette$ or smok$) adj4 (tax or taxes or taxation or excise or duty-free or duty-paid or customs)).ti,ab.
20. ((cigarette$ or tobacco) adj3 (price$ or pricing or cost$)).ti,ab.
21. point of sale.ti,ab.
22. vending machine$.ti,ab.
23. (trade adj (restrict$ or agreement$)).ti,ab.
24. (contraband$ or smuggl$ or bootleg$ or cross-border shopping).ti,ab.
25. or/12-24
26. 11 and 25

EMBASE: Ovid (http://gateway.ovid.com/athens)

The EMBASE search covered the date range 1980 to 2007 (Week 25). The search was carried out on 27 June 2007 and identified 1507 records.

1. SMOKING/
2. Smoking Cessation/
3. TOBACCO/
4. "tobacco dependence"/
5. NICOTINE/
6. smoking.ti,ab.
7. (smokers or smoker).ti,ab.
8. tobacco.ti,ab.
9. cigarette$.ti,ab.
10. nicotine.ti,ab.
11. or/1-10
12. ((smok$ or anti-smok$ or tobacco or cigarette$) adj3 (legislat$ or government$ or authorit$ or law or laws or bylaw$ or byelaw$ or bye-law$ or regulation$)).ti,ab.
13. ((sale or sales or sponsor$) adj3 (restrict$ or limit$ or ban or bans or prohibit$)).ti,ab.
14. ((smok$ or tobacco) adj (policy or policies or program$)).ti,ab.
15. ((retailer$ or vendor$) adj3 (prosecut$ or legislat$)).ti,ab.
16. test purchas$.ti,ab.
17. ((sale or sales or retail$ or purchas$) adj3 (minors or teenage$ or underage$ or under-age$ or child$)).ti,ab.
18. (youth access adj3 restrict$).ti,ab.
19. ((tobacco or cigarette$ or smok$) adj4 (tax or taxes or taxation or excise or duty-free or duty-paid or customs)).ti,ab.
20. ((cigarette$ or tobacco) adj3 (price$ or pricing or cost$)).ti,ab.
21. point of sale.ti,ab.
22. vending machine$.ti,ab.
23. (trade adj (restrict$ or agreement$)).ti,ab.
24. (contraband$ or smuggl$ or bootleg$ or cross-border shopping).ti,ab.
25. or/12-24
26. 11 and 25

Cumulative Index to Nursing and Allied Health Literature (CINAHL): Ovid (http://gateway.ovid.com/athens)

The CINAHL search covered the date range 1982 to June 2007 (Week 4). The search was carried out on 27 June 2007 and identified 603 records.

1. SMOKING/
2. Smoking Cessation/
3. TOBACCO/
4. "Tobacco Use Disorder"/
5. NICOTINE/
6. smoking.ti,ab.
7. (smokers or smoker).ti,ab.
8. tobacco.ti,ab.
9. cigarette$.ti,ab.
10. nicotine.ti,ab.
11. or/1-10
12. ((smok$ or anti-smok$ or tobacco or cigarette$) adj3 (legislat$ or government$ or authorit$ or law or laws or bylaw$ or byelaw$ or bye-law$ or regulation$)).ti,ab.
13. ((sale or sales or sponsor$) adj3 (restrict$ or limit$ or ban or bans or prohibit$)).ti,ab.
14. ((smok$ or tobacco) adj (policy or policies or program$)).ti,ab.
15. ((retailer$ or vendor$) adj3 (prosecut$ or legislat$)).ti,ab.
16. test purchas$.ti,ab.
17. ((sale or sales or retail$ or purchas$) adj3 (minors or teenage$ or underage$ or under-age$ or child$)).ti,ab.
18. (youth access adj3 restrict$).ti,ab.
19. ((tobacco or cigarette$ or smok$) adj4 (tax or taxes or taxation or excise or duty-free or duty-paid or customs)).ti,ab.
20. ((cigarette$ or tobacco) adj3 (price$ or pricing or cost$)).ti,ab.
21. point of sale.ti,ab.
22. vending machine$.ti,ab.
23. (trade adj (restrict$ or agreement$)).ti,ab.
24. (contraband$ or smuggl$ or bootleg$ or cross-border shopping).ti,ab.
25. or/12-24
26. 11 and 25

Health Management Information Consortium (HMIC): Ovid (http://gateway.ovid.com/athens)

The HMIC search covered the date range 1979 to May 2007. The search was carried out on 27 June 2007 and identified 398 records.

1. SMOKING/
2. Smoking Cessation/
3. TOBACCO/
4. smoking treatment/
5. NICOTINE/
6. smoking.ti,ab.
7. (smokers or smoker).ti,ab.
8. tobacco.ti,ab.
9. cigarette$.ti,ab.
10. nicotine.ti,ab.
11. or/1-10
12. ((smok$ or anti-smok$ or tobacco or cigarette$) adj3 (legislat$ or government$ or authorit$ or law or laws or bylaw$ or byelaw$ or bye-law$ or regulation$)).ti,ab.

13. ((sale or sales or sponsor$) adj3 (restrict$ or limit$ or ban or bans or prohibit$)).ti,ab.
14. ((smok$ or tobacco) adj (policy or policies or program$)).ti,ab.
15. ((retailer$ or vendor$) adj3 (prosecut$ or legislat$)).ti,ab.
16. test purchas$.ti,ab.
17. ((sale or sales or retail$ or purchas$) adj3 (minors or teenage$ or underage$ or under-age$ or child$)).ti,ab.
18. (youth access adj3 restrict$).ti,ab.
19. ((tobacco or cigarette$ or smok$) adj4 (tax or taxes or taxation or excise or duty-free or duty-paid or customs)).ti,ab.
20. ((cigarette$ or tobacco) adj3 (price$ or pricing or cost$)).ti,ab.
21. point of sale.ti,ab.
22. vending machine$.ti,ab.
23. (trade adj (restrict$ or agreement$)).ti,ab.
24. (contraband$ or smuggl$ or bootleg$ or cross-border shopping).ti,ab.
25. or/12-24
26. 11 and 25

PsycINFO: Ovid (http://gateway.ovid.com/athens)

The PsycINFO search covered the date range 1806 to June 2007 (Week 3). The search was carried out on 27 June 2007 and identified 650 records.

1. tobacco smoking/
2. Smoking Cessation/
3. cigarette smoking/
4. nicotine withdrawal/
5. NICOTINE/
6. smoking.ti,ab.
7. (smokers or smoker).ti,ab.
8. tobacco.ti,ab.
9. cigarette$.ti,ab.
10. nicotine.ti,ab.
11. or/1-10
12. ((smok$ or anti-smok$ or tobacco or cigarette$) adj3 (legislat$ or government$ or authorit$ or law or laws or bylaw$ or byelaw$ or bye-law$ or regulation$)).ti,ab.
13. ((sale or sales or sponsor$) adj3 (restrict$ or limit$ or ban or bans or prohibit$)).ti,ab.
14. ((smok$ or tobacco) adj (policy or policies or program$)).ti,ab.
15. ((retailer$ or vendor$) adj3 (prosecut$ or legislat$)).ti,ab.
16. test purchas$.ti,ab.
17. ((sale or sales or retail$ or purchas$) adj3 (minors or teenage$ or underage$ or under-age$ or child$)).ti,ab.
18. (youth access adj3 restrict$).ti,ab.
19. ((tobacco or cigarette$ or smok$) adj4 (tax or taxes or taxation or excise or duty-free or duty-paid or customs)).ti,ab.
20. ((cigarette$ or tobacco) adj3 (price$ or pricing or cost$)).ti,ab.
21. point of sale.ti,ab.
22. vending machine$.ti,ab.
23. (trade adj (restrict$ or agreement$)).ti,ab.
24. (contraband$ or smuggl$ or bootleg$ or cross-border shopping).ti,ab.
25. or/12-24
26. 11 and 25

BIOSIS Previews: Dialog (http://www.datastarweb.com/)

The BIOSIS search covered the date range 1993 to July 2007 (Week 3). The search was carried out on 27 July 2007 and identified 1232 records.

1	52197	SMOKING FROM 55
2	15554	SMOKERS FROM 55
3	4119	SMOKER FROM 55
4	33075	TOBACCO FROM 55
5	19162	CIGAR? FROM 55
6	14685	NICOTINE FROM 55
7	21	SMOK?(3W)LEGISLAT? FROM 55
8	7	SMOK?(3W)GOVERNMENT? FROM 55
9	2	SMOK?(3W)AUTHORIT? FROM 55
10	15	SMOK?(3W)LAW FROM 55
11	13	SMOK?(3W)LAWS FROM 55
12	2	SMOK?(3W)BYLAW? FROM 55
13	0	SMOK?(3W)BYE(W)LAW? FROM 55
14	41	SMOK?(3W)REGULATION? FROM 55
15	1	ANTI(W)SMOK?(3W)LEGISLAT? FROM
16	0	ANTI(W)SMOK?(3W)GOVERNMENT? FROM
17	0	ANTI(W)SMOK?(3W)AUTHORIT? FROM
18	1	ANTI(W)SMOK?(3W)LAW FROM 55
19	0	ANTI(W)SMOK?(3W)LAWS FROM 55
20	0	ANTI(W)SMOK?(3W)BYLAW? FROM 55
21	0	ANTI(W)SMOK?(3W)BYE(W)LAW? FROM
22	0	ANTI(W)SMOK?(3W)REGULATION? FROM
23	26	TOBACCO(3W)LEGISLAT? FROM 55
24	6	TOBACCO(3W)GOVERNMENT? FROM 55
25	0	TOBACCO(3W)AUTHORIT? FROM 55
26	11	TOBACCO(3W)LAW FROM 55
27	11	TOBACCO(3W)LAWS FROM 55
28	0	TOBACCO(3W)BYLAW? FROM 55
29	0	TOBACCO(3W)BYE(W)LAW? FROM 55
30	33	TOBACCO(3W)REGULATION? FROM 55
31	1	CIGARETTE?(3W)LEGISLAT? FROM 55
32	0	CIGARETTE?(3W)GOVERNMENT? FROM
33	0	CIGARETTE?(3W)AUTHORIT? FROM 55
34	2	CIGARETTE?(3W)LAW FROM 55
35	1	CIGARETTE?(3W)LAWS FROM 55
36	0	CIGARETTE?(3W)BYLAW? FROM 55
37	0	CIGARETTE?(3W)BYE(W)LAW? FROM 55
38	8	CIGARETTE?(3W)REGULATION? FROM
39	5	SALE(3W)RESTRICT? FROM 55
40	5	SALES(3W)RESTRICT? FROM 55
41	1	SPONSOR?(3W)RESTRICT? FROM 55
42	1	SALE(3W)LIMIT? FROM 55
43	5	SALES(3W)LIMIT? FROM 55
44	6	SPONSOR?(3W)LIMIT? FROM 55
45	3	SALE(3W)BAN FROM 55
46	9	SALES(3W)BAN FROM 55
47	0	SPONSOR?(3W)BAN FROM 55
48	0	SALE(3W)BANS FROM 55
49	1	SALES(3W)BANS FROM 55
50	1	SPONSOR?(3W)BANS FROM 55
51	5	SALE(3W)PROHIBIT? FROM 55
52	1	SALES(3W)PROHIBIT? FROM 55

53	0	SPONSOR?(3W) PROHIBIT? FROM 55
54	89	SMOK?(3W)POLICY FROM 55
55	83	SMOK?(3W)POLICIES FROM 55
56	659	SMOK?(3W)PROGRAM? FROM 55
57	64	TOBACCO(3W)POLICY FROM 55
58	61	TOBACCO(3W)POLICIES FROM 55
59	170	TOBACCO(3W)PROGRAM? FROM 55
60	0	RETAILER?(3W)EDUCAT? FROM 55
61	0	RETAILER?(3W)SURVEILLANCE FROM
62	0	RETAILER?(3W)PROSECUT? FROM 55
63	1	RETAILER?(3W)LEGISLAT? FROM 55
64	3	VENDOR?(3W)EDUCAT? FROM 55
65	0	VENDOR?(3W)SURVEILLANCE FROM 55
66	0	VENDOR?(3W)PROSECUT? FROM 55
67	0	VENDOR?(3W)LEGISLAT? FROM 55
68	1	TEST(W)PURCHAS? FROM 55
69	0	MINORS(3W)SALE FROM 55
70	1	TEENAGE?(3W)SALE FROM 55
71	1	UNDERAGE?(3W)SALE FROM 55
72	0	UNDER(W)AGE?(3W)SALE FROM 55
73	0	CHILD?(3W)SALE FROM 55
74	1	MINORS(3W)SALES FROM 55
75	0	TEENAGE?(3W)SALES FROM 55
76	4	UNDERAGE?(3W)SALES FROM 55
77	0	UNDER(W)AGE?(3W)SALES FROM 55
78	1	CHILD?(3W)SALES FROM 55
79	2	MINORS(3W)RETAIL? FROM 55
80	0	TEENAGE?(3W)RETAIL? FROM 55
81	0	UNDERAGE?(3W)RETAIL? FROM 55
82	0	UNDER(W)AGE?(3W)RETAIL? FROM 55
83	4	CHILD?(3W)RETAIL? FROM 55
84	5	MINORS(3W)PURCHAS? FROM 55
85	1	TEENAGE?(3W)PURCHAS? FROM 55
86	3	UNDERAGE?(3W)PURCHAS? FROM 55
87	0	UNDER(W)AGE?(3W)PURCHAS? FROM 55
88	14	CHILD?(3W)PURCHAS? FROM 55
89	1	YOUTH(W)ACCESS(W)RESTRICT? FROM
90	4	TAX(3W)TOBACCO FROM 55
91	4	TAX(3W)CIGARETT? FROM 55
92	7	TAX(3W)SMOK? FROM 55
93	7	TAXES(3W)TOBACCO FROM 55
94	3	TAXES(3W)CIGARETT? FROM 55
95	10	TAXES(3W)SMOK? FROM 55
96	1	TAXATION(3W)TOBACCO FROM 55
97	0	TAXATION(3W)CIGARETT? FROM 55
98	5	TAXATION(3W)SMOK? FROM 55
99	1	EXCISE(3W)TOBACCO FROM 55
100	2	EXCISE(3W)CIGARETT? FROM 55
101	4	EXCISE(3W)SMOK? FROM 55
102	0	DUTY(W)FREE(3W)TOBACCO FROM 55
103	0	DUTY(W)FREE(3W)CIGARETT? FROM 55
104	0	DUTY(W)FREE(3W)SMOK? FROM 55
105	0	DUTY(W)PAID(3W)TOBACCO FROM 55
106	0	DUTY(W)PAID(3W)CIGARETT? FROM 55
107	0	DUTY(W)PAID(3W)SMOK? FROM 55

108	0	CUSTOMS(3W)TOBACCO FROM 55
109	0	CUSTOMS(3W)CIGARETT? FROM 55
110	0	CUSTOMS(3W)SMOK? FROM 55
111	33	CIGARETTE?(3W)PRICE? FROM 55
112	2	CIGARETTE?(3W)PRICING FROM 55
113	8	CIGARETTE?(3W)COST? FROM 55
114	11	TOBACCO?(3W)PRICE? FROM 55
115	3	TOBACCO?(3W)PRICING FROM 55
116	12	TOBACCO?(3W)COST? FROM 55
117	0	POINT(W)SALE FROM 55
118	76	VENDING(W)MACHINE? FROM 55
119	34	TRADE(W)RESTRICT? FROM 55
120	88	TRADE(W)AGREEMENT? FROM 55
121	19	CONTRABAND? FROM 55
122	110	SMUGGL? FROM 55
123	1	BOOTLEG? FROM 55
124	0	CROSS(W)BORDER(W)SHOPPING FROM
125	92970	S1:S6 FROM 55
126	201	S7:S50 FROM 55
127	1084	S51:S100 FROM 55
128	389	S101:S124 FROM 55
129	1600	S126:S128 FROM 55
130	1236	S125 AND S129 FROM 55
131	1232	RD S130 (unique items)

ECONLIT: WebSPIRS (http://arc.uk.ovid.com/webspirs)

The ECONLIT search covered the date range 1969 to May 2007. The search was carried out on 28 June 2007 and identified 359 records.

#26 #24 and #25(359 records)
#25 #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23(3374 records)
#24 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10(3969 records)
#23 ((contraband* or smuggl* or bootleg* or cross-border shopping) in AB)or((contraband* or smuggl* or bootleg* or cross-border shopping) in TI)(234 records)
#22 (((trade) near3 (restrict* or agreement*)) in TI)or(((trade) near3 (restrict* or agreement*)) in AB)(2660 records)
#21 ((vending machine*) in AB)or((vending machine*) in TI)(6 records)
#20 ((point of sale) in AB)or((point of sale) in TI)(30 records)
#19 (((tobacco or cigarett*)near3 (prices or pricing or cost*)) in TI)or(((tobacco or cigarett*) near3 (prices or pricing or cost*)) in AB)(96 records)
#18 (((tobacco or cigarett* or smok*) near4 (tax or taxes or taxation or excise or duty-free or duty-paid or customs)) in TI)or(((tobacco or cigarett* or smok*) near4 (tax or taxes or taxation or excise or duty-free or duty-paid or customs)) in AB)(179 records)
#17 (((youth access) near3 (restrict*)) in TI)or(((youth access*) near3 (restrict*)) in AB)(4 records)
#16 (((sale or sales or retail* or purchas*) near3 (minors or teenage* or underage* or under-age* or child*)) in TI)or(((sale or sales or retail* or purchas*) near3 (minors or teenage* or underage* or under-age* or child*)) in AB)(19 records)
#15 ((test purchas*) in AB)or((test purchas*) in TI)(5 records)
#14 (((retailer* or vendor*) near3 (prosecut* or legislat*)) in TI)or(((retailer* or vendor*) near3 (prosecut* or legislat*)) in AB)(0 records)
#13 (((smok$ or tobacco) near1 (policy or policies or program*)) in TI)or(((smok$ or tobacco) near1 (policy or policies or program*)) in AB)(34 records)

#12 (((sale or sales or sponsor*) near3 (restrict* or limit* or ban or bans or prohibit*)) in TI)or(((sale or sales or sponsor*) near3 (restrict* or limit* or ban or bans or prohibit*)) in AB)(121 records)
#11 (((smok* or anti-smok* or tobacco or cigarette*) near3 (legislat* or government* or authorit* or law or laws or bylaw* or byelaw* or bye-law* or regulation*)) in TI)or(((smok* or anti-smok* or tobacco or cigarette*) near3 (legislat* or government* or authorit* or law or laws or bylaw* or byelaw* or bye-law* or regulation*)) in AB)(78 records)
#10 ((cigarette*) in AB)or((cigarette*) in TI)(572 records)
#9 ((nicotine) in AB)or((nicotine) in TI)(22 records)
#8 ((tobacco) in AB)or((tobacco) in TI)(664 records)
#7 (((smokers or smoker)) in TI)or(((smokers or smoker)) in AB)(182 records) #6 ((smoking) in TI)or((smoking) in AB)(636 records)
#5 NICOTINE(24 records)
#4 TOBACCO-CONTROL(4 records)
#3 TOBACCO(3316 records)
#2 SMOKING-CESSATION(2 records)
#1 SMOKING(664 records)

Database of Abstracts of Reviews of Effects (DARE): Internal CRD Database (http://www.crd.york.ac.uk/crdweb/)

The DARE search was carried out on 12 July 2007, using CRD's internal search interface. The search identified 13 records.

1. S (smoking or smokers or smoker or tobacco or cigar$ or nicotine)
2. S (smok$ or anti(w)smok$ or tobacco or cigarette$) and (legislat$ or government$ or authorit$ or law or laws or bylaw$ or byelaw$ or bye(w)law$ or regulation$)
3. S (sale or sales or sponsor$)(w3)(restrict$ or limit$ or ban or bans or prohibit$)
4. S (smok$ or tobacco)(w3)(policy or policies or program$)
5. S (retailer$ or vendor$)(w3)(educat$ or surveillance or prosecut$ or legislat$)
6. S test(w)purchas$
7. S (minors or teenage$ or underage$ or under(w)age$ or child$)(w3)(sale or sales or retail$ or purchas$)
8. S youth(w)access(w)restrict$
9. S (tax or taxes or taxation or excise or duty(w)free or duty(w)paid or customs) (w3)(tobacco or cigarette$ or smok$)
10. S (cigarette$ or tobacco)(w3)(price$ or pricing or cost$)
11. S point(w)sale
12. S vending(w)machine$
13. S trade(w)(restrict$ or agreement$)
14. S contraband$ or smuggl$ or bootleg$ or (cross(w)border(w)shopping)
15. s s2 or s3 or s4 or s5 or s6 or s7 or s8 or s9 or s10 or s11 or s12 or s13 or s14
16. s s1 and s15

NHS Economic Evaluation Database (NHS EED): Internal CRD Database (http://www.crd.york.ac.uk/crdweb/)

The NHS EED search was carried out on 12 July 2007, using CRD's internal search interface. The search identified 77 records.

1. S (smoking or smokers or smoker or tobacco or cigar$ or nicotine)
2. S (smok$ or anti(w)smok$ or tobacco or cigarette$) and (legislat$ or government$ or authorit$ or law or laws or bylaw$ or byelaw$ or bye(w)law$ or regulation$)
3. S (sale or sales or sponsor$)(w3)(restrict$ or limit$ or ban or bans or prohibit$)
4. S (smok$ or tobacco)(w3)(policy or policies or program$)

5. S (retailer$ or vendor$)(w3)(educat$ or surveillance or prosecut$ or legislat$)
6. S test(w)purchas$
7. S (minors or teenage$ or underage$ or under(w)age$ or child$)(w3)(sale or sales or retail$ or purchas$)
8. S youth(w)access(w)restrict$
9. S (tax or taxes or taxation or excise or duty(w)free or duty(w)paid or customs) (w3)(tobacco or cigarette$ or smok$)
10. S (cigarette$ or tobacco)(w3)(price$ or pricing or cost$)
11. S point(w)sale
12. S vending(w)machine$
13. S trade(w)(restrict$ or agreement$)
14. S contraband$ or smuggl$ or bootleg$ or (cross(w)border(w)shopping)
15. s s2 or s3 or s4 or s5 or s6 or s7 or s8 or s9 or s10 or s11 or s12 or s13 or s14
16. s s1 and s15

Health Technology Assessment Database (HTA): Internal CRD Database (http://www.crd.york.ac.uk/crdweb/)

The HTA search was carried out on 12 July 2007, using CRD's internal search interface. The search identified 14 records.

1. S (smoking or smokers or smoker or tobacco or cigar$ or nicotine)
2. S (smok$ or anti(w)smok$ or tobacco or cigarette$) and (legislat$ or government$ or authorit$ or law or laws or bylaw$ or byelaw$ or bye(w)law$ or regulation$)
3. S (sale or sales or sponsor$)(w3)(restrict$ or limit$ or ban or bans or prohibit$)
4. S (smok$ or tobacco)(w3)(policy or policies or program$)
5. S (retailer$ or vendor$)(w3)(educat$ or surveillance or prosecut$ or legislat$)
6. S test(w)purchas$
7. S (minors or teenage$ or underage$ or under(w)age$ or child$)(w3)(sale or sales or retail$ or purchas$)
8. S youth(w)access(w)restrict$
9. S (tax or taxes or taxation or excise or duty(w)free or duty(w)paid or customs) (w3)(tobacco or cigarette$ or smok$)
10. S (cigarette$ or tobacco)(w3)(price$ or pricing or cost$)
11. S point(w)sale
12. S vending(w)machine$
13. S trade(w)(restrict$ or agreement$)
14. S contraband$ or smuggl$ or bootleg$ or (cross(w)border(w)shopping)
15. s s2 or s3 or s4 or s5 or s6 or s7 or s8 or s9 or s10 or s11 or s12 or s13 or s14
16. s s1 and s15

Science Citation Index (SCI): ISI Web of Knowledge (http://apps.isiknowledge.com/)

The SCI search covered the date range 1990 to 2007. The search was carried out on 5 July 2007 and identified 1823 records.

#14	#13 AND #1 *DocType=All document types; Language=All languages;*
#13	#12 OR #11 OR #10 OR #9 OR #8 OR #7 OR #6 OR #5 OR #4 OR #3 OR #2 *DocType=All document types; Language=All languages;*
#12	TI=((youth access) SAME restrict*) *DocType=All document types; Language=All languages;*
#11	TI=((point of sale) or (vending machine*))

	DocType=All document types; Language=All languages;
#10	TI=((trade SAME (restrict* OR agreement*)) OR (contraband* OR smuggl* OR bootleg* OR (cross-border shopping))) *DocType=All document types; Language=All languages;*
#9	TI=((cigarette* OR tobacco or smok*) SAME (price* OR pricing OR cost* or tax OR taxes OR taxation OR excise OR duty-free OR duty-paid OR customs)) *DocType=All document types; Language=All languages;*
#8	TI=((cigarette* OR tobacco) SAME (packaging OR packet* OR marketing OR marketed OR price* OR pricing OR tax OR taxes OR taxation OR excise OR duty-free OR duty-paid OR customs)) *DocType=All document types; Language=All languages;*
#7	TI=((sale OR sales OR retail* OR purchas*) SAME (minors OR teenage* OR underage* OR under-age* OR child*)) *DocType=All document types; Language=All languages;*
#6	TI=(test purchas*) *DocType=All document types; Language=All languages;*
#5	TI=((retailer* OR vendor*) SAME (prosecut* OR legislat*)) *DocType=All document types; Language=All languages;*
#4	TI=((sale OR sales OR sponsor*) SAME (restrict* OR limit* OR ban OR bans OR prohibit*)) *DocType=All document types; Language=All languages;*
#3	TI=((tobacco OR smok* OR cigarette*) SAME (policy OR policies OR program*)) *DocType=All document types; Language=All languages;*
#2	TI=((smok* OR anti-smok* OR tobacco OR cigarette*) SAME (legislat* OR government* OR authorit* OR law OR laws OR bylaw* OR byelaw* OR bye-law* OR regulation*)) *DocType=All document types; Language=All languages;*
#1	TI=(Smoking OR smokers OR smoker OR tobacco OR cigar* OR nicotine) *DocType=All document types; Language=All languages;*

Social Science Citation Index (SSCI): ISI Web of Knowledge (http://apps.isiknowledge.com/)

The SSCI search covered the date range 1990 to 2007. The search was carried out on 5 July 2007 and identified 1497 records.

#14	#13 AND #1 *DocType=All document types; Language=All languages;*
#13	#12 OR #11 OR #10 OR #9 OR #8 OR #7 OR #6 OR #5 OR #4 OR #3 OR #2 *DocType=All document types; Language=All languages;*
#12	TI=((youth access) SAME restrict*) *DocType=All document types; Language=All languages;*
#11	TI=((point of sale) or (vending machine*)) *DocType=All document types; Language=All languages;*
#10	TI=((trade SAME (restrict* OR agreement*)) OR (contraband* OR smuggl* OR bootleg* OR (cross-border shopping))) *DocType=All document types; Language=All languages;*
#9	TI=((cigarette* OR tobacco or smok*) SAME (price* OR pricing OR cost* or tax OR taxes OR taxation OR excise OR duty-free OR duty-paid OR customs)) *DocType=All document types; Language=All languages;*

#8	TI=((cigarette* OR tobacco) SAME (packaging OR packet* OR marketing OR marketed OR price* OR pricing OR tax OR taxes OR taxation OR excise OR duty-free OR duty-paid OR customs)) *DocType=All document types; Language=All languages;*
#7	TI=((sale OR sales OR retail* OR purchas*) SAME (minors OR teenage* OR underage* OR under-age* OR child*)) *DocType=All document types; Language=All languages;*
#6	TI=(test purchas*) *DocType=All document types; Language=All languages;*
#5	TI=((retailer* OR vendor*) SAME (prosecut* OR legislat*)) *DocType=All document types; Language=All languages;*
#4	TI=((sale OR sales OR sponsor*) SAME (restrict* OR limit* OR ban OR bans OR prohibit*)) *DocType=All document types; Language=All languages;*
#3	TI=((tobacco OR smok* OR cigarette*) SAME (policy OR policies OR program*)) *DocType=All document types; Language=All languages;*
#2	TI=((smok* OR anti-smok* OR tobacco OR cigarette*) SAME (legislat* OR government* OR authorit* OR law OR laws OR bylaw* OR byelaw* OR bye-law* OR regulation*)) *DocType=All document types; Language=All languages;*
#1	TI=(Smoking OR smokers OR smoker OR tobacco OR cigar* OR nicotine) *DocType=All document types; Language=All languages;*

ISI Technology & Science Proceedings (ISTP): ISI Web of Knowledge (http://apps.isiknowledge.com/)

The ISTP search covered the date range 1990 to 2007. The search was carried out on 5 July 2007 and identified 471 records.

#14	#13 AND #1 *DocType=All document types; Language=All languages;*
#13	#12 OR #11 OR #10 OR #9 OR #8 OR #7 OR #6 OR #5 OR #4 OR #3 OR #2 *DocType=All document types; Language=All languages;*
#12	TS=((youth access) SAME restrict*) *DocType=All document types; Language=All languages;*
#11	TS=((point of sale) or (vending machine*)) *DocType=All document types; Language=All languages;*
#10	TS=((trade SAME (restrict* OR agreement*)) OR (contraband* OR smuggl* OR bootleg* OR (cross-border shopping))) *DocType=All document types; Language=All languages;*
#9	TS=((cigarette* OR tobacco or smok*) SAME (price* OR pricing OR cost* or tax OR taxes OR taxation OR excise OR duty-free OR duty-paid OR customs)) *DocType=All document types; Language=All languages;*
#8	TS=((cigarette* OR tobacco) SAME (packaging OR packet* OR marketing OR marketed OR price* OR pricing OR tax OR taxes OR taxation OR excise OR duty-free OR duty-paid OR customs)) *DocType=All document types; Language=All languages;*
#7	TS=((sale OR sales OR retail* OR purchas*) SAME (minors OR teenage* OR underage* OR under-age* OR child*)) *DocType=All document types; Language=All languages;*

#6	TS=(test purchas*) *DocType=All document types; Language=All languages;*
#5	TS=((retailer* OR vendor*) SAME (prosecut* OR legislat*)) *DocType=All document types; Language=All languages;*
#4	TS=((sale OR sales OR sponsor*) SAME (restrict* OR limit* OR ban OR bans OR prohibit*)) *DocType=All document types; Language=All languages;*
#3	TS=((tobacco OR smok* OR cigarette*) SAME (policy OR policies OR program*)) *DocType=All document types; Language=All languages;*
#2	TS=((smok* OR anti-smok* OR tobacco OR cigarette*) SAME (legislat* OR government* OR authorit* OR law OR laws OR bylaw* OR byelaw* OR bye-law* OR regulation*)) *DocType=All document types; Language=All languages;*
#1	TS=(Smoking OR smokers OR smoker OR tobacco OR cigar* OR nicotine) *DocType=All document types; Language=All languages;*

Cochrane Library: Internet (http://www3.interscience.wiley.com/cgi-bin/mrwhome/106568753/HOME)

The Cochrane Library search covered the date range from inception to Issue 2 2007. The search was carried out on 12 July 2007 and identified 95 records (Cochrane Central Register of Controlled Trials 50 records, Cochrane Database of Systematic Reviews 45 records).

#1 MeSH descriptor Smoking, this term only in MeSH
#2 MeSH descriptor Smoking Cessation, this term only in MeSH
#3 MeSH descriptor Tobacco, this term only in MeSH
#4 MeSH descriptor Tobacco Use Disorder, this term only in MeSH
#5 MeSH descriptor Nicotine, this term only in MeSH
#6 smoking or smokers or smoker or tobacco or cigar* or nicotine in All Fields
#7 (#1 OR #2 OR #3 OR # OR #5 OR #6)
#8 (smok* or anti-smok* or tobacco or cigarette*) near (legislat* or government* or authorit* or law or laws or bylaw* or byelaw* or bye-law* or regulation*) in All Fields
#9 (sale or sales or sponsor*) near (restrict* or limit* or ban or bans or prohibit*) in All Fields or (smok* or tobacco) near (policy or policies or program*) in All Fields
#10 (retailer* or vendor*) near (prosecut* or legislat*) in All Fields or test near purchas* in All Fields or (sale or sales or retail* or purchas*) near (minors or teenage* or underage* or under-age* or child*) in All Fields or (youth near access) near restrict* in All Fields
#11 (tobacco or cigarette* or smok*) near (tax or taxes or taxation or excise or duty-free or duty-paid or customs) in All Fields or (cigarette* or tobacco) near (price* or pricing or cost*) in All Fields
#12 "point of sale" in All Fields or vending machine* in All Fields or trade near (restrict* or agreement*) in All Fields
#13 contraband* or smuggl* or bootleg* or (cross-border near shopping) in All Fields
#14 (#8 OR #9 OR #10 OR #11 OR #12 OR #13)
#15 (#7 AND #14)

Public Affairs Information Service (PAIS): CSA Illumina (http://www.csa1.co.uk/csaillumina/login.php)

The PAIS search covered the date range 1972 to date. The search was carried out on 13 July 2007 and identified 553 records.

(DE=(smoking or (tobacco industry)) or KW=(smoking or smokers or smoker) or KW=(tobacco or cigarette* or nicotine)) and ((contraband* or smuggl* or bootleg* or cross-border shopping) or (((smok* or anti-smok* or tobacco or cigarette*) within 3 (legislat* or government* or authorit* or law or laws or bylaw* or byelaw* or bye-law* or regulation*)) or ((sale or sales or sponsor*) within 3 (restrict* or limit* or ban or bans or prohibit*)) or ((smok* or tobacco) within 2 (policy or policies or program*))) or (((retailer* or vendor*) within 3 (prosecut* or legislat*)) or (test purchas*) or ((sale or sales or retail* or purchas*) within 3 (minors or teenage* or underage* or under-age* or child*))) or ((youth access within 3 restrict*) or ((tobacco or cigarette* or smok*) within 4 (tax or taxes or taxation or excise or duty-free or duty-paid or customs)) or ((cigarette* or tobacco) within 3 (price* or pricing or cost*))) or ((point of sale) or (vending machine*)))

Internet Documents in Economics Access Service (IDEAS): Internet (http://ideas.repec.org/)

The IDEAS search covered the date range from inception to date. The search was carried out on 13 July 2007 and identified 460 records.

(smoking or smokers or smoker or tobacco or cigarette or cigarettes or nicotine) and (sale or sales or retail or retailers or purchase or purchases or purchaser or tax or taxes or taxation or excise or duty or duty-free or duty-paid or customs or price or prices or pricing or cost or costs or vending)

Sociological Abstracts: CSA Illumina (http://www.csa1.co.uk/csaillumina/login.php)

The SocAbs search covered the date range 1972 to date. The search was carried out on 13 July 2007 and identified 216 records.

(DE=(smoking or (tobacco industry)) or KW=(smoking or smokers or smoker) or KW=(tobacco or cigarette* or nicotine)) and ((contraband* or smuggl* or bootleg* or cross-border shopping) or (((smok* or anti-smok* or tobacco or cigarette*) within 3 (legislat* or government* or authorit* or law or laws or bylaw* or byelaw* or bye-law* or regulation*)) or ((sale or sales or sponsor*) within 3 (restrict* or limit* or ban or bans or prohibit*)) or ((smok* or tobacco) within 2 (policy or policies or program*))) or (((retailer* or vendor*) within 3 (prosecut* or legislat*)) or (test purchas*) or ((sale or sales or retail* or purchas*) within 3 (minors or teenage* or underage* or under-age* or child*))) or ((youth access within 3 restrict*) or ((tobacco or cigarette* or smok*) within 4 (tax or taxes or taxation or excise or duty-free or duty-paid or customs)) or ((cigarette* or tobacco) within 3 (price* or pricing or cost*))) or ((point of sale) or (vending machine*)))

National Technical Information Service (NTIS): Internet (http://www.ntis.gov)

The NTIS search covered the date range 1964 to date. The search was carried out on 13 July 2007 and identified 4 records.

(smoking or smokers or smoker or tobacco or cigarette or cigarettes or nicotine) and (sale or sales or retail or retailers or purchase or purchases or purchaser or tax or taxes or taxation or excise or duty or duty-free or duty-paid or customs or price or prices or pricing or cost or costs or vending)

Robert Wood Johnson Foundation: Internet (http://www.rwjf.org)

The RWJF search covered the date range 1993 to date. All 194 'Journal Articles' or 'Reports and White Papers' listed on the website under the topic 'tobacco' were reviewed. As of 13 July 2007 3 potentially relevant records were identified for screening.

Appendix 3: Price elasticity of demand

We are interested in reviewing the evidence on the responsiveness of young people to changes in the price of cigarettes. The level of responsiveness determines the effectiveness of prices as a policy instrument. Responsiveness is usually expressed as an elasticity, for example, the price elasticity of the demand for cigarettes. The elasticity of demand is an economic concept that describes the percentage change in quantity demanded over the percentage change in price. Accordingly, it can be read as "a 1 percent change in price will cause a X percent change in demand."

Figures 1 and 2 show the price elasticity of demand graphically. The demand curve is downward sloping, reflecting the notion that as price increase, the consumption of the good (cigarettes) decreases. In Figure 1, consumption is responsive to price and a relatively small increase in price leads to large reductions in the quantity demanded. The slope of the demand schedule represents the price elasticity of demand. In Figure 1 demand is price elastic. By contrast, Figure 2 is relatively price inelastic; a large increase in price is required to reduce substantially the quantity demanded.

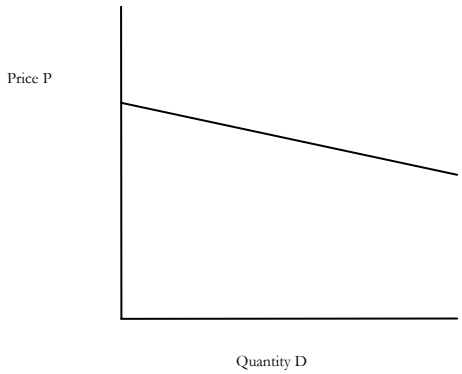

Figure 1: Elastic demand

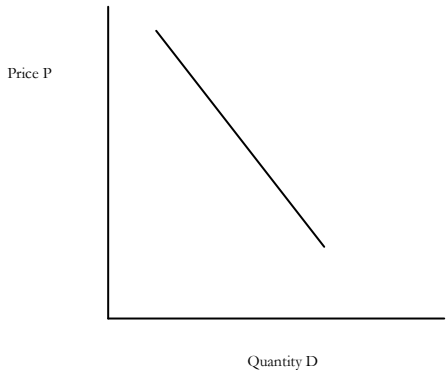

Figure 2: Inelastic demand

As evident from the demand schedules in Figures 1 and 2, the steeper the slope, the more inelastic is demand and the lower the elasticity ratio. Consumers are less responsive to price and hence price is less useful as a policy instrument. Since the demand schedule is downward sloping we expect to observe a negative elasticity ratio. A positive elasticity would imply that the demand increases with increasing prices. The greater the negative elasticity, the more effective price is in influencing demand.

For cigarette consumption, changes in taxation provides the most popular method for altering price. However, where taxation alone is used to provide variation in prices, then the corresponding elasticity estimate reflects a change in taxes, and not a change in overall cigarette price. An X% reduction in the quantity of cigarettes demanded through a 1% tax increase will not equate to the same reduction in quantity for a 1% change in price. It has been shown how a tax elasticity of demand can be converted into an approximate price

elasticity of demand.[8] If taxes are passed through to prices at a rate of α then the price elasticity of demand, η_{price} can be computed from the tax elasticity, η_{tax} as:

$$\eta_{price} = \eta_{tax} \times (\alpha t / p)^{-1}$$

where *t* is tax and *p*, price.

Calculation of price elasticity of demand

The price elasticity of demand can be represented as the proportionate change in demand for a proportionate change in price:

$$\frac{proportionate\ change\ in\ demand}{proportionate\ change\ in\ price} = \frac{\Delta y \big/ y}{\Delta x \big/ x} = \frac{\Delta y}{\Delta x} \times \frac{x}{y} = \frac{\%\Delta y}{\%\Delta x} \qquad (1)$$

Algebraically, this can be written as:

$$\frac{dy \big/ y}{dx \big/ x} = \frac{dy}{dx} \times \frac{x}{y} \qquad (2)$$

where *y* is quantity demanded and *x* is price. The expression includes the term, dy/dx, the first derivative of *y* with respect to *x*.

Linear models

The expression for the elasticity can be obtained from a linear regression of consumption, *y*, on price, *x*. For example if we believe that consumption is a linear function of price, such that:

$$y = \beta_0 + \beta x \qquad (3)$$

then, from (1) (or directly from (2)), the elasticity can be calculated as:

$$\frac{\Delta y}{\Delta x} \times \frac{x}{y} = \beta \frac{x}{\beta_0 + \beta x}$$

This expression shows that the elasticity depends on the value of price. However, a constant elasticity of demand can be computed by making use of the following approximation:

$$100 \times \Delta \log(y) \approx \%\Delta y$$

and therefore from (1):

$$\frac{\%\Delta y}{\%\Delta x} = \frac{\Delta \log y}{\Delta \log x} \qquad (4)$$

Assuming that $y, x > 0$, this can be obtained directly from the model:

$$\log y = \beta_0 + \beta \log x \quad (5)$$

as simply β. Alternatively, re-expressing (5) as: $y = \exp(\beta_0 + \beta \log x)$ then using (2) we also see that:

$$\frac{dy}{dx} \times \frac{x}{y} = \frac{\beta}{x} \exp(\beta_0 + \beta \log x) \times \frac{x}{y} = \beta \quad (6)$$

This is the elasticity reported in the majority of the demand studies reviewed.

Non-linear models

The approach to calculating elasticities can be extended to non-linear models (for example, models for smoking participation). If we define a general form for a model as:

$$y = f(\beta x)$$

then the elasticity of *y* with respect to *x* is simply:

$$\frac{df(\beta x)}{dx} \times \frac{x}{f(\beta x)} \quad (7)$$

This differs from the linear case, in that expression (7) contains $f(\beta x)$. This means that the elasticity of *y* with respect to *x* will depend on the value the function $f(\beta x)$ takes. If, as is the usual case, $f(\beta x)$ contains explanatory variable in addition to *x*, then the elasticity of *y* with respect to *x* will depend on the values of the additional regressors.

Two-part models

Some studies estimate so-called two-part models. These models separate smoking behaviour into smoking participation and, conditional on smoking, smoking intensity (level of consumption). For each of the two parts, a price elasticity can be calculated. For participation this is represented by (7) and for the level of smoking by (6). If the price elasticity of participation is η_{part}, and the price elasticity of consumption conditional on participation is η_{cons}, then the overall elasticity, η_{total} is the sum of the two estimates:

$$\eta_{total} = \eta_{part} + \eta_{cons}$$

Appendix 4: Table of excluded studies

	Primary reason for exclusion					
Author	**Not an analysis of price/tax effects**	**No results for young people (<25)**	**Not assessing cigarettes**	**Duplicate report**	**Review**	**Simulation Study**
Anonymous[77]	●					
Becker[78]		●				
Centers for Disease Control[79]	●					
Chaloupka[80]		●				
Chaloupka[81]	●					
Chaloupka[82]	●					
Chaloupka[83]			●			
Chaloupka[84]				●		
Coppejans[85]	●					
Ding[86]	●					
Douglas[61]		●				
Duffy[87]	●					
Farrelly[88]	●					
Forster[89, 90]		●				
Glied[91]	●					
Glied[92]		●				
Gruber[93]				●		
Gruber[94]				●		
Hanewinkel[95]		●				
Keeler[96]		●				
Lee[97]	●					
Liang[98]	●					
Lopez Nicolas[99]		●				
Peretti-Watel[100]		●				
Pierce[101]	●					
Pinilla[102]					●	
Ross[103]				●		
Ross[104]						●
Saloojee[105]		●				
Sung[106]		●				
Suranovic[107]	●					
Tauras[108]				●		
United States General Accounting Office[109]	●					
Waller[110]				●		

Appendix 5: Data extractions tables

Study details	Methods	Results	Conclusions
Bishai et al (2005)[53] **Objectives:** To examine the extent to which government policies influence the participation of adolescents in alcohol and tobacco consumption and unsafe sex. **Specific to young people:** Yes, youths, mean age 16 years. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross section. **Years of data:** Only data from 1995 were used. **Survey details:** The Youth Behavioral Risk Survey. **Survey unit:** School-based. **Sampling scheme:** Survey deployed by the CDC in 1995 as a nationally representative sample made public without geographical information, based on 35 states and 16 cities. This sample is not nationally representative of US teenagers, but is similar to the national data set;	**DATA DESCRIPTION** **Sample size used in models:** n=29,693 (with smoking data) n=29,454 (in probit models) **Smoking behaviour outcomes:** Ever tried smoking (yes/no); proportion of days in the last month in respondent smoked at all. Actual survey questions not reported. **Data description**: 31% ever smokers; mean proportion (SD) days smoked in previous 30: 0.17 (0.34); mean (SD) age: 16.1 (1.2); 47.6% male; 18.5% African-American. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Dichotomous variables for the participation in each risk behaviour (smoking, drinking, unsafe sex). Continuous variables for the degree of participation (proportion of days smoked) were used in multivariate modelling of all three behaviours simultaneously. **Explanatory variables:** For smoking analysis: log (tobacco tax +1); presence of state law; limiting vending machines; log age; gender; ethnicity. **Expected direction of results stated:** No. **Unit of analysis**: Individual.	**RESULTS** Coefficient (Z statistic). **Probit model** Participation elasticity -0.19 (eg 10% increase in Tax equates to a -1.9% decrease in participation) ($p<0.10$). **SEM** (fraction of days in last month smoked). Conditional elasticity 0.00 (not significant). Overall (participation and quantity) -0.19. **Sub-group results:** No. **Elasticity calculations reported**: Yes, from the probit estimates using means of the explanatory variables from the full sample. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes, for the SEM, by performing additional OLS regressions for each type of risk behaviour which provided similar results.	**Authors' conclusions**. Government policies can have a substantial impact on adolescent risk behaviour. The effects of state policies on smoking participation are similar to those published in previous studies. State legislation as cigarette and beer taxes, limitations on vending machines and increased family planning services appear to descriptively be negatively associated with youth decisions to participate in risky behaviours. **Other comments** This study aimed to jointly estimate (using a seemingly unrelated regression model (SUR)) risk behaviour amongst adolescents (smoking, drinking and unsafe sex). The authors place the emphasis on the SUR model results as this has improved statistical efficiency compared to separate models for each behaviour. From the SUR results, for those that do smoke, cigarette taxes did not have a significant deterrent effect but laws limiting vending machines have a deterrent effect. Cigarette tax result also holds when modelling the number of cigarettes consumed in the last 30 days.

also high-school dropouts were not included. **Price data based on**: State taxes. **Source of price data:** Price data was derived from the National Cancer Institute State Cancer Legislative Database and the Tobacco Tax Council. **Years of data:** Appears to be 1995. **Source of variation:** Across states.	**Type of analysis**: Cross-sectional. Participation and quantity (fraction of days smoked in last 30). **Form of model:** Probit regression (smoking only); structural equation modelling (SEM) for the joint analysis of smoking, drinking and unsafe sex with common unobserved error component some as seemingly unrelated regression (SUR); ordinary least squares regression (for comparison with the SEM results). **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By adjusting for covariates thought likely to influence smoking initiation. Also heterogeneity captured in SEM model by having a common error correlated across equations (SUR model). It was not possible to adjust for fixed unobservable state effects. **Tests of model assumptions**: Yes. Robust standard errors in the OLS models and EGLS for the SEM. Tests of heteroscedasticity were also performed.		

Study details	Methods	Results	Conclusions
Carpenter & Cook (2007)[12] **Objectives:** To assess the effects of state cigarette taxes on the consumption of cigarettes by high school teens. **Specific to young people:** Youths. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Repeated cross-sectional. **Years of data:** 1991-2005. **Survey details:** National Youth Risk Behavior Surveys (YRBS), in conjunction with the independent state and local versions of the YRBS. **Survey unit:** School-based Sampling scheme: Restricted use area-identified versions of the 1991-2005 national Youth Risk Behaviour Surveys (YRBS), in conjunction with the independent state and local versions of the YRBS are used. **Price data based on**: State taxes. **Source of price data**: State tax on a pack of cigarettes from The Tax Burden on Tobacco and the	**DATA DESCRIPTION** **Sample size used in models:** National YRBS (n=101,633) State YRBS (n=181). City YRBS (n=97). **Smoking behaviour outcomes:** Binary outcome of "During the past 30 days on how many days did you smoke cigarettes". **Data description**: For National YRBS: mean age 16.1. Sex n=49,800 (female), n=51,833 (male). Race n=13,212 (black), n=7,114 (other race), n=13,212 (hispanic). 29% past 30-day smoker, 13% past 30-day frequent smoker (smoked on at least 20 of past 30 days) For YRBS local surveys, 51% female, 19% white, 19% past 30-day smoker, 6% frequent smoker. For YRBS state surveys, 50% female, 68% white, 29% past 30-day smoker, 14% frequent smoker. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Probability that an individual has smoked in the last month (yes/no for if smoked in the last 30 days). For state and local models the proportion of sample reporting smoking.	**RESULTS** Distinction made between tax elasticity of smoking and price elasticity of smoking (*** sig at 1%, *sig at 10%). <u>Tax elasticities</u>: **Participation - Tax elasticity of national YRBS (individual) data:** **-0.106*****. Prevalence - Tax elasticity of state YRBS data: -0.0447***. Prevalence - Tax elasticity of city/local YRBS data: Not provided. <u>Price elasticities (implied from tax elasticities)</u>: **Participation - Price elasticity of national YRBS data:** **-0.56*****. Prevalence - Price elasticity of state YRBS data: -0.25***. Prevalence - Price elasticity of city/local YRBS data: -0.49*. Across all three data sources increases in state cigarette taxes significantly reduce youth smoking participation. **Other variables:** No.	**Authors' conclusions**. The results offer support for the belief that raising cigarette taxes will help discourage youths from smoking. **Other comments**

Campaign for Tobacco Free Kids. **Years of data:** 2005. **Source of variation:** Across states and time.	**Explanatory variables:** Cigarette tax, demographic characteristics, state unemployment rate and clean indoor air laws, state, survey year. **Expected direction of results stated:** No. **Unit of analysis**: Individual for National YRBS, aggregate analysis for State and City YRBS. **Type of analysis**: Pooled repeated cross-sectional. **Form of model:** For individual data (repeated cross-section YRBS samples for years 1991-2005) – Standard logistic-regression including year and state dummies. For aggregate analysis (state or local YRBS samples) – Weighted ordinary least squares on ln (Y/1-Y) with weights representing relevant sample sizes of the surveys. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. Observed characteristics listed in explanatory variables, also controlled for fixed effects by time-invariant state/area characteristics. **Tests of model assumptions**: No.	**Sub-group results:** No. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Models were estimated with, and without, state area level fixed effects to asses the impact on tax effects. Results from preferred individual level models based on YRBS samples 1991-2005 were compared to state and local sample results.	

Study details	Methods	Results	Conclusions
Cawley et al (2003)[26] **Objectives:** To examine the dual roles of body weight and tobacco control policies in predicting smoking initiation by male and female adolescents. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Longitudinal. **Years of data:** 1997 to 2000. **Survey details:** The National Longitudinal Survey of Youth. **Survey unit:** Survey of youths. **Sampling scheme:** Data from the National Longitudinal Survey of Youth, which is a nationally representative sample. **Price data based on**: Weighted average across packs. **Source of price data:** The price of cigarettes in all models comes from the Tax Burden on Tobacco (Tobacco Institute). **Years of data:** Not reported but appear to be same as smoking data	**DATA DESCRIPTION** **Sample size used in models:** Less stringent initiation sample: n=12,811 (overall); 6,426 (men); 6,385 (women). More stringent initiation sample: n=11,788 (overall); 5,906 (men); 5,882 (women). **Smoking behaviour outcomes:** Two measures of smoking initiation: "less stringent initiation" which is the transition from being a non-smoker to smoking any cigarettes; "more stringent initiation" is the transition from being a non-smoker to a frequent smoker (smoked on at least 15 days in the past 30), light smokers (more than 1 but less than 15 days) were excluded from this measure. **Data description**: 10.3% men and 8.5% women started smoking; 3.9% men and 2.5% women were heavy smokers. Mean age 16.6 years (range 12 to 21). **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** Yes. A model of smoking initiation using standard models developed by Becker (1965) and Grossman (1972) based on a utility function for adolescents being a function of smoking, health and other goods, all subject to tastes. A quasi-structural equation is used for the estimation of smoking status where status is determined by the full price of smoking, body weight, income and tastes. Two-stage least squares used to instrument body weight. **Empirical model**	**RESULTS** Price had a negative and statistically significant impact on smoking initiation for men in all models, but were not significant for women. Price elasticities were (only fully reported for men): **Less stringent initiation (any)** **[Main result: -0.912 (model including BMI); significant at 10% level]** -0.913 (including wish to lose weight or not) -0.946 (including opinion of whether under, over or normal weight) **More stringent initiation (15+ days)** **[Main result: -1.55 (model including BMI); not significant]** -1.60 (including wish to lose weight or not) -1.61 (including opinion of whether under, over or normal weight) **Sub-group results:** Yes, by gender but not all results were reported. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes, to assess the impact of living in tobacco-producing states, results not presented but stated to be similar.	**Authors' conclusions**. Cigarette price has an insignificant effect on female smoking initiation, although those with a high BMI, who report that they are trying to lose weight, and who describe themselves as overweight are more likely to initiate smoking. However, price is a strong determinator of initiation for men, but body weight or body image did not predict smoking initiation. **Other comments** The main aim of the paper was to assess the effects of body weight and image on smoking initiation, price was a subsidiary investigation.

years. **Source of variation:** Across states and time.	**Dependent variables**: Smoking initiation from non-smoker to less stringent smoker or non-smoker to more stringent smoker. Time to a transition in smoking status (using the two measures of smoking transition). Transitions between consecutive years were used providing up to 3 observations per individual. **Explanatory variables:** Price, body weight (one objective (dichotomous for if BMI is over the 85th percentile), and two subjective measures (if the participant is trying to lose weight, and 2 indicator variables for self-perceived weight), age, race, gender, educational level, marital status, youth income (both earned and obtained from parents), household size, family structure, identify with religion (yes/no), work status, dichotomous indicator for if residing in a tobacco producing state (to pick up on state sentiment). **Expected direction of results stated:** Yes, that as girls are more sensitive to their weight then tax increases may be less effective for girls than for boys. **Unit of analysis**: Individual. **Type of analysis**: Duration. **Form of model:** Discrete time duration model using a probit specification for estimating the hazard rate. In the current period, current smokers are removed from the sample as not at risk of making a transition. Smokers who quit are removed from the analysis after the first transition. Models for all data and separately for men and women. 3 separate models for each outcome including different measures of weight. **Was the model appropriate for the type of**		

	data: Yes. **Attempts to control for heterogeneity**: Yes. An indicator for residence in a tobacco producing state was included to try and account for unobserved state attitudes towards smoking. State fixed effects were assessed for inclusion, but there was not enough variation in cigarette prices to justify including these in the models. Models were also rerun excluding individuals who resided in tobacco producing states and results were unaffected. **Tests of model assumptions**: Yes. Robust standard errors to account for clustering at the individual level (Huber method).		

Study details	Methods	Results	Conclusions
Cawley et al (2006)[27] **Objectives:** To examine the role of body weight in the decisions of adolescents to initiate smoking, controlling for cigarette prices and state tobacco control policies. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Longitudinal. **Years of data:** 1988, and data for first initiation measure for 1990, 1992, 1994, 1996, 1998 and 2000. **Survey details:** The Children of the National Longitudinal Survey of Youth, 1979 cohort (CoNLSY). Children who were living in their mothers household at the time of a child assessment interview – baseline survey in 1986. **Survey unit:** Survey of children to mothers of NLYS. **Sampling scheme:** The Children of the National Longitudinal Survey of Youth, 1979 Cohort (CoNLSY) consists of the biological children of female respondents of the National Longitudinal Survey of Youth, 1979	**DATA DESCRIPTION** **Sample size used in models:** Not specified. Maximum sample for girls 4307, maximum sample for boys 5536. **Smoking behaviour outcomes:** Three measures of smoking initiation: 1. Whether the respondent has ever smoked a cigarette (initiation). 2. Whether the respondent smoked at least once a week in the 30 days prior to interview. 3. Whether the respondent has smoked 5-6 times a week in the 30 days prior to interview. **Data description**: Of the girls in the sample, 4% are clinically underweight, 17.4% at risk of overweight, 13.7% are overweight. Of the boys in the sample, 4.4% are clinically underweight, 16.7% at risk of overweight, 15.3% are overweight. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Defined above. **Explanatory variables:** Price, BMI, Index of state laws barring youth possession use and/or purchase (0-3), Index of magnitude of state-level policies on smoke-free air (0-32), natural log of family income, current grade in school, percentile score on PIAT reading test, year, mother's highest grade completed, mothers age, indicator variables for black, Hispanic, age, enrolled in	**RESULTS** **[Average price elasticity of initiation (based on boys and girls) -0.72]** If a mother is married with a spouse present, the child is significantly less likely to smoke. For girls this result holds for virtually all models and the magnitude is such that girls with married mothers are between 2 and 5 percentage points less likely to initiate. For boys this is significant only for the first, most liberal, definition of smoking initiation and in those regressions boys with married mothers are 4.5 percentage points less likely to initiate. Girls whose mothers have some kind of smoking history are more likely to initiate smoking, but for boys there is no such correlation. For girls the correlation varies depending upon definition of initiation used. The initiation of heavier smoking appears to be driven by non-price considerations. Also find no evidence that price offsets the probability that girls initiate smoking, no matter how initiation is defined. **Sub-group results:** Yes. **Initiation results** Boys price elasticity of initiation -1.2 (significant at 1%). Girls price elasticity of initiation -0.24 (not significant).	**Authors' conclusions**. .Smoking initiation (defined liberally) is less common among lighter adolescent girls, whether weight is measured by BMI, weight in pounds or an indicator variable for clinically underweight. Current weight is uncorrelated with the initiation decisions of adolescent boys. **Other comments**

Cohort (NLSY79). CoNLSY is not a nationally representative data set, but it is representative of children (aged 10-20) born to women aged 14-21 in 1979. **Price data based on**: Weighted average across packs. **Source of price data:** The Tobacco Institute's annual Tax Burden on Tobacco. **Years of data:** Not specified**.** **Source of variation:** States and time.	school, mother is married with spouse present, mother is employed, mother has smoked 100 cigarettes in lifetime, mother currently smokes. BMI, weight in pounds, clinical weight classification. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Panel. **Form of model:** Linear probability regression based on simple latent variable model. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: No. **Tests of model assumptions**: Yes. Hausman tests indicate that it is not possible to reject the hypothesis that weight is exogenous, indicating that linear probability models are preferable to IV models. Non-IV models were estimated using probit instead of linear probability regression – results were similar.	**Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** No.	

Study details	Methods	Results	Conclusions
Chaloupka (1991)[28] **Objectives:** To test the predictions of the Becker-Murphy model using micro data and to estimate the price elasticity of demand for cigarettes based on individual data. (Aim of paper was to test the rational addiction model, rather than assess the effects of price on young people). **Specific to young people:** No. Separate models for ages 17 to 24. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Repeated cross-section. **Years of data:** 1976 to 1980. **Survey details**: The Second National Health and Nutrition Examination Survey (NHANES2) conducted by the National Center for Health Services Research. **Survey unit**: Individual. **Sampling scheme:** A national survey of 28,000 people aged 6	**DATA DESCRIPTION** **Sample size used in models:** Ages 17 to 24 (n=2,575). **Smoking behaviour outcomes:** Actual survey questions not reported. Data were collected on current cigarette consumption, lagged consumption, and consumption at the time of maximum smoking, number of years before interview when started smoking, and number of years not smoked (for former smokers). **Data description:** Not reported. **Cross-border issues accounted for:** Yes. By constructing a price measure based on a weighted average between own state price and that in a state with a lower price within 25 miles. Sensitivity analysis performed on different price variables. **MODELLING** **Evidence of theoretical model:** Yes. Analysis was based on the Becker-Murphy model of rational addiction. Tastes are constant and individuals are assumed to be fully rational (aware of and account for the interdependence of past, current and future consumption when making current consumption decisions). **Empirical model** **Dependent variables**: Average number of cigarettes smoked per day. **Explanatory variables:** Age, age-squared, sex, race, real family income, marital status, labour force status, educational attainment (all models). Past (one year lag), current, and future (one year lead) cigarette prices and consumption (depending on the model). **Expected direction of results stated:** Yes. Current	**RESULTS** Range of long run price elasticities from 4 models assuming depreciation rates of 100%, 80%, 60% and no assumed rate. Full sample results presented – smokers and non-smokers. **Ages 17 to 24 Total demand: [-0.06]** Result based on restricted analysis (restriction to do with depreciation rates) and with an 80% depreciation rate. The results depend upon how great a discount is placed on future prices – that is how rational young people behave. **Sub-group results:** No. **Elasticity calculations reported**: Yes. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Models were estimated using alternative measures of price which only produced minor differences in results (results not reported). Restricted estimates of model coefficients did not alter the results which suggested that the restrictions were appropriate.	**Authors' conclusions** The Becker-Murphy hypothesis that more present oriented individuals will be more affected by the market price of addictive goods than more future oriented individuals, was not supported by the estimates for the three age groups. Young adults (17 to 24) and the elderly (65 to 73) were insensitive to price changes whereas those aged 25 to 64 showed a significant long run response to price changes. **Other comments**

months to 74 years conducted from 1976-1980. **Price data based on**: Weighted average across packs. **Source of price data:** Tobacco Institute annual reports. Weighted average statewide price for pack of 20 cigarettes based on the price of single packs, cartons and vending machine sales, inclusive of state sales taxes. **Years of data:** Not reported. **Source of variation:** State level and time.	consumption was predicted to be negatively related to current prices but positively related to both past and future prices. Individuals with fewer years of formal education or who were younger were expected to behave more myopically. **Unit of analysis**: Individual. **Type of analysis**: Cross-sectional. **Form of model**: Following Becker's methods a quadratic utility function in three arguments was assumed. Two demand equations for current consumption were estimated: one included past and current price and consumption and current price (as consumption for only two consecutive periods was available in the data then previous consumption was estimated); the other included current price and future price and consumption. Three separate sets of models by age group: 17 to 24, 25 to 64, and 65 to 73 for the full sample (non-smokers, current and former smokers). Additional restricted models were run to try and account for collinearity between prices and past and future consumption by imposing restrictions on model coefficients for future price and consumption. Models were estimated using two-stage least squares methods. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By adjusting for some demographic covariates. **Tests of model assumptions**: No.		

Study details	Methods	Results	Conclusions
Chaloupka & Grossman (1996)[29] **Objectives:** To assess the effectiveness of several tobacco control policies in discouraging cigarette smoking amongst young people. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Repeated cross-sectional. **Years of data:** 1992, 1993, 1994. **Survey details:** The Monitoring the Future project. **Survey unit:** School-based. **Sampling scheme:** A nationally representative survey but population coverage was not reported. **Price data based on**: Average across packs. **Source of price data:** The Tax Burden on Tobacco (Tobacco	**DATA DESCRIPTION** **Sample size used in models:** n=110,716 (full sample) n=75,090 (restricted sample accounting for cross-border issues). **Smoking behaviour outcomes:** Binary measure of smoking participation for any cigarette smoking in previous 30 days. A proxy continuous measure of daily consumption based on the midpoints of categorical responses. Average consumption is reported in 7 categories. **Data description:** Mean age (SD) 16.1 (1.82), 48% male; 12% black; 23% smokers with mean (SD) daily consumption 0.74 (1.44) cigarettes. **Cross-border issues accounted for:** Yes. By repeating models excluding people living within 25 miles of a state with lower prices. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Smoking participation (yes/no); log of continuous average daily consumption based on midpoint of the categories reported. **Explanatory variables:** Price; state/county/city level restrictions on smoking in public places/work sites (five variables for fraction of population subject to restrictions in private workplaces, restaurants, retail stores, schools, or any other place); restrictions on availability to youths (state minimum purchase age, signs displaying minimum purchase age, fraction of population subject to restrictions on vending machine sales, limits on free sample distribution, licensing for	**RESULTS** Cigarette price had a negative statistically significant effect on both smoking participation and demand in all models. Price elasticities (methods of calculation were not reported) from the two-part model. Authors claim price only model provides an upper limit on the elasticity. Full model result is a lower limit. All respective results associated with the price elasticities were significant at 5% level: **Full sample** Price only model (excluding other tobacco control policies) -0.799 (participation) -0.651 (consumption) -1.450 (total) Full model including other policies -0.376 (participation) ($p<0.05$) -0.470 (consumption) ($p<0.05$) -0.846 (total demanded) ($p<0.05$) Average across price only model and model including all policy variables: **[-0.561]** **[Total demand: -1.148]** **Restricted sample –** Removes individuals who live in counties within 25 miles of a state with a lower cigarette price to control for cross-border shopping. Price only model (excluding other tobacco control policies) -0.923 (participation) -0.779 (consumption) -1.702 (total)	**Authors' conclusions** Tobacco control policies, including higher excise taxes, can be effective in reducing cigarette smoking amongst youths. The average price elasticity of demand of -1.313 indicates that large increases in taxes, through price rises would lead to sharp reductions in youth smoking. **Other comments** The authors state that the results from the model containing all tobacco control policies is likely to be affected by multicollinearity and may be interpreted as a lower bound for the true price elasticity of youth smoking. Estimated price elasticities from the restricted sample were higher than those using all data.

Institute annual report) state level average price of pack of 20 cigarettes, based on the price of single packs, cartons and vending machine sales and includes generic cigarettes. **Years of data:** 1992 to 1994. **Source of variation:** Across states and time.	tobacco vendors); age; average weekly income; year of survey; school grade; race (black, other); parental education; family structure; mother's work status; siblings; average number of hours worked weekly; living in rural area; participation in religious services. Additional binary variables if a state earmarks a portion of cigarette excise taxes for tobacco control activities, and if a state has smoking protection legislation. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Pooled repeated cross-section. **Form of model**: Two-part model using probit estimation for smoking participation and ordinary least squares for consumption by smokers. Multiple models were used: adjusting for all explanatory variables plus each of 12 tobacco control policies individually; and including all 12 policies together in the same model. All models were repeated on the restricted sample. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By adjusting for covariates and other tobacco control policies to control for observable heterogeneity. **Tests of model assumptions**: No.	Full model including other policies -0.602 (participation) -0.652 (consumption) -1.254 (total) The overall estimate of elasticity was -1.313 (average of the 4 total elasticities). Also gives averages for participation: -0.675; consumption: -0.638. **Tobacco restrictions** Strong restrictions on smoking in private workplaces, restaurants or retails stores had a negative and statistically significant impact on the probability of youth smoking when assessed individually. When they were all included in one model, only smoking restrictions in workplaces remained statistically significant although these restrictions did not affect daily consumption. Restrictions on the availability to youths had little impact on youth smoking. Whether a state earmarks a portion of tobacco taxes for other tobacco control policies had a negative and significant effect on smoking outcomes, but as this is correlated with cigarette prices it may also be capturing the effects of tax increases. **Sub-group results:** No **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Multiple models assessing other tobacco control policies. Restricted sample excluding those within 25 miles of a state with a lower cigarette price.	

Study details	Methods	Results	Conclusions
Chaloupka & Pacula (1999)[30] **Objectives:** To determine if there are differences in young peoples responsiveness to price and tobacco control policies, and if these differences can explain sex and racial differences in smoking prevalence trends. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Repeated cross-sectional. **Years of data:** 1992 to 1994. **Survey details**: The Monitoring the Future Survey conducted by the Institute for Social Research, University of Michigan. **Survey unit**: School-based. **Sampling scheme:** Nationally representative survey of 17,000 high-school students (8th, 10th and 12th grade, ages 13 to 18). **Price data based on**: Average	**DATA DESCRIPTION** **Sample size used in models:** n=53,209 (male) n=57,508 (female) n=74,745 (white) n=12,897 (black) **Smoking behaviour outcomes:** Binary outcome of whether smoked any cigarettes in previous 30 days. **Data description:** % currently smoking: 23.1% (male), 22.7% (female), 25.6% (white), 8.0% (black). **Cross-border issues accounted for:** Yes. By including a binary variable capturing potential cross-border shopping (0 if live in states with lower prices than neighbours or if live in counties more than 25 miles from another state, 1 otherwise). **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Smoking prevalence (yes/no for if smoked in previous 30 days). **Explanatory variables:** Price; state tobacco control policies (setting aside tax revenues for anti-tobacco activities, having smoker protection legislation); clean indoor air restrictions (index of five factors representing restrictions in work sites, restaurants, shops, schools, other public places); youth access restrictions (index of five factors representing minimum purchase age of 18, point-of-sale signage, vending machine and free sample restrictions, vendors need a license to sell tobacco); gender; race (white/black/other); age; average weekly income; school grade; marital status; parental education; family structure; siblings; hours worked per week; place of residence (rural, urban);	**RESULTS** **[Participation - average elasticity (men and women) – 0.765.]** **Tobacco control policies** Using tax revenue to promote anti-tobacco activities had a statistically significant negative effect on young white men and women. Smoker protection laws had a statistically significant positive effect for young black men only. Clean indoor air laws had a statistically significant negative effect on young white men only. Stricter youth access laws significantly decreased (at the 10% significance level) smoking prevalence amongst young black people. **Sub-group results:** Yes, all results were by race and gender. Participation elasticities (average of all models) [*** p<0.01, **p<0.05, *p<0.10, all 2-sided] **Men** -0.93*** (all) -0.86*** (white) -1.65*** (black) **Women** -0.60** (all) -0.45** (white) -0.45 (black) **White** -0.64***(all) **Black** -1.11* (all)	**Authors' conclusions** Different youths respond differently to changes in price and public policies. Significant differences exist by sex and race. Young men are more responsive to price changes than young women. Smoking rates amongst young black men are more responsive to price changes than young white men. Smoking rates among young whites are more responsive than amongst young blacks to anti-tobacco activities and clean indoor air restrictions. However, smoker protection laws and youth access restrictions influence young blacks but not whites. **Reviewers' comments** The authors note that this analysis only measures the existence of other tobacco control policies and not their enforcement. The elasticities were used to predict changes in prevalence from 1981 to 1990 which were smaller than the actual changes. The poor performance of the models in predicting shifts in prevalence may be linked to large increases in industry advertising in this period.

across packs. **Source of price data:** Average state price for pack of 20 cigarettes from 'The Tax Burden on Tobacco' (Tobacco Institute) based on the weighted average of the price of single packs, cartons and vending machine sales, including state level excise taxes and the price of generics. **Years of data:** 1992 to 1994. **Source of variation:** Across states and time.	participation in religious services; year (to account for differences in smoking rates across time). **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Pooled repeated cross-sectional. **Form of model**: Probit regression models estimated using maximum likelihood. Separate models for each of 8 race and gender combinations with 5 estimations of each, one including price and 4 including price and each individual other tobacco policy. Collinearity prevents other tobacco control policies being modelled simultaneously. Price elasticities were calculated as the average across all 5 estimates. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By adjusting for demographic covariates and presence of other tobacco control policies. **Tests of model assumptions**: Yes. Standard errors were adjusted for clustering within a state.	**Elasticity calculations reported**: No **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Models were estimated including other tobacco control policies individually. Including these policies had little impact on the price coefficients.	

Study details	Methods	Results	Conclusions
Chaloupka & Wechsler (1995)[31] **Objectives:** To examine the effectiveness of several tobacco control policies in discouraging cigarette smoking among young adults. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Repeated cross section. **Years of data:** 1993. **Survey details**: The Harvard College Alcohol Study. **Survey unit**: General college or university. **Sampling scheme:** Survey focussed on binge drinking in colleges. It was a nationally representative survey of students from 140, 4 year colleges and universities. **Price data based on**: Typical price. **Source of price data:** Inter-city	**DATA DESCRIPTION** **Sample size used in models:** n=16,277 (full sample) n=6,972 (male) n=9,305 (female) **Smoking behaviour outcomes:** Smoking participation (yes/no for smoking cigarettes in previous 30 days); average daily consumption (none, <1, 1 or more but < ½ pack, ½ pack, more than ½ pack but < 1 pack, more than 1 pack). These survey questions were used to create additional outcomes: level of consumption with light (up to 9 per day), moderate (10 to 19), heavy smokers (one or more packs per day). Also a proxy continuous measure of amount smoked (0, 0.5, 5, 10, 15, 20 and 50 based on categorical responses). **Data description:** Mean (SD) age 21.2 (2.4); 42.8% male, 22.3% smoked, mean average daily consumption by smokers 7.6 (7.98). **Cross-border issues accounted for:** Yes. By re-estimating models with a restricted sample (n=13,611) which excluded students attending college within 20 miles of a state with lower excise taxes. **MODELLING** **Evidence of theoretical model:** No **Empirical model** **Dependent variables**: Daily consumption (ordered categorical); smoking participation and average daily consumption by smokers. **Explanatory variables:** Price, smoking restrictions, minimum purchase age, vending machine restrictions, free sample restrictions, tobacco licensing laws, age, gender, race, marital status, income (using proxy measures), importance of religion, parental education, type of college/university. State or local tobacco control policies to reflect restrictions on smoking in public	**RESULTS** Elasticities from 2-part model Average across the three model results for the full sample: **[-0.617]** **Participation** Full sample / Restricted sample Model 1: -0.616** / -0.698** Model 2: -0.610** / -0.700** Model 3: -0.626** / -0.735** **Conditional demand** Full sample / Restricted sample Model 1: -0.860** / -0.687* Model 2: -0.833** / -0.666* Model 3: -0.847** / -0.703* **Overall elasticity of demand (derived)** Full sample / Restricted sample Model 1: -1.476 / -1.385 Model 2: -1.443 / -1.367 Model 3: -1.473 / -1.437 **Sub-group results:** Yes, by gender Men Participation: -0.446* Conditional demand: -1.186** Overall: -1.632 Women Participation: -0.682** Conditional demand: -0.566* Overall: -1.248	**Authors' conclusions** These estimates indicate that college students are quite sensitive to the price of cigarettes, with an average estimated participation elasticity of -0.66, and an overall average price elasticity of -1.43. Relatively stringent restrictions on smoking in public places are found to reduce participation rates, whereas the quantity smoked by smokers is lowered by any restrictions on public smoking. Limits on tobacco availability to underage youths have no impact on college students. **Other comments**

Cost of Living Index (quarterly report of the American Chamber of Commerce Researchers Association). **Years of data:** 1992 (fourth quarter), 1993 (first quarter), used separately and as an average. Only results using 1992 data are presented as there was little difference between the results. **Source of variation:** Across cities (sub-state level).	places, regulations limiting availability of tobacco products to youth. Five for restrictions: 1. State/local limits on smoking in workplace. 2. State/local limits on smoking in restaurants. 3. State/local limits on smoking in retail stores. 4. State/local limits on smoking in schools. 5. State/local limits on smoking in other public places. Four for regulations: 1. State level minimum legal purchase age. 2. Prohibition of free samples to youths. 3. Tobacco retailers to hold licenses. 4. Limits on vending machine sales. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Cross-sectional. **Form of model**: Ordered probit (for consumption measured as a categorical variable). 2-part model (probit estimation for participation and ordinary least squares modelling the log of consumption). Model 1 had demographic variables plus price, model 2 also included indicators for restrictions on smoking in public places and private worksites, model 3 also included measures of state and local policies limiting tobacco product availability to youths. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By adjusting for observed covariates using two additional models which controlled for policies limiting youth tobacco availability. **Tests of model assumptions**: No.	**Elasticity calculations reported**: No **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Different models adjusting for other tobacco control policies, price results were similar across models. The results for analyses on the restricted sample accounting for cross-border issues were also similar to the full sample results.	

Study details	Methods	Results	Conclusions
Czart (2001)[55] **Objectives:** To estimate the demand for cigarettes as a function of price, smoking regulation policies, and an array of sociodemographic variables. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-sectional. **Years of data:** 1997. **Survey details**: The Harvard School of Public Health College Alcohol Study. **Survey unit**: General college or university. **Sampling scheme:** Nationally representative survey in 1997 of 15,699 students from 130 randomly selected 4-year colleges and universities (a resurvey of 93% of colleges from the original 1993 survey of 140 4-year colleges and universities).	**DATA DESCRIPTION** **Sample size used in models:** n=15,148 (with smoking data). **Smoking behaviour outcomes:** Answers to 'how many cigarettes a day do you smoke on average': none, <1, < ½ pack, about ½ pack, > ½ pack but <1, 1 pack, >1 pack. Used to create binary outcome of smoked any cigarettes in previous 30 days. Daily consumption measured in 2 ways: ordered categorical of non-smokers, light (<1), moderate (½ pack), heavy (>½ pack); also proxy continuous measure using the mid-points of the categories (0, 0.5, 5, 10, 15, 20 and 30). **Data description:** Mean (SD) age 21.0 (2.2); 40% male; 5.9% black; 7.5% Asian; 9.2% Hispanic; 24.3% current smokers with mean (SD) number smoked per day 1.9 (5.0) overall, and 8 for the smokers. **Cross-border issues accounted for:** No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Smoking participation (if smoked in previous 30 days); daily consumption demand (as a categorical variable and using log of the continuous measure). **Explanatory variables:** Price; age; gender; race; ethnicity (Hispanic or not); marital status; religious status; parental education; sorority membership; on-campus living; student employment and income; type and region of college; campus tobacco policy (prohibited areas, campus cigarette availability on campus, campus advertising); local-level (city or county) restrictions (workplaces; restaurants, retail,	**RESULTS** **[Price elasticities not reported in results section.]** Three models are considered: In Model A local clean indoor air laws are included; In Model B state clean indoor air laws are included; In Model C local and state clean indoor air policies are represented as a single index. The model coefficients (SE) from models including clean air laws but excluding college smoking policies are as follows. **Frequency of consumption** Model A: -0.00128 (0.00053)** Model B: -0.00119 (0.00062)* Model C: -0.00110 (0.00054)** **Current participation** Model A: 0.99827 (0.00119)* Model B: 0.99831 (0.00139) Model C: 0.99849 (0.00120) **Consumption (demand) by smokers** Model A: -0.003165 (0.00123)** Model B: -0.00271 (0.00151)* Model C: -0.00265 (0.00121)** [* = p<0.1, ** = p<0.05, ***= p<0.01 (all 2-sided)] Clean air restrictions did not have any effect on student smoking behaviour and none of the individual local or state tobacco control policies significantly influences the level of smoking or smoking participation. However, when these restrictions were represented using a single index for the number of restrictions present, the amount and frequency of cigarettes smoked were both statistically significantly negatively affected by stronger restrictions,	**Authors' conclusions** These results provide evidence to support the argument that higher cigarette prices discourage smoking participation and the level of smoking amongst young adults. **Other comments** Price elasticities were not reported in the results section but the discussion states that the average elasiticities were -0.26 for participation and -0.62 for the amount smoked by smokers.

Price data based on: Average across packs. **Source of price data:** Average state price for branded pack of 20 from 'The Tax Burden on Tobacco' (Tobacco Institute). **Years of data:** 1997. **Source of variation:** Across states.	other public places) as individual binary variables and as an overall index; presence of clean-indoor air laws. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Cross-sectional. **Form of model**: Ordered probit regression models of daily consumption (categorical; measure). Two-part models with participation estimated using a logistic specification, and ordinary least squares estimation for consumption (continuous measure). Models were run including and excluding other tobacco control policies. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By adjusting for demographic covariates and presence of other tobacco control policies. **Tests of model assumptions**: Yes. Standard errors adjusted for clustering at the college and state level.	suggesting that it is the combination of these policies that most significantly influences full-time college students. It was not possible to draw strong conclusions as the effects of college-level smoking restrictions were mixed. **Sub-group results:** No. **Elasticity calculations reported**: Elasticities were not calculated. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Models were with and without state and college-level tobacco policies. Including college-level restrictions affected the price estimates, increasing their size and significance suggesting that excluding these variables leads to omitted variable bias.	

Study details and data sources	Methods	Results	Conclusions
DeCicca et al (2002)[8] **Objectives:** To examine the impact of taxes on the onset of youth smoking, and to explore the relationship between schooling and smoking. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Longitudinal. **Years of data:** 1988 with repeat interviews in 1990 and 1992. **Survey details:** The National Education Longitudinal Survey. **Survey unit:** School-based. **Sampling scheme:** Data on cigarette smoking by American 8th graders in 1988, with follow-up surveys 2 and 4 years later. **Price data based on**: State taxes. **Source of price data:** State excise tax data from the 'Tax Burden on Tobacco' historical complication (1999). Taxes were converted using the consumer price index for the hazard modelling.	**DATA DESCRIPTION** **Sample size used in models:** n=13,316 (cross-sectional model 8th grade) n=13,132 (cross-sectional model 10th grade) n=12,889 (cross-sectional model 12th grade) n=12,089 (onset model complete cases) n=13,989 (onset model imputed data) n=33,392 (hazard models). **Smoking behaviour outcomes:** 'How many cigarettes do you smoke in a day?' with categorical responses: none, 1 to 5, 6 to 10, 11 to 40, >40. **Data description**: 8th to 12th grade students aged 13 to 18. % non-smokers: 94.8% (8th grade), 82.6% (10th grade), 76.4% (12th grade), 21.1% of 8th grade non-smokers were smoking at 12th grade. **Cross-border issues accounted for**: No. They state that cross-border purchase are less of a problem for young people and can be ignored in estimating youth demand. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Cross-sectional models: ordered categorical variable for the amount smoked per day (categories as previous). Onset models: ordered categorical variables for the onset of smoking between 8th and 10th grades, and 8th and 12th grades; binary variable	**RESULTS** **[Average -1.35]** **Cross-sectional models:** Tax effects were significant in all models. Elasticities (for $0.20 tax increase): 8th grade: -2.03 10th grade: -1.31 12th grade: -0.72 **Onset models:** Tax effects were not statistically significant. Model coefficients (t statistics): Change in tax: -0.0021 (-1.07) 8th grade tax: -0.0012 (-0.54) Model of heavy smoking: Change in tax: 0.0036 (0.95) 8th grade tax: -0.0005(-0.17) Note elasticity estimates for onset of smoking between 8th and 10th grade is reported as -0.9 and between 8th and 12th grade -0.46. However, these results are not used as they are cited as not the authors' preferred results – preferred results not given as elasticity estimates. **Hazard models:** Model coefficients (t statistics). Without state fixed effects: Tax: -0.0038 (-3.49) (no tax/grade	**Authors' conclusions** The authors concluded that cigarette taxes and smoking onset between 8th and 12th grades are not strongly related. Treating the data as three separate cross-sections produced results for the effect of cigarette tax increases on youth smoking that are comparable to previous studies. The inclusion of state fixed effects has a large impact on the estimated relationship between taxes and the 8th grade hazard rate but these results must be treated with caution as only three different time periods are used. **Other comments** This analysis only considered smaller tax rises and the authors' state that using the results to predict the effects of larger tax rises could be problematic. Elasticities are only presented for the cross-sectional models but these are not well-specified models as they used tax data at grade 12, they also cannot control for heterogeneity. The hazard models are presented as the best specification, without controlling for heterogeneity across states there is a significant negative effect on the hazard of starting smoking, but with state fixed effects this is a positive, non-significant relationship.

Years of data: 1988, 1990 and 1992 using the tax rate in effect in the month preceding the survey interview date. **Source of variation:** Across states.	for the onset of heavy smoking (>1/2 pack/day). Hazard models: the hazard of starting smoking (between 8th and 12th grades). **Explanatory variables:** State cigarette tax (cents); change in tax from 1988 to 92 (onset models only); youth smoking restrictions; restrictions in public places; legislation banning discrimination amongst smokers; race; gender; rural residence; region; family size; religion; academic achievement; parental education and occupation; family income; parental marital status, variable indicating if high school drop-out. Hazard models also included dummy variables for school grade and interactions between tax and grade. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Cross-sectional. **Form of model**: Ordered probit regression models (for cross-sectional and onset analyses); discrete-time hazard models. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By adjusting for covariates. State fixed-effects were used in duration modelling to control for unobserved state anti-smoking sentiment. **Tests of model assumptions**: Yes. Robust estimation techniques used to account for clustering of error terms within states.	interaction) Tax: -0.0069 (-1.88) (with tax/grade interaction) With state fixed effects: Tax: 0.002 (0.63) (no tax/grade interaction) Tax: -0.0029 (-0.67) (with tax/grade interaction) **Sub-group results**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Additional models replacing missing data using conditional mean imputation which confirmed the main results. Hazard models were ran with and without state fixed effects which led to different conclusions as the effects of taxes were only significant in the model without state fixed-effects.	However there were only 3 waves of data so only limited variation in prices.

Study details	Methods	Results	Conclusions
DeCicca et al (2000)[54] **Objectives:** To examine how the determinants of the onset of smoking vary by race and ethnicity, focussing on prices, peer influences, academic success and other factors. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey (schools). **Type of data:** Longitudinal. **Years of data:** 1988 (and 1990 and 1992). **Survey details:** 1988 National Education Longitudinal Study of 1988 (NELS:88). **Survey unit:** School-based. **Sampling scheme:** Data on cigarette smoking by American 8th graders in 1988, with follow-up surveys 2 and 4 years later. **Price data based on**: Not stated. **Source of price data:** The Tobacco Institute price for 1988, 1990 and 1992 merged for 1993.	**DATA DESCRIPTION** **Sample size used in models:** 23,442 for whites model 3,297 for Hispanics model. 2,671 for African-Americans model. **Smoking behaviour outcomes:** How many cigarettes do you currently smoke in a day (0, 1-5, 6-10, 11-40, 40+). **Data description**: 8,546 white students, 1,180 Hispanic students and 912 African-American students. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Probability of starting to smoke (responses other than 0 in the above question are coded as a smoking participant). **Explanatory variables:** Price, state of residence, academic success, family income, parents occupation, intact family, residence (urban/suburban), religion, individuals in family, peer influences. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Duration analysis. **Form of model:** Model 1 is a **d**iscrete time hazard model with state fixed effects. Model 2 omits state fixed-effects or other controls for	**RESULTS** Baseline hazard rate of starting to smoke for: whites was 0.165, Hispanics was 0.173 and African-Americans was 0.078. Average hazard for: whites was 0.115, Hispanics was 0.094 and African-Americans was 0.035. Results suggest that higher cigarette prices do not reduce the hazard rate of starting to smoke amongst white youth. For Hispanic students a 20% increase in the price reduces the hazard rate from 17.3% to 13.2%. The youth's state of residence is one of the most powerful determinants of the hazard of starting to smoke. Overall academic success is strongly associated with lower smoking onset for white youth but less so for African-Americans and Hispanics. In general, measured aspects of family background are more important predictors of the hazard rate for white youth than for Hispanic and African-American youth. Exogenous peer influences are important determinants of youth smoking behaviour and suggest some racial and ethic differences in the roles of these determinants. **Sub-group results:** No.	**Authors' conclusions**. The association between academic success and smoking rates varies by race. White youth who are more successful academically have significantly lower rates of smoking compared with other whites. This relationship is not as strong for Hispanics and African-Americans. Evidence from the data suggests that increases in taxes will be largely ineffective in reducing smoking onset for the majority of students in the sample. Controlling for state fixed effects there is no evidence that higher cigarette prices deter youth smoking onset for whites. The results for Hispanics and African-Americans provide some support that higher taxes will reduce smoking in these populations. **Other comments**

Years of data: 1992. **Source of variation:** Across states and time.	state-level influences. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes, through explanatory variables and state fixed-effects. **Tests of model assumptions**: No.	**Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Controlling for state fixed effects.	

Study details and data sources	Methods	Results	Conclusions
DeCicca et al (2006)[32] **Objectives:** To explore in greater depth the role of state anti-smoking sentiment and their impact on price responsiveness of demand, in empirical models of youth and young adult smoking. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Longitudinal. **Years of data:** 1992 and 2000 were used in the models of youth smoking. **Survey details:** The National Education Longitudinal Survey (NELS). **Survey unit:** School-based. **Sampling scheme:** Data on cigarette smoking by American 8th graders in 1988, with follow-up surveys 2, 4, 6 and 12 years later.. **Price data based on**: Weighted average across packs. **Source of price data:** The 'Tax Burden on Tobacco' historical complication (2002). Average price per	**DATA DESCRIPTION** **Sample size used in models:** n=16,730 (1992 data) n=11,490 (2000 data) **Smoking behaviour outcomes:** Participation (smoker or non-smoker). The survey asked 'How many cigarettes do you currently smoke in a day?' with categorical responses: none, 1 to 5, 6 to 10, 11 to 40, >40. For analyses of conditional demand these were assigned values of 0, 2.2, 7.5, 25 and 45 respectively. **Data description**: 1992 data: 18.8% smokers with mean (SD) amount smoked 12.4 cigarettes (11.3). 2000 data: 23.3% smokers with mean (SD) amount smoked 13.2 cigarettes (9.6). **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Smoking participation; number of cigarettes smoked per day by smokers. **Explanatory variables:** Price, gender, age, race/ethnicity, region of residence, an index of state laws restricting youth access to tobacco products, a measure of state anti-smoking sentiments (developed in another section of the paper using factor analysis of data from the Tobacco Use Supplements of the Current Population Survey). 1992 model also included an index of state laws restricting youth access which scores the	**RESULTS** Estimated price elasticities (significance levels where *p<0.1, **p<0.05, ***p<0.01) **1992 data:** **Participation** -0.763***(model excluding state anti-smoking sentiment) **[0.082 (model including state anti-smoking sentiment)(p=ns)]** **Amount smoked** -0.302 (model excluding state anti-smoking sentiment) **[0.022 (model including state anti-smoking sentiment)(p=ns)]** **Overall price elasticity** -1.065*** (model excluding state anti-smoking sentiment) **[0.014 (model including state anti-smoking sentiment)]** **2000 data:** **Participation** -0.586***(model excluding state anti-smoking sentiment) -0.111 (model including state anti-smoking sentiment) **Amount smoked** -0.658*** (model excluding state anti-smoking sentiment) 0.518*** (model including state anti-smoking	**Authors' conclusions** The empirical results from cross-sectional models show two consistent patterns: after controlling for state anti-smoking sentiment cigarette price has a weak non-significant effect on smoking participation; and that state anti-smoking sentiment may be an important influence on youth smoking participation. These results are supported by hazard models of smoking initiation where models including state fixed effects showed the same pattern. **Other comments** .

pack of 20 cigarettes (inclusive of state and federal taxes) in November of each year, weighted by market share. The average price is used exclusive of generic brands. **Years of data:** Appears to be 1993. **Source of variation:** Across states.	strictness of 9 dimensions: minimum purchase age; packaging; clerk intervention; photo identification; vending machine restrictions; free distribution; graduated penalties; random inspections and statewide enforcement. The 2000 model did not include this index as it measures laws specific to younger teens. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Cross-sectional. **Form of model**: Two-part model. A probit model of smoking participation and an ordinary least squares regression of amount smoked by smokers. Separate models for each year (1992 and 2000) and also with (the preferred specification) and without variables representing state anti-smoking sentiment. Additional hazard models of duration to smoking initiation were a sensitivity analysis. Hazard models used pooled data from 1988, 1990, 1992 and 2000 (37,937 person-years). **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By adjusting for covariates and also estimating models with and without a variable representing state anti-smoking sentiment. The authors discussed the impact of unobserved heterogeneity on their findings and concluded that this meant the estimated price coefficients are biased in a negative direction. **Tests of model assumptions**: Yes. Use of robust standard errors to adjust for clustering of error terms within states.	sentiment) **Overall price elasticity** -1.244*** (model excluding state anti-smoking sentiment) -0.629*** (model including state anti-smoking sentiment) **Time to smoking initiation:** Model coefficient (significance level) -0.0015***(without state fixed effects) -0.0005 (with state fixed effects) **Sub-group results**: No. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Assessment of multicollinearity between prices, youth access restrictions and state anti-smoking sentiments. Results were robust to excluding youth access laws from the model. An alternative measure of state anti-smoking sentiment based only on people living in never-smoking households was also used to assess possible feedback between state-level prices and anti-smoking sentiment but price results remained unchanged. Further alternative models were conducted to control for state anti-smoking sentiment using the 2000 data and different singe variables and indices representing smoking bans.	

Study details	Methods	Results	Conclusions
Diener et al (2007)[19] **Objectives:** To examine the effect of retailer compliance on youth smoking behaviour by examining the effect of retailer compliance and cigarette prices on how youth obtain cigarettes, on smoking participation, and the quantity smoked by smokers. **Specific to young people:** Yes (aged 15 to 18). **Country:** Canada. **DATA** **Source of smoking data:** Survey. **Type of data:** Repeated cross-sectional. **Years of data:** 1999 to 2005. **Survey details:** The Canadian Tobacco Use Monitoring Survey (CTUMS). **Survey unit:** Survey of 15yr olds and over. **Sampling scheme:** CTUMS (1999-2005) collects annual smoking behaviour data from Canadians aged 15 or above. For this study data were restricted to youths aged 15-17 for the 4 provinces where it is illegal to furnish tobacco products to youth under the age of 18 and those aged 15-18 in the	**DATA DESCRIPTION** **Sample size used in models:** n=29,514. **Smoking behaviour outcomes:** 30 day smoking status (whether or not had smoked in past 30 days); average number of cigarettes smoked (derived from survey questions asking how many they smoked in each of past 7 days). **Data description**: 51.7% male, average age 16.3 years, 18.7% had smoked in previous 30 days and average number smoked per day was 8.4. Between 1999 and 2005 smoking prevalence fell from 25.5% to 13.7% and the average number smoked per day fell from 8.9 to 6.4. Participation was higher for men (20.1%) compared with women (17.4%). **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Smoking participation and quantity smoked by smokers (average number per day). There was an additional model of the source of cigarettes (whether retail or other sources). **Explanatory variables:** Price, retailer compliance rate (annual rate per province taken from a random sample of 5,000 retailers in 25 cities each year since 1995), sex. Age was included in the participation model only, and duration in the quantity smoked model (number of years since smoking first whole cigarette). **Expected direction of results stated:** Yes.	**RESULTS** Price and retailer compliance were both significant predictors of smoking participation although price was not a significant predictor of quantity smoked by smokers. Price elasticities were: **Overall** **[Participation: -0.77; p<0.01)]** Quantity smoked: Not reported as price coefficient was not significant (p>0.10) **Men** Not reported for either outcome as price coefficient was not significant (p>0.10) **Women** Participation: -0.979 Quantity smoked: Not reported as price coefficient was not significant (p>0.10) **Other variables** Price was also found to have a significant negative effect on the source of cigarettes for women (elasticity -0.8) and overall (elasticity -0.535) but not for men. This implied that price increases would mean that young people would be less likely to buy cigarettes from retailers. **Sub-group results:** Yes, by gender. **Elasticity calculations reported**: Yes for participation but not for quantity smoked as price results were not significant. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** No.	**Authors' conclusions**. Consistent with previous research, price had a greater effect on smoking participation than cigarette consumption, this may be because the young people in this sample did not smoke large quantities of cigarettes. Men were less responsive to price than women. As the compliance rate of retailers increase, youth moved away from retail sources and towards social sources for their cigarettes. **Other comments**

6 provinces where it is illegal to furnish tobacco products to youth under the age of 19. **Price data based on**: Not stated. **Source of price data:** Annual price indices and personal income data from the Cansim database (Statistics Canada). **Years of data:** 1999 to 2005. **Source of variation:** Across provinces and time.	**Unit of analysis**: Individual. **Type of analysis**: Pooled repeated cross-sectional. **Form of model:** Two-part model (Cragg). Probit estimation was used for participation and a mixed regression model for the quantity smoked. Mixed models were used for both analyses including time as a random effect. Data were weighted using the sampling weights in the survey dataset. Observations who smoked but the quantity smoked was missing were excluded from the analyses. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: No. **Tests of model assumptions**: No.		

Study details	Methods	Results	Conclusions
Ding (2003)[33] **Objectives:** To use more recent data to investigate the nuances of cigarette price increases by looking at differences in sub-cohorts of youth and types of decreased demand. **Specific to young people:** No. Four separate analyses of young people and adults using data from different sources. This extraction is for two analyses relating to young people. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Repeated cross-section. **Years of data:** 1976 to 1998 (prevalence analysis); 1974, 78 to 80, 83, 85, 87 to 88, 90 to 95 (smoking history analysis). **Survey details**: The Monitoring the Future Project (prevalence analysis); National Health Interview Surveys (smoking history analysis). **Survey unit**: School-based. **Sampling scheme:** The	**DATA DESCRIPTION** **Sample size used in models:** The number of years with available data (22 for prevalence analysis, and approximately 14 for history analysis). **Smoking behaviour outcomes:** Percentage of those surveyed who had smoked a cigarette over past 30 days (prevalence). **Data description:** Smoking history analysis was of young people aged 18 to 24, no further details were reported. **Cross-border issues accounted for:** No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Percentage of current smokers (prevalence analysis) also percentage smoking <15 cigarettes per day, 15-24 and ≥25 per day. Percentage of current, former and never smokers (smoking history analysis). **Explanatory variables:** Price. **Expected direction of results stated:** No. **Unit of analysis**: Country (across time). **Type of analysis**: Time series. **Form of model**: Log-log regression model estimated by ordinary least squares. Outcomes already as percentages were not logged. One model for the prevalence data and 3 for smoking history data (current, former and never smokers).	**RESULTS** Elasticities (SE) and p-values **Youth smoking prevalence** **[NHIS: All youths: -4.74 p<0.05]** **[MTF: All youths: -1.41 p>0.10]** **Sub-group results:** Yes, from MTF. By gender and race results reported previously. Males: 0.29 (1.03) p=0.78 Females: -2.98 (0.69) p<0.05 White: 0.89 (0.93) p=0.35 Black: -9.11 (0.88) p<0.05 Hispanic: -2.01 (0.85) p<0.05 **Elasticity calculations reported**: Yes **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** No.	**Authors' conclusions** These results show that in youth, taxation is effective in cutting down the number of cigarettes smoked, leading to the cessation of smoking and deterring others from starting smoking. The youth population is more responsive to price changes with a price elasticity of demand of -1.4, compared with elasticities of -0.15 and -0.19 for adults. **Other comments** The reporting of the methods and data were limited, with no sample sizes or descriptive statistics of any data. The authors state that their results are optimistic but only assuming that the historical time series data use din the modelling remains reflective of today's current youth consumption.

Monitoring the Future Project (prevalence analysis) based on data for 1976-1998; National Health Interview Surveys (smoking history analysis). Neither survey is discussed in detail. **Price data based on**: Average across packs. **Source of price data:** The price used represents the average retail price of a pack of cigarettes throughout the USA from 'The Tax Burden on Tobacco' (Tobacco Institute), both brand name and generic substitute brands. **Years of data:** Not reported. **Source of variation:** Time.	**Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: No. **Tests of model assumptions**: No.		

Study details	Methods	Results	Conclusions
Douglas (1998)[34] **Objectives:** To investigate the determinants of the hazard rates of both starting and quitting cigarette smoking. **Specific to young people:** No. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-section. **Years of data:** 1987. **Survey details:** 1987 Health Interview Survey. **Survey unit:** General non-institutionalised population. **Sampling scheme:** Data in this study based on the Cancer Risk Factor Supplement from the 1987 National Health Interview Survey. **Price data based on**: Weighted average across packs. **Source of price data:** The Tobacco Institute weighted average price per pack (including taxes) for each state for each year from 1954 to 1991, with cigarette price deflated by the yearly consumer price index.	**DATA DESCRIPTION** **Sample size used in models:** Sample size for all models is 8,754. **Smoking behaviour outcomes:** Starting and quitting smoking. **Data description**: 43% of the sample are male and mean age of starting smoking was 18.14 years. 48% have never smoked and mean years smoked (if ever quit) is 9.9. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** Yes, based on rational addiction model. **Empirical model** **Dependent variables**: Hazard of starting smoking. **Explanatory variables:** Gender, race, family income, age in 1987, marital stability, cigarettes smoked per day at 'peak period', education, threshold, price, advertising policy changes, report on health effects of smoking. **Expected direction of results stated:** Yes, restrictions on smoking and increases in cigarette prices increase the probability that a smoker will quit smoking. **Unit of analysis**: Individual. **Type of analysis**: Duration analysis. **Form of model:** Ordered probit split-sample duration model.	**RESULTS** Starting hazard coefficients of past, present and future price exhibit slightly different patterns in the split and unsplit models and the coefficients are smaller and statistically insignificant in the split model. **[Hazard of starting -0.41]** The split sample estimates indicate that a 1% increase in the future price of cigarettes causes a 0.5% fall in 15-year old's smoking hazard rate. Indicated elasticity falls sharply with age, from -0.57 at age 12 to -0.15 at age 20. Elasticity of starting hazard at age 12 -0.57 and at age 20 -0.15 (10% increase in price = 5.7% decrease in the probability of starting). **Sub-group results:** Yes. **Elasticity calculations reported**: Yes. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. 1. With and without regulation variables. 2. Split-sample and non-split sample approach used. Price estimates were reasonably similar across models, particularly across split and non-split approaches.	**Authors' conclusions**. The split-sample provides evidence that state-level regulations promote quitting, but none that they deter starting. The unsplit model indicate a strong negative effect of state regulation on starting hazard. In general, results indicate a higher sensitivity of quitting hazards than starting hazards to cigarette prices, regulation and information. **Other comments**

Years of data: 1954 to 1991. **Source of variation:** Across states and time.	**Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes, through time-varying covariates. **Tests of model assumptions**: No.		

Study details	Methods	Results	Conclusions
Emery et al (2001)[35] **Objectives:** To examine the relationship between smoking experiences and adolescent price sensitivity. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-section. **Years of data:** 1989 with follow-up in 1993. **Survey details**: The Teenage Attitudes and Practices Survey (household survey). **Survey unit**: Teenagers (derived from a households survey). **Sampling scheme:** The study used data from the second wave (1993) of the longitudinal teenage attitudes and practices survey (TAPS). **Price data based on**: Average across packs. **Source of price data:** Average pack price per state of cigarettes from 'The Tax Burden on Tobacco' (Tobacco Institute), adjusted by the consumer	**DATA DESCRIPTION** **Sample size used in models:** For those aged 14 +: 9,166 (all subjects) 5,368 (experimenters) 2,073 (current smokers) 1,630 (established smokers) Experimenters aged 10-13: 526. **Smoking behaviour outcomes:** Questions were "have you ever smoked a cigarette?" and "have you ever tried or experimented with cigarette smoking, even a few puffs?" Never smokers answered no to both; experimenters had positive response and smoked <100 cigarettes; current smokers had smoked in past 30 days; established smokers had smoked in past 30 days and smoked >100 cigarettes. Consumption for current or established smokers was average of number smoked on each of previous 7 days. **Data description:** Aged 10-22; 50-56% male depending on dataset. For 10-13 year olds there were 14% experimenters, 1.4% current smokers, 0.3% established smokers. **Cross-border issues accounted for:** No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Smoking participation (yes/no); conditional demand (amount smoked by smokers). **Explanatory variables:** Price; additive index of state-level tobacco control activities (values from 0-9); gender; race; rural residence; living with one or both parents; religious beliefs; employed; weekly disposable	**RESULTS** Elasticity (significance level). **[Participation: -0.83 (p<0.01)]** **[Conditional demand: -0.87 (p<0.05)]** **[Total: -1.7 (derived)]** **Participation** Established smokers 14+: -1.56 (p<0.05) Current smokers 14+: -0.83 (0.05<p<0.10) Results were not significant (p>0.10) for experimenters aged 14+, or 10-13 and elasticities were not reported. **Conditional demand (Quantity for smokers)** These are for quantity smoked given smoker. **[Established smokers 14+: -0.87 (p<0.05)]** Current smokers 14+: -0.68 (p<0.05) **Total elasticity** Established smokers 14+: -2.24 **[Current smokers 14+: -1.70]** **Other variables** Tobacco control activities did not have a significant effect on any smoking outcomes. Gender, age and psycho-social factors including exposure to family smoking and ease of purchasing cigarettes had more effect on experimentation than price. **Sub-group results:** No. **Elasticity calculations reported**: No.	**Authors' conclusions** The results show that price was not significantly associated with experimentation but is a factor in more advanced smoking behaviour amongst adolescents. **Other comments** Only the cross-sectional data was used this analysis and so the price estimates for current and established smoking may be biased upwards.

price index. **Years of data:** 1992 real price (the 1993 data was not used as a 10% price reduction occurred April 1993). **Source of variation:** Across states.	income; parental education; household income; school performance; depression; rebelliousness; sports participation; parental bond; family smoking and belief about ease of obtaining cigarettes. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Cross-sectional. **Form of model**: Two-part model. Separate models of demand for current and established smokers. Models of participation only for experimenters. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. via covariates. **Tests of model assumptions**: No.	**SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** No.	

Study details	Methods	Results	Conclusions
Evans & Farrelly (1998)[36] **Objectives:** To test whether smokers alter their smoking habits in the face of higher taxes. **Specific to young people:** No. Data were from two sources with only one reporting results for those aged 18 to 24. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-sectional. **Years of data:** 1987 (for youth results). **Survey details**: The Cancer Control Supplement from the National Health Interview Survey. **Survey unit**: General non-institutionalised population. **Sampling scheme:** Primary data sources are two supplements from the National Health Interview Survey (NHIS): the Smoking Supplement from 1979 and the Cancer Control Supplement (CCS) from 1987. **Price data based on**: Average across packs.	**DATA DESCRIPTION** **Sample size used in models:** 2,806 (ages 18-24 with 736 smokers) 7,650 (25-39 with 2,408 smokers) 11,428 (40 and over with 2,816 smokers) A small percentage of people without state of residence data were excluded from analyses. **Smoking behaviour outcomes:** Survey asked smokers how many cigarettes were smoked, and the most frequently smoked brand. Details of the cigarettes including tar and nicotine content, length of cigarette and type of filer were also recorded. **Data description:** 27.5% current smokers. Mean (SD) consumption per day: 19.9 (12.2) cigarettes. **Cross-border issues accounted for:** No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Smoking participation (yes/no); average number smoked per day (for smokers). Other outcomes analysed were: average cigarette length in mm, mm smoked per day (average number smoked x length), average tar content, average nicotine content, daily tar intake, daily nicotine intake (results only reported here for smoking. **Explanatory variables:** Tax, age, age squared, gender, income, an indicator variable for if income is missing, family size, race, marital status, urban centres and education. Regional dummy variables. **Expected direction of results stated:** No.	**RESULTS** Tax elasticites (t-statistic) **[Participation: -0.575 (-1.453)]** Amount smoked: -0.223 (-0.681) Total elasticity: -0.798 (derived) **Sub-group results:** No. **Elasticity calculations reported**: Yes. Total demand elasticity can be estimated as the sum of the elasticities from the 2-part model. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Not for analyses by age group. Other analyses were repeated using price instead of tax and produced similar results. Tax was the primary covariate of interest as it directly measures the impact of governments on smoking, and price may be correlated with a state-specific error in the models. General specification tests were preformed but not for young people models, however, provide general reassurance to the robustness of the models. The Heckman sample selection model was used to test for non-random missing data on nicotine and tar levels. Panel data models were run with state fixed effects to control for state-level endogeneity bias. Results were also verified using analyses of an alternative data source.	**Authors' conclusions** Younger smokers are most likely to quit as a result of higher taxes but are also the group most likely to switch to smoking cigarettes with higher tar and nicotine content. **Other comments** The NHIS survey data underreports cigarette consumption. The results for young people are based on cross-sectional data only and so could not account for state effects. Further analyses (pooling data from the two timepoints and using state and year dummy variables; and using time-series data from another study) were performed but this was for overall tax effects, and not the results stratified by age group.

Source of price data: State excise tax rate and average cigarette price from the Tobacco Institute's publication 'The Tax Burden on Tobacco'. **Years of data:** 1982 to 1984 (in cents as constant prices). **Source of variation:** Across states.	**Unit of analysis**: Individual. Models used sample weights (although the results were not sensitive to this). **Type of analysis**: Cross-sectional. **Form of model**: Two-part model. A probit equation was used to estimate the probability of smoking, followed by ordinary least squares regression of the amount smoked. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. Via observed covariates. Additional pooled models with state dummy variables were also ran. **Tests of model assumptions**: No.		

Study details	Methods	Results	Conclusions
Farrelly et al (2001)[37] **Objectives:** To evaluate the effect of cigarette price increases by gender, income, age and ethnicity, using a nationally representative sample of over 350,000 adults. **Specific to young people:** No but results for ages 18 to 24 were reported. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Repeated cross-sectional. **Years of data:** 1976-80, 83, 85, 87-93. **Survey details**: The National Health Interview Survey. **Survey unit**: Individual. **Sampling scheme:** The National Health Interview Survey, a nationally representative multistage probability sample of the civilian, non-institutionalised population aged 18 and over. **Price data based on**: Average across packs. **Source of price data:** Average pack	**DATA DESCRIPTION** **Sample size used in models:** All (n=354,228) and 18-24 years (n=46,379). **Smoking behaviour outcomes:** Survey asked: "have you smoked 100 cigarettes in your entire life" and "do you smoke cigarettes now" (before 1992); and in 1992-93 "do you smoke cigarettes every day, some days or not at all". Current smokers defined as those smoking everyday or some days and had smoked at least 100 cigarettes during lifetime. Cigarette demand was the number smoked per day by smokers. **Data description:** 29.4% smokers for 18-24. Mean daily consumption for smokers: 16.19 for 18-24. 46.6% men, 81.2% white non-Hispanic, 37.8% high school graduate and 35.2% college or higher education. **Cross-border issues accounted for:** No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Smoking participation (yes/no); number of cigarettes smoked by smokers. **Explanatory variables:** Price, age, age squared, real family income (0 if missing), indicator for missing income, state of residence, year, city size (2 categories), race, education, marital status, family size, gender. State-level fixed effects. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Pooled repeated cross-sectional.	**RESULTS** Elasticity (* if p<0.05) **Ages 18 to 24** **[Participation: -0.30*]** **[Amount smoked: -0.25*]** **[Total: -0.55]** **Sub-group results:** Yes, by ethnicity. These were estimated from a figure as not reported directly in the paper. For 18-24 year olds, white non-Hispanic had an elasticity = -0.44, African-Americans = -0.86 and Hispanics = -1.0. **Elasticity calculations reported**: Yes. Total demand elasticity was the sum of the elasticities from the 2 separate parts of the model. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** In estimating price elasticities a constraint was imposed so that all other covariates had the same coefficient. Additional models relaxing this constraint didn't alter the price results.	**Authors' conclusions** These results suggest that price increases will have differential effects on smokers of different gender, income, age and race or ethnicity. Young adults aged 18 to 24 are more responsive to price than older adults aged over 40. **Other comments**

price per state from 'The Tax Burden on Tobacco' (Tobacco Institute, 1998) adjusted for inflation (constant 1982 to 1984 dollars). Price includes state taxes. **Years of data:** 1976-1993. **Source of variation:** Across states and time.	**Form of model**: Two-part model. A probit equation was used to estimate the probability of smoking, followed by ordinary least squares regression of the amount smoked. Results for age sub-groups were obtained by including the interaction between age and price. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. Via observed covariates and use of state-level fixed effects. **Tests of model assumptions**: No.		

Study details	Methods	Results	Conclusions
Gilleskie & Strumpf (2000)[38] **Objectives:** To provide price/tax sensitivity based on a dynamic behavioural model of smoking. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Longitudinal. **Years of data:** 1988, 1990, 1992. **Survey details:** National Education Longitudinal Survey. **Survey unit:** School-based. **Sampling scheme:** State-level data (Tobacco Institute 1997) and measures of inflation to determine the appropriate real cigarette price, and state tax rate, for all individuals in each year. **Price data based on**: Not stated. **Source of price data:** State-level data (Tobacco Institute 1997) and measures of inflation to determine the appropriate real cigarette price, and state tax rate, for all individuals in each year.	**DATA DESCRIPTION** **Sample size used in models:** The sample consists of three years of observations on 4755 males and 5478 females. **Smoking behaviour outcomes:** "How many cigarettes do you smoke in a day". Responses limited to: do not smoke, smoke less than 1 cigarette per day, smoke 1-5 cigarettes per day, smoke about half a pack (6-10), smoke more than half a pack but less than 2 packs (11-39) and smoke 2 packs or more (40+). **Data description**: 4.6% of youths started smoking in 8th grade (1988) and 22.7% reported smoking in the second follow-up. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** Yes. Dynamic model of smoking behaviour that accounts for decisions made in the past as well as expectations of the future. **Empirical model** **Dependent variables**: Lifetime utility modelled as: smoke at all; smoke 1-5 cigarettes per day; smoke 6-10 cigarettes per day and smoke 11+ cigarettes per day. **Explanatory variables:** Price (nine versions), previous smoker (three versions), duration smoking, dropout indicator, sex, race, age, religion, test score. number of older siblings, living status, family status, socio-economic status, parents education, parents income,	**RESULTS** The price elasticities based on the preferred model is: **[Any smoking (participation): -0.24]** Levels of smoking (demand for smokers): smoke 1-5 cigarettes per day (conditional on smoking): 0.64 smoke 6-10 cigarettes per day (conditional on smoking): -1.28 smoke 11+ cigarettes per day (conditional on smoking): -1.68 **Sub-group results**: No. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Specifications, substituting taxes for prices, with/without heterogeneity.	**Authors' conclusions**. By controlling for a wide range of observed and unobserved individual differences it is apparent that behaviour modification plays an important role in smoking persistence. Price increases can influence future behaviour by reducing the current number of smokers. Prices have a non-linear effect on smoking behaviour, with large increases having a much stronger influence than small increases (at least for younger teens). **Other comments**

Years of data: 1997**.** **Source of variation:** State level and time**.**	guardian's age, school type, school location. **Expected direction of results stated:** No. **Unit of analysis**: Individual in schools. **Type of analysis**: Panel with jointly estimated equations. **Form of model:** Joint estimation of part, demand and drop-out. The empirical model comprises three equations which are estimated jointly and are linked by dependence on the common individual observables. The three models consist of: 1. Probability of smoking. 2. Quantity smoked conditional on smoking. 3. Probability of school drop-out **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes, through covariates but also by modelling individual unobserved heterogeneity as factor loadings and state fixed effects. **Tests of model assumptions**: Number Huber standard errors with clustering on individuals.		

Study details	Methods	Results	Conclusions
Goel & Nelson (2005)[25] **Objectives:** To study the effectiveness of tobacco policies in reducing tobacco use amongst different population groups in the USA. **Specific to young people:** No. Separate analyses of adults aged over 18, and young people in grades 9 to 12 (ages 14 to 18). **Country:** USA. **DATA** **Source of smoking data:** Administrative data. **Type of data:** Cross-sectional. **Years of data:** 1997. **Survey details**: Administrative data: Centres for Disease Control and Prevention. **Survey unit**: Administrative data. **Sampling scheme:** Not applicable. **Price data based on**: Percentage of retail price. **Source of price data:** Two tax (price) variables are included in the estimating equation. One is the federal and state excise tax as	**DATA DESCRIPTION** **Sample size used in models:** n=34 (states in analysis of young persons smoking). **Smoking behaviour outcomes:** The percentage of the population smoking; and the percentage consuming smokeless tobacco. **Data description:** Not reported. **Cross-border issues accounted for:** No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Percentage of population in a state who smoke cigarettes. **Explanatory variables:** Federal and state excise tax (as % of state retail price); state tax on smokeless tobacco (as % of either retail price, wholesale price or state production cost); per-capita state income; binary variable for presence of state tobacco advertising restrictions; index for smoking restrictions (0 to 5 covering government worksites, private worksites, restaurants, day care centres, home based day care); minimum purchase age; index for youth access restrictions (0 to 6 for purchasing, possessing and using tobacco, vending machine restrictions, signs, licensure). **Expected direction of results stated:** No. **Unit of analysis**: State. **Type of analysis**: Cross-sectional. **Form of model**: Ordinary least squares regression.	**RESULTS** Coefficient (t-statistic) * p<0.10 ** <0.05, no elasticities reported. **All youth** Cigarette tax (tax as a % of the price of cigarettes): Model including tax and income only: -0.30 (0.72) As above plus tobacco restrictions: 0.0004 (0.00) As above plus smokeless tax: -0.05 (0.24) Other factors: Income had a significant effect on boys suggesting higher income is a more powerful deterrent than higher taxes. Indoor smoking restrictions had a significant effect on boys. The minimum purchase age had a consistently negative significant effect in all models, overall and for boys and girls. **Sub-group results:** No. **Elasticity calculations reported**: No **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** No.	**Authors' conclusions** Higher taxes deter adult smokers but are not effective for young people. The weak effect of youth taxes enforces previous research. **Other comments** Analysis was conducted at the state level and the reporting of the data and methods was brief, which hampers understanding of the appropriateness of the modelling. Federal state taxes as a % of retail price instead of absolute price were used so it is difficult to interpret results unless it is assumed that retail prics are constant over all states.

a percentage of the retail price per pack of cigarettes in a state. The other is the state tax on smokeless tobacco. **Years of data:** 1997. **Source of variation:** Across states.	**Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes, through covariates. **Tests of model assumptions**: No.		

Study details	Methods	Results	Conclusions
Gruber (2000)[39] **Objectives:** To provide a comprehensive analysis of the impact of prices and other public policies on youth smoking in the 1990s. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Repeated cross-section. **Years of data:** 1991 to 1997 (MTF); 1991, 3, 5 and 7 (YRBS); 1991 to 1997 (Natality data). **Survey details**: Monitoring the Future (MTF), Youth Risk Behaviour Survey and Vital Statistics Natality Files. **Survey unit**: Census of birth certificates and school-based. **Sampling scheme:** Three different data sets are used. Monitoring the Future (MTF, University of Michigan) an in-school survey of 8th, 10th and 12th grade school children from 1991-1997. Youth Behaviour Risk Survey (YRBS, Centers for Disease Control) sample of 9th to 12th graders for	**DATA DESCRIPTION** **Sample size used in models:** 641,759 (MTF) 106,556 (YBRS) 3,970 (Natality) **Smoking behaviour outcomes:** Whether or not smoked in past month. Smoking intensity was recorded in intervals (details not reported) by the MTF and YBRS data and the mid-point of each interval was used for analysis. **Data description:** % of smokers: 24.6% (MTF); 32.6% (YBRS); 16.4% (Natality data) Mean (SD) number of cigarettes smoked: 6.13 (8.63 MTF); 5.42 (5.85 YBRS); 9.93 (1.51 Natality) Age range 13 to 18 years. **Cross-border issues accounted for:** No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Participation (yes/no for if smoked in past month); amount smoked by smokers (conditional intensity). **Explanatory variables:** Price; clean air regulations (categories covering private and public	**RESULTS** Elasticity, * if statistically significant at 5% level. **MTF data** *All data:* **[Participation: -0.311]** **[Amount smoked for smokers: -0.02]** **[Total demand: -0.331]** *12th grade:* Participation: -0.666* Amount smoked: -0.059 *8th and 10th grade:* Participation: -0.21 Amount smoked: -0.003 Other restrictions: for seniors (12th grade) smoking restrictions in government worksites and other places had significant negative effects, and also for younger pupils who were more affected by youth access restrictions. **YRBS data** *All data:* **[Participation: -0.126; p=ns]** **[Amount smoked: -0.526; p=ns]** **[Total demand -0.652]** *12th grade:* Participation: -1.534* Amount smoked: -1.576* *9th to 11th grade:* Participation: 0.419 Amount smoked: -0.227 Other restrictions: restaurant clean air restrictions had a significant	**Authors' conclusions** The results suggest that the single greatest policy determinant of youth smoking is cigarette price. Several datasets have shown that older teens are sensitive to cigarette prices with a central elasticity estimate of -0.67. This price sensitivity rises for more socio-economically disadvantaged groups such as blacks or those with less educated parents. **Other comments** The price of cigarettes in the US fell by 14 cents during the data period of this study (1991 to 1997). Authors place most emphasis on results of MTF data.

1991, 1993, 1995 and 1997. Vital Statistics Natality Detail Files (VSNDF), a census of birth certificates for the US which contain data on smoking behaviour of teen mothers during pregnancy, available from 1991 onwards. **Price data based on**: Not stated. **Source of price data:** Price and taxes per state per year from 'The Tax Burden on Tobacco' (Tobacco Institute 1998). **Years of data:** Appear to be 1991 to 1997. Average price from consecutive Novembers, and the tax rate from February were used. **Source of variation:** States and time.	workplaces, restaurants, schools and other public places); youth access restrictions (an index covering 9 categories of state regulation and providing an overall score per state) with and without the inclusion of current taxes and two lags of current taxes; gender; race; age; school grade; parental education (YRBS data only). Year dummies and state fixed effects. **Expected direction of results stated:** No. **Unit of analysis**: Individual and State by year by age cell means. **Type of analysis**: Aggregate analysis and pooled repeated cross-sectional. **Form of model**: Linear regression, estimation method was not reported. Separate models for each dataset and older and younger teenagers. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. Via covariates; use of state fixed effects and instrumental variables (by instrumenting prices with the tax rate in the state). **Tests of model assumptions**: No.	negative effect on seniors but not younger pupils. **Natality data** *All data:* **[Participation: -0.353*]** **[Amount smoked: -0.124*]** **[Total demand: -0.477]** *13 to 16 years:* Participation: -0.240* Amount smoked: -0.058* *17 to 18 years:* Participation: -0.376 Amount smoked: -0.145 Other restrictions: Access restrictions and clean air restrictions had significant negative effects on 17 to 18 year olds and clean air restrictions in restaurants affected younger teenagers. **Sub-group results:** Yes, by race and parental education level. For older teenagers (over 16) black or non-whites were more responsive to prices. For younger teenagers price elasticities were not significant for whites or blacks, except in the teenage mother dataset where price had a significant effect on participation by white older teenagers. Older teenagers with more educated parents were also more price-responsive but there was no clear relationship for younger teenagers. For MTF data price coefficients: **Whites**: Older teens (participation -0.350, Cigs/Day 0.130), younger teens (participation -0.300, Cigs/Day -0.393) and all teens (participation -0.277, Cigs/Day -0.181). **Non-Whites**: Older teens (participation -2.324, Cigs/Day -2.03), younger teens	

		(participation 0.226, Cigs/Day 1.488) and all teens (participation -0.327, Cigs/Day 0.691). For YRBS data - price coefficients: **Whites**: Older teens (participation -0.628, Cigs/Day -2.662), younger teens (participation 0.303, Cigs/Day 0.106) and all teens (participation 0.092, Cigs/Day -0.775). **Blacks**: Older teens (participation -9.259, Cigs/Day -8.248), younger teens (participation -0.874, Cigs/Day 4.958) and all teens (participation -2.530, Cigs/Day 4.393). For Natality data - price coefficients: **Whites**: Older teens (participation -0.412, Cigs/Day -0.109), younger teens (participation -0.385, Cigs/Day 0.040) and all teens (participation -0.433, Cigs/Day -0.076). **Blacks**: Older teens (participation 0.534, Cigs/Day -0.539), younger teens (participation 1.115, Cigs/Day -0.494) and all teens (participation 0.671, Cigs/Day -0.539). **Elasticity calculations reported**: No **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Analyses controlling for school dropout rates which did not alter the price results. Additional models controlling for aggregate cigarette consumption in a state in previous year to investigate if taxes are endogenous to cigarette consumption. The coefficients for lagged sales were generally not significant suggesting little correlation between aggregate consumption and tax setting and youth smoking.	

Study details	Methods	Results	Conclusions
Hammar & Martinsson (2001)[23] **Objectives:** To analyse the determinants of the age of smoking initiation amongst youth and young adults. **Specific to young people:** Yes, and young adults. Sample restricted to individuals who started smoking between the ages of 10 and 25 and who were born between 1935 and 1965. **Country:** Sweden. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-sectional. **Years of data:** 2000. **Survey details:** Survey of individuals, identified as smokers in a previous study, in northern Sweden. **Survey unit:** Sample of smokers. **Sampling scheme:** The sample was identified from a study on the health effects of moist snuff undertaken as part of a previous study. The questionnaire was mailed to 935 individuals, identified as smokers in a previous study, in two counties in Sweden.	**DATA DESCRIPTION** **Sample size used in models:** n=385 (158 male, 227 female). **Smoking behaviour outcomes:** Starting age based on answer to "How old were you when you started to smoke everyday" where length of spell is defined as age-9 (the study is restricted to individuals who are non-smokers at the age of 9 years). **Data description**: 41% men and 59% women. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Age of smoking initiation. **Explanatory variables:** Price, sex, parental smoking behaviour, social class, percentage price changes, policy, information campaigns, law or regulation, voluntary smoking bans in public. **Expected direction of results stated:** Yes the estimated coefficients on the socio-economic characteristics were in line with expectations and men who start smoking do so at a younger age than women. **Unit of analysis**: Individual. **Type of analysis**: Duration. **Form of model:** Duration: log-logistic and gamma distribution**.** Based on the Akaike	**RESULTS** Results show that men who start smoking do so at a younger age than women. Parental smoking implies that individuals will start at an earlier age, but only if both parents are smokers. ($p<0.10$). Public policies, both in terms of cigarette prices and information campaigns, and laws and regulations, do not affect the age of smoking initiation. There is a significant effect on the time trend. From the generalized gamma distribution without heterogeneity the coefficient for log average price is -0.498. From the lognormal distribution without heterogeneity: Model 1 – coefficient for log average price is -0.993 (p=ns). Model 2 – coefficient for log average price is -0.466 (p=ns). **Other variables:** No. **Sub-group results:** No. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes, see tests of model assumptions.	**Authors' conclusions**. The age of smoking initiation is not determined randomly but is explained by personal characteristics, particularly parental smoking and gender. Public policies do not appear to have a direct effect on the age of smoking onset, but public policies may change attitudes and awareness of the effects of smoking. **Other comments**

Price data based on: Average across packs. **Source of price data:** Average price of twenty cigarettes deflated by the consumer price index (at 1995 price level for period 1945-1989). Source is described as "SCB (various issues), Statistics Sweden". **Years of data:** Not clear - At 1995 price level for the period 1945-1989. **Source of variation:** Across time.	Information Criterion the authors use the generalized gamma model without heterogeneity. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. Estimated models, with log-logistic or generalized gamma distribution, both with and without heterogeneity. Unobserved heterogeneity was tested for. Although the Akaike Information Criterion suggests that heterogeneity was not a problem. **Tests of model assumptions**: Yes. 1) Functional form of hazard function was tested using Akaike information criterion. Choice between lognormal log-logistic , generalized gamma model. 2) RESET test applied and the model fails to reject and is therefore well specified. 3) Adding previous periods prices and next period prices as in rationale addiction model, overall conclusions remain unchanged.		

Study details	Methods	Results	Conclusions
Harris & Chan (1999)[13] **Objectives:** To use a continuum-of-addiction model of the onset of cigarette smoking. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-sectional. **Years of data:** September 1992, January and May 1993. **Survey details:** Tobacco Use Supplements to the Current Population Survey. **Survey unit:** Population survey. **Sampling scheme:** The 1992-1993 Tobacco Use Supplements to the Current Population Survey is a national survey (Washington DC Chamber of Commerce, Bureau of the Census) of people aged 15-29 years. **Price data based on**: Derived from scanned sales data. **Source of price data:** "Infoscan: market and regional profiles 1993-Current markets" produced by	**DATA DESCRIPTION** **Sample size used in models:** n=34,145 (overall) n=6,210 (aged 15 to 17) n=5,713 (aged 18 to 20) n=6,748 (aged 21 to 23) **Smoking behaviour outcomes:** Current smokers were those who answered yes to the question "Have you smoked at least 100 cigarettes in your life?" and who answered every day or some days to "Do you now smoke cigarettes every day, some days or not at all?" Participation model. **Data description**: Not reported. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Participation (current smoking yes or no); the natural logarithm of the number of cigarettes smoked per day. **Explanatory variables:** Price, gender, age in years, race, ethnicity, education, family income, whether the respondent was still in school, proxy or self-response to the survey. **Expected direction of results stated:** Yes. That the price sensitivity of demand declines with increasing age; that youngest smokers are the most price sensitive, and that in the face of higher prices adolescent smokers are less likely to progress to daily smoking.	**RESULTS** The probability of current smoking was inversely related to both price and family smoking. Estimated price elasticities (standard errors) were: **[Participation: -0.575 (p<0.05)** **Conditional quantity smoked: -0.231 (p=ns)** **Total: -0.806 (derived)]** **Current smoking (participation):** 15 to 17: -0.831 (0.402) 18 to 20: -0.524 (0.258) 21 to 23: -0.370 (0.188) **Current smoking on some days only:** 15 to 17: -0.304 (0.501) 18 to 20: -0.596 (0.304) **Current smoking every day:** 15 to 17: -0.165 (0.276) 18 to 20: -0.255 (0.165) 21 to 23: -0.274 (0.184) A generalised least squares regression of price elasticity against age showed a decline in elasticity with increasing age, of 0.053 per year (p=0.003). Additional models were run using the prices of premium and discount brand cigarettes. The price elasticity for premium brands was consistently higher than for discount brands, whose elasticity was not significant. When both types were included in the same models, the coefficients for the discount brands were mostly positive and significant. **Sub-group results:** Yes, by age. Premium	**Authors' conclusions**. These results confirm previous reports that the price-responsiveness of smoking varies inversely with age. The findings suggest that nicotine addiction is acquired and reinforced over an extended time period, starting in adolescence and continuing to the mid to late twenties. **Other comments** The authors state that their elasticities for 15 to 17 and 18 to 20 year olds are consistent with those reported in recent research.

Connecticut Information Resources Inc. Price data were derived from the barcode scanning of sales in large food stores. **Years of data:** Appears to be 1993. **Source of variation:** Across markets at sub-state level. related to metropolitan statistical areas (MSAs).	**Unit of analysis**: Individual. **Type of analysis**: Cross-sectional. **Form of model:** Participation modelled using a discrete-choice probit model; and amount smoked using an ordinary least squares regression model. Asymptotic standard errors were calculated using the delta method. Sampling weights provided in the survey data were used. Five separate models were used for different age groups: 15 to 17 years; 18 to 20; 21 to 23; 24 to 26 and 27 to 29. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes on observed variables only by adjusting for covariates. Although only demographic data were used and no control was made for other tobacco control policies. In the model for 15 to 17 year olds only, state and local youth access restrictions were included but did not have a significant effect (results were not presented). **Tests of model assumptions**: No.	brands and discount brands Participation <18 years: -0.831 Participation >18 years: -0.447 Conditional quantity <18 years: -0.165 Conditional quantity >18 years: -0.2645 Total < 18 years: -0.996 Total > 18 years: -0.7115 Participation premium: -0.762 Conditional premium: -0.38 Participation discount: -0.234 Conditional discount: -0.104 **Elasticity calculations reported**: Yes. For the probit models where they were calculated at the sample means of the independent variables. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. By including youth access restrictions for the 15 to 17 year old models; by re-estimating models using different price measures. There were also additional sub-group analyses of low-income youths, although these results were not reported.	

Study details	Methods	Results	Conclusions
Katzman et al (2002)[40] **Objectives:** To develop a theoretical model to allow for a better understanding of the determinants of teenage smoking and to look at the effects of price and other restrictions on smoking decisions. **Specific to young people:** Yes. Grades 9 to 12 (ages 14 to 18). **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Repeated cross-sectional. **Years of data:** 1995, 97 and 99. **Survey details**: Youth Risk Behaviour Survey. **Survey unit**: School-based. **Sampling scheme:** The Youth Risk Behaviour Surveys for 1995, 1997 and 1999 are used. This is a nationally representative sample of high school students in grades 9-12. **Price data based on**: Not stated. **Source of price data:** Both real cigarette price (inclusive of taxes)	**DATA DESCRIPTION** **Sample size used in models:** 37,513 (full sample) 10,644 (current smokers) 6,853 (buyers) 3,971 (bummers) **Smoking behaviour outcomes:** Number of days smoked in past 30 days with categorical responses: 0, 1 or 2, 3 to 5, 6 to 9, 10 to 19, 20 to 29, all 30. Each category is represented by its midpoint and non-smokers are those smoking on zero days. Number of cigarettes smoked on days when smoked with categories: 0, <1. 1, 2 to 5, 6 to 10, 11 to 20, >20 with category midpoints used in analyses. Buyers and bummers identified from question "During past 30 days, how did you usually get your own cigarettes" with buyers those who bought them from a store, vending machine or who gave someone else money to buy them. Bummers borrowed cigarettes from someone else. **Data description:** Mean number of days smoked in past month: 19.88 (buyers), 5.81 (bummers). Mean number of cigarettes smoked per day: 6.04 (buyers), 1.82 (bummers). Mean number of years since started smoking: 4.36 (buyers), 3.19 (bummers). **Cross-border issues accounted for:** No. **MODELLING** **Evidence of theoretical model:** Yes. Based on expected utility maximisation model that accounts for price, other anti-smoking policies and the teenage lending/borrowing market. This was based on the Cobb-Douglas utility function. The results from the theoretical and empirical models were consistent, indicating the accuracy of the theoretical model. **Empirical model** **Dependent variables**: Category of smoker (non-smoker,	**RESULTS** Elasticity (* p<0.05) **Category of smoker** Changes of the probability of being a non-smoker, bummer or buyer resulting from price changes were not statistically significant. Price had a statistically significant negative marginal effect on the probability of a current smoker being a buyer, indicating that as prices rise the probability of buying cigarettes decrease and the probability of bumming increases. ***Price elasticities:*** **Number of cigarettes smoked [-0.280* (overall)]** -0.282* (buyers) -0.001 (bummers) **Number of days smoked [-0.366* (overall)]** -0.280* (buyers) -0.475* (bummers) **Sub-group results** Yes, by buyers and bummers, see above. **Other results** Some types of school smoking bans had a significant negative effect on consumption by buyers, but had no effect on the number of cigarettes consumed by bummers. **Elasticity calculations reported**: No. Not for individual calculations, but the overall elasticity of consumption was a weighted sum of four elasticities (probability of being	**Authors' conclusions** As prices rise, teenagers are less likely to be regular smokers who purchase cigarettes and are more likely to lend cigarettes. Higher prices induce a substitution away from buying and towards bumming. **Other comments**

and state-level excise tax on cigarettes are used. Both are from the 'Tax Burden on Tobacco' (Tobacco Institute). **Years of data:** Not stated but appear to be same as survey years. **Source of variation:** Across states and time.	buyer, bummer); cigarette consumption (number of days smoked and number of cigarettes consumed on days smoked). **Explanatory variables:** Price or tax, age, gender, race, dummy variables indicating if a students age is greater than the majority of the class (as class is not included as highly correlated with age), real income per capita (as proxy for income), unemployment rate in state (as proxy for teenage employment opportunities), wearing of a car seat belt (attitude to risk), number of sports teams a member of, religion, dummy variables for region of residence (to account for unobserved area-level smoking sentiments); four indicator variables for clean air laws. **Expected direction of results stated:** Yes. Price increases will reduce number of buyers but increase the numbers "bumming" cigarettes. **Unit of analysis**: Individual. **Type of analysis**: Pooled repeated cross-sectional. **Form of model**: OLS. Multinomial logits were used to estimate the probability of being in each category of smoker. Logits were used to estimate the impact of probability of being a buyer or a bummer, for current smokers only. Consumption was modelled with ordinary least squares regression. Consumption modelled separately for all smokers, buyers and bummers. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. Via covariates; included dummy variables of the region of residence, state dummies were tested but not included as they were correlated with taxes. **Tests of model assumptions**: No.	a buyer or bummer, and quantity smoked by buyers and bummers) with weights proportional to the share of the groups total consumption. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Separate models using price and tax, results were similar so only price results have been extracted.	

Study details	Methods	Results	Conclusions
Kidd & Hopkins (2004)[22] **Objectives:** To examine the impact of the price of smoking on the decision to start and the decision to quit smoking; and whether this impact differs by gender. **Specific to young people:** No. Using national datasets to look at the duration to both starting and quitting although there were 2 analyses, one of those aged 27 to 37 and another of those aged 18 to 26. **Country:** Australia. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-sectional. **Years of data:** 1990 (1998 in sensitivity analyses). **Survey details:** The National Health Survey (NHS 1990) was used for the main analyses; the National Drug Strategy Household Survey (NDSHS 1998) was used for sensitivity analyses (due to its smaller sample size). **Survey unit:** Not stated.	**DATA DESCRIPTION** **Sample size used in models:** Starting analysis n=9,402 n=4,619 (men) n=4,783 (women) Quitting analysis n=4,946 n=2,618 (men) n=2,328 (women) **Smoking behaviour outcomes:** NHS data: age commenced regular smoking where regular is defined as one or more cigarettes per day and age at quitting smoking, smoking questions were only asked of those aged 18 or over. NDSHS data used questions: 'what age were you when you started smoking daily?' and 'what age were you when you last smoked daily?' **Data description**: Overall 53.7% started to smoke with 58.5% of men and 49.1% of women. The main analysis was restricted to those aged 27 to 37 with a mean age 31.9 years. Mean starting age 17.1 (men) and 17.4 (women). 74.9% Australian born. 16.4% men and 12% women had degrees. In the quitting analyses, 37% quit with a mean age of starting of 17 and mean age of quitting 25.1. 50% were male. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Time until starting smoking; for those who start the time from starting to quitting. **Explanatory variables:** Log price (as a time-varying	**RESULTS** **Starting** *Elasticities (t-statistic)* Overall: 0.133 (2.750) Men: 0.162 (2.320) Women: 0.122 (1.830) In these models price had a statistically significant effect overall and for men ($p<0.05$) but a smaller effect on women ($p<0.10$). **[Hazard of starting: 0.125 (average)]** **Quitting** *Coefficient (t-statistic) for all data* Weibull model: 0.199 (0.930) Gamma model: 0.245 (1.210)* Weibull split-population model: 0.172 (0.940)* *Preferred models Although results were not reported price results were consistent by gender. **Other variables** Education had a significant effect on starting with those with a degree starting to smoke later and being less likely to take up the habit. **Sub-group results:** Yes. Gender (for ages 18-26). Hazard of starting for males: 0.11 (p=ns). Hazard of starting for females: 0.14 ($p<0.10$). **Elasticity calculations reported**: Yes. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Multiple sensitivity analyses: to check the split-population model a non-split model on the subsample starting smoking before 1990 was	**Authors' conclusions**. The price of tobacco has a significant role in the decision to start smoking, but not the decision to quit. However sensitivity analyses questioned the robustness of the results relating price to smoking initiation. Results for younger and older women were similar for initiation, but price had a significant effect for older men but not those aged 18 to 26. **Other comments** Price elasticities were not reported. The authors discussed discrepancies between their results and those of other researchers, particularly with respect to the non-significant effect of price on quitting.

Sampling scheme: Two sources are used: The National Health Survey (NHS 1990) was used for the main analyses; the National Drug Strategy Household Survey (NDSHS 1998) was used for sensitivity analyses (due to its smaller sample size). **Price data based on**: Price adjusted for quality (tobacco content). **Source of price data:** Time series data on cigarette price from an unpublished Australian Bureau of Statistics Source. **Years of data:** 1963 to 1999. **Source of variation:** Across capital cities (which captures differential state tobacco tax rates) and time.	variable); time (as a quartic polynomial to capture time effects since 1963) (both in the hazard part of the model only); gender; whether or not born in Australia (as a proxy for race which was not captured in the surveys; educational attainment (degree/trade/diploma/other). **Expected direction of results stated:** Yes but not for price. Those with higher levels of education are expected to be less likely to smoke (i.e. take longer to start). **Unit of analysis**: Individual. **Type of analysis**: Duration. **Form of model:** Starting analysis: Duration was estimated using a log-logistic distribution. A split population hazard model (Douglas and Hariharan).was also used. This used a log-logistic model for duration and a probit model for whether a person eventually starts smoking. Quitting analysis: Weibull and gamma models as well as a weibull split-population model. For the gamma models a test was made of whether weibull or log-normal distributions for modelling the hazard function were appropriate. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By adjusting for observed covariates (gender/nationality/education) and distribution of survival models. **Tests of model assumptions**: Yes. Tests of distributional shape of hazard function, plus whether male and female models can be pooled.	used and the results were similar. Models were repeated for the 18 to 26 age group and price results for men were no longer significant (coefficient 0.11, t-statistic 1.25) but results similar for women (coefficient 0.14, t-statistic not reported but $p<0.10$). For the 18 to 26 age group price did not have a significant effect on the age of starting smoking.	

Study details	Methods	Results	Conclusions
Lewit et al (1981)[41] **Objectives:** To examine the impact of three sets of government regulations on the demand for cigarettes by teenagers in the United States. Specifically to assess the effects of cigarette excise tax, the airing of anti-smoking messages on radio and television between 1967 and 1971 (the Fairness Doctrine) and the Public Health Cigarette Smoking Act of 1970 (ban on cigarette advertising after 1971). **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-sectional. **Years of data:** 1966 to 1970. **Survey details**: Cycle III of the US Health Examination Survey. **Sampling scheme:** Cycle III of the US Health Examination Survey (HES III) is a random sample of 6,768 non-institutionalised youths aged 12 to 17. **Price data based on**: Not stated. **Source of price data:** Tax Burden on Tobacco, measured in cents per pack adjusted for municipal excise and retail	**DATA DESCRIPTION** **Sample size used in models:** n=5,308 (whole sample) n=1,814 (before Fairness Doctrine) n=3,494 (during Fairness Doctrine) n=2,964 (subsample with no border effect, i.e. the border price is larger than or equal to the price in their own area). **Smoking behaviour outcomes:** Participation (smoking yes or no); number of packs smoked per day using categorical values: 0, 0.25, 0.75, 1.5, 2.5. Survey question details were not reported. **Data description:** 13.1% smokers (14.6% before and 12.4% after the Fairness Doctrine). **Cross-border issues accounted for:** Yes. By using 2 price variables. One for own price (the price in city and state of residence) and one for low price (the price in an area of low price if a youth lives within 20 miles of a lower-priced area; if not then the price in their own area). To control for cross-border purchases both own prices and the difference between own and low prices were included in the model. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Smoking participation (yes/no); number of packs smoked per day - frequency. **Explanatory variables:** Own price, difference between own price and low price, real family income (family income divided by the cost of living index), number of persons in household aged 20 or less (as a proxy for the number of children in the family), mothers working	**RESULTS** The price of cigarettes (in a respondents own city) had a negative and statistically significant effect in all models. Elasticities at sample means were (** Significant at 1%): **Total sample** **Participation** **[Model 1: -1.43**]** Model 2: -1.19** Model 3: -0.97** **Quantity smoked** **[Model 1: -1.44**]** Model 2: -1.44** Model 3: -1.42** **Quantity smoked by smokers** **[Model 1: -0.01]** Model 2: -0.25 Model 3: -0.45 The results also show that the border phenomenon is not an important issue in estimating youth cigarette demand, consistent with the idea that youths are less mobile and have less incentive to search for lower priced cigarettes. All coefficients for cross-border price differences were small and not significant. **Sub-group results:** No. **Elasticity calculations reported**: Yes. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Sub-group analysis to investigate cross-border price differences. Also 7	**Authors' conclusions** Teenage price elasticities of demand are large with a participation elasticity of -1.2 and a quantity smoked elasticity of -1.4, these are larger than corresponding adult elasticities. If future reductions are required then an increase in the Federal excise tax would be a relevant policy. The Fairness Doctrine had a substantial negative impact on teenage smoking participation. **Other comments**

sales taxes and deflated by a cost of living index. **Years of data:** 1966 to 1970. **Source of variation:** Across states and time.	status, absence of father from the household, level of parental education, age, gender, race, student status, whether or not youth has paid work during the school year, number of hours worked, part-time work during vacations, receipt of an allowance, region of residence, size of place of residence, parental smoking, mean smoking rate of youths in the locality (as a proxy for sibling and peer smoking), variables relating to the Fairness Doctrine, time, number of hours per day spent watching TV (as a proxy for exposure to TV cigarette advertising). **Expected direction of results stated:** Yes. That an increase in the Federal excise tax on cigarettes would reduce teenage smoking. **Unit of analysis**: Individual. **Type of analysis**: Cross-sectional. **Form of model**: Ordinary least squares regression for both the participation and quantity smoked models. Three models were estimated: model 1 included cross-border price differences between own state price and cross-border price; model 2 excluded cross-border price differences; model 3 was on a restricted sample of those unaffected by lower cross-border prices (the cross-border price difference was zero). **Was the model appropriate for the type of data**: Yes for quantity smoked; unclear for participation. **Attempts to control for heterogeneity**: Yes, by adjusting for observed covariates. **Tests of model assumptions**: No.	additional models to look at the effects of the Fairness Doctrine. Price results were unaffected.	

Study details	Methods	Results	Conclusions
Lewit et al (1997)[18] **Objectives:** To examine the effect of cigarette taxes, limits on public smoking, laws regulating access to tobacco by young people, and exposure to anti-tobacco messages on smoking participation and intention to smoke amongst ninth-grade students. **Specific to young people:** Yes. 9th grade (age 13 to 16). **Country:** USA and Canada. **DATA** **Source of smoking data:** Survey. **Type of data:** Repeated cross-sectional. **Years of data:** 1990 and 1992 were pooled (repeated cross-section of 9th grade students). **Survey details**: A project specific survey conducted as part of the COMMIT project. **Survey unit**: School-based. **Sampling scheme:** Data were derived from two school-based surveys (in 1990 and 1992 of 9th grade students in 21 communities (two in Ontario, rest USA). **Price data based on**: Average across	**DATA DESCRIPTION** **Sample size used in models:** 15,432 (all) 7,833 (boys) 7,599 (girls) **Smoking behaviour outcomes:** Participation: those who smoked at least one cigarette per day on one or more of 30 days preceding the survey. Intention to smoke amongst non-smokers measured by answering yes to the question "Do you think you will be smoking cigarettes one year from now?" Results for quantity smoked were not used as the sample is very young, and this measure is likely to be highly variable and measured with error. **Data description:** 21% smokers, 19% non-smokers who think they will be smoking within one year. Most students were aged 14 (65%) or 15 (24%). **Cross-border issues accounted for:** No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Smoking participation, intention to smoke (both binary outcomes). **Explanatory variables:** Price adjusted by an index to reflect cross-sectional variation in the price of goods and services bought by teenagers (including prices of hamburgers, pizza, beer, men's jeans, movie, Coke and game of bowling), index for exposure to pro- and anti-tobacco advertising (based on survey questions about any television, radio, billboard advertising. To account for correlation with smoking status, indices were weighted by the proportions of smokers and non-	**RESULTS** Elasticity (*p<0.05) **Participation** *Overall* -0.87* (price only model) **[-0.49 (price plus all covariates)]** **Intention to smoke** *Overall* -0.95* (price only model) -1.07* (price plus all covariates) **Other variables** Policies restricting smoking in schools and public places had little effect on smoking. Laws restricting cigarette purchasing to only those over 18 had significant negative effects on participation. Exposure to tobacco advertising in the media had a significant positive effect on participation and intention to smoke overall and for girls, indicating increases in smoking behaviour. **Sub-group results:** Yes. By gender, results reported previously. **Participation** *Boys* -1.51* (price only model) -1.02* (price plus all covariates) *Girls* -0.32 (price only model) -0.06 (price plus all covariates) **Intention to smoke** *Boys* -0.92* (price only model) -0.84 (price plus all covariates)	**Authors' conclusions** A variety of tobacco control policies, including higher excise taxes can be effective in reducing smoking participation amongst ninth-grade students. The price elasticity of participation is substantially higher for males than females. High prices are associated with large reductions in the intent to smoke among young non-smokers. However, the results showed no evidence that stronger restrictions on smoking in public places were related to reductions in youth smoking. **Other comments** In their discussion the authors discuss their findings in relation to those of other studies but do not consider potential reasons for any discrepancies.

packs (US) and Canadian prices. **Source of price data:** Nominal 1990 and 19932 cigarette price were taken for each community from "The Tax Burden on Tobacco" (The Tobacco Institute) where price reflects the average retail price of pack of 20 cigarettes inclusive of taxes. **Years of data:** 1990 and 1992. **Source of variation:** Across states and time.	smokers in the entire sample), stringency of school smoking policy (mean of responses regarding different school areas using same weights as for advertising), three indicator variables for ease of access to cigarettes (ban on vending machines, free samples and minimum purchase age restrictions), age, gender, race, year of survey. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Pooled repeated cross-sectional. **Form of model**: Logistic regression models. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. Via covariates and use of weighted indices of other anti-tobacco policies. **Tests of model assumptions**: Yes. Analyses used standard errors adjusted for clustering but there were no tests of model assumptions.	*Girls* -0.99* (price only model) -1.26* (price plus all covariates) **Elasticity calculations reported**: Yes. Elasticity = $\beta(1-d^*)p^*$ where β is logit coefficient, d^* is mean of dependent variable, and p^* is average price of cigarettes. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Separate models including price alone, and price plus other covariates. Conclusions were altered for participation overall, and intention to smoke for boys. Adjusting for other anti-tobacco policies resulted in smaller price elasticities in all cases, except for intention to smoke overall and for girls.	

Study details	Methods	Results	Conclusions
Lewit & Coate (1982)[42] **Objectives:** To examine the potential for reducing cigarette smoking through increases in excise taxes by analysing individual smoking behaviour. **Specific to young people:** No. Results reported separately for those aged 20 to 25. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-sectional. **Years of data:** 1976. **Survey details**: The Health Interview Survey. **Survey unit**: Household survey. **Sampling scheme:** The 1976 Health Interview Survey (HIS): a nationwide survey which collected data by household interview for a large sample of non-institutionalised adults. **Price data based on**: Weighted average across packs. **Source of price data:** Average cigarette price were calculated for each survey Primary Sampling Unit (PSU) in the Health Interview Survey (HIS)	**DATA DESCRIPTION** **Sample size used in models:** 19,268 (all); 11,052 (restricted sample to account for bootlegging); 1,472 (aged 20 to 25); 656 (men aged 20 to 25); 836 (women aged 20 to 25). **Smoking behaviour outcomes:** Binary variable for smoker or not. Number of cigarettes smoked per day overall and by smokers only. Details of survey questions not reported. **Data description:** % smokers: 36.4% (all data restricted sample), 39% (all aged 20 to 25), 45% (men), 35% (women). Mean (SD) amount smoked per day by smokers: 19.9 (11.7) (all data restricted sample), 17.2 (10.4) (all aged 20 to 25), 18.0 (10.4) (men), 16.3 (10.3) (women). **Cross-border issues accounted for:** Yes. By repeated analyses on a restricted sample by deleting data for individuals who lived in areas where the price was greater than the price within a 20 mile radius. Results are for restricted sample. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Smoking participation (yes/no); demand by smokers and non-smokers, demand by smokers. **Explanatory variables:** Average price per state, family income, family size, education, age, sex, marital status, race, region and city size characteristics (to partially control for cross-sectional differences in the cost of living). **Expected direction of results stated:** No.	**RESULTS** Price elasticity (*p<0.05, **p<0.01) **Participation** All: -0.135 Restricted sample: -0.264* **[Aged 20 to 25: -0.74]** Men aged 20 to 25: -1.276* * Women aged 20 to 25: -0.136 **Demand by smokers and non-smokers** All: -0.221 Restricted sample: -0.416** **[Aged 20 to 25: -0.89*]** Men aged 20 to 25: -1.401 * Women aged 20 to 25: -0.302 **Demand by smokers** All:-0.037 (all) Restricted sample: -0.103 **[Aged 20 to 25:-0.20*]** Men aged 20 to 25:-0.171 Women aged 20 to 25: -0.025 **Sub-group results:** Yes. By gender, results reported previously. **Participation** Men aged 20 to 25: -1.276* * Women aged 20 to 25: -0.136 **Demand by smokers and non-smokers** Men aged 20 to 25: -1.401 * Women aged 20 to 25: -0.302 **Demand by smokers** Men aged 20 to 25:-0.171 Women aged 20 to 25: -0.025	**Authors' conclusions** The results show that the overall price elasticity of demand for cigarettes is -0.42; the decision to begin smoking by men aged less than 25 years old is price elastic; and that price effects appear to be larger for men than for women. Income effects appear small relative to previous studies. In contrast to price, income appears to impact cigarette demand primarily by influencing the amount smoked, rather than the participation rate. **Other comments**

based on data from the Tobacco Tax Council. **Years of data:** Not reported but assumed to be 1976. **Source of variation:** Across states.	**Unit of analysis**: Individual. **Type of analysis**: Cross-sectional. **Form of model**: Ordinary least squares regression for the demand models. Full information maximum likelihood logit models for participation. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. Via covariates. **Tests of model assumptions**: Yes. Used variance components GLS to adjust for within and across PSU variation. Results were similar to the OLS regression.	**Elasticity calculations reported**: No but was calculated at sample means. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes, by repeating analyses using a restricted sample to account for bootlegging.	

Study details	Methods	Results	Conclusions
Liang & Chaloupka (2002)[56] **Objectives:** To investigate the differential effects of cigarette price on the intensity of youth smoking, taking into account the ordinal nature of smoking behaviour data. **Specific to young people:** Yes, 8th to 12th grade (ages 13 to 18). **Country:** USA. **DATA** **Source of smoking data:** Survey (schools). **Type of data:** Repeated cross-sectional. **Years of data:** 1992, 93 and 94. **Survey details**: The Monitoring the Future Survey. **Survey unit**: School-based. **Sampling scheme:** Data came from the 1992, 1993 and 1994 Monitoring the Future Surveys of 8th, 10th and 12th grade students. The sampling scheme was not reported but was stated to be nationally representative. **Price data based on**: Average across packs. **Source of price data:** State-level	**DATA DESCRIPTION** **Sample size used in models:** 110,717. **Smoking behaviour outcomes:** Recent cigarette smoking in the past 30 days with 7 response categories in the survey. These were collapsed into 5 categories due to small numbers in some categories: non-smokers; <1 cigarette per day; 1-5 per day; ½ pack per day, 1 or more packs per day. **Data description:** 77.1% non-smokers Amount smoked per day: 10.2% smoked <1 cigarette 6.3% smoked 1-5 cigarettes 3.4% smoked ½ pack 3.0% smoke one or more packs. **Cross-border issues accounted for:** Yes. By including a variable set at 0 for youths living in states with lower prices than nearby states or in counties more than 25 miles from another state, and 1 otherwise. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Amount smoked per day (as ordered categorical variable). **Explanatory variables:** Price category, dummy variables (0/1) for: living in a state that earmarks a portion of cigarette tax revenue for anti-tax revenues; a state with smoker protection legislation; indices for state and local clean indoor air laws (sum of five measures for: restrictions in private worksites, restaurants, retail stores, schools and other public places); youth access restrictions (sum of five measures for minimum	**RESULTS** **[No price elasticities reported]** Odds ratios (95% CI) *p<0.05, **p<0.01, ***p<0.001 for increasing the amount smoked (crossing from one threshold to the next), an odds ratio>1 indicates being less likely to increase the amount smoked. **Medium versus low price** 1.057 (1.014, 1.102)** moving from non-smoking to 1 per day 1.051 (1.001, 1.104)* 1-5 per day 1.094 (1.027, 1.165)** ½ pack 1.128 (1.035, 1.229)** 1 pack **High versus low price** 1.132 (1.077, 1.188)*** moving from non-smoking to 1 per day 1.190 (1.124, 1.260)*** 1-5 per day 1.255 (1.169, 1.348)*** ½ pack 1.307 (1.186, 1.439)*** 1 pack Pair-wise Wald tests were used to compare odds ratios and found significant differences in the effects of medium and high prices (p<0.01) and between the effect of high prices on the different thresholds of amount smoked (p<0.05), but no evidence that the effects of medium price differed between amounts smoked. **Other variables** A greater difference in prices between state of residence and nearby states increased the odds of smoking more (p<0.05), earmarking of tax revenues decreased the odds of smoking more by 27% (p<0.001), and stronger clean indoor air laws (p<0.001)	**Authors' conclusions** These results demonstrate the effectiveness of higher cigarette prices for controlling youth smoking. The negative effect of price was robust when allowing price effects to vary across different smoking intensities. **Other comments** The authors state that their estimates are consistent with other recent econometric studies suggesting that higher prices have the most effect on the initiation of regular smoking. A limitation of this research is that it was not possible to look at the effects of price changes within different categories of cigarette consumption. There was minimal description of the data or modelling methods used in this analysis. Prices were categorised by the authors rather than being left as a continuous variable and the results may be affected by the choice of cut-off points.

average price for a pack of 20 cigarettes from the "Tax Burden on Tobacco" (The Tobacco Institute). **Years of data:** Not reported but assumed to be 1976. **Source of variation:** Across states and time.	purchase age, free sample distribution, tobacco retailer licensing, point of sale signs about minimum purchase age); gender; race (black or not); age; frequency of participation in religious services; living in a rural area; living with parents; having siblings; parental education; mothers employment status whilst growing up; average number of hours worked weekly; income from employment and other sources; grade (8^{th} or 10^{th} versus 12^{th}); year of survey. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Pooled repeated cross-sectional. **Form of model**: Threshold of Change model estimated using maximum likelihood (a generalised version of the ordered logit model). All explanatory variables, except price, were assumed to have equal effects across all 4 thresholds of changes in the amount smoked. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. Via covariates. **Tests of model assumptions**: Yes. Test of equal price effects.	and youth access restrictions ($p<0.01$) were also related to a lower level of smoking intensity. **Sub-group results:** No. **Elasticity calculations reported**: Not applicable, elasticities were not reported. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes, by allowing the effects of price to vary across different smoking intensities, and also by treating the effects of price as fixed in order to compare the overall effect of price.	

Study details	Methods	Results	Conclusions
Nonnemaker (2002)[51] **Objectives:** This is a doctoral thesis. The objective was to examine the effects of tobacco control policies (state excise taxes, state tobacco control policies, school smoking policies, school smoking norms) and peer-smoking have on adolescent smoking behaviour. S**pecific to young people:** Yes, aged 13 to 18 (grades 7 to 12). **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-sectional and longitudinal. **Years of data:** 1994-1996. **Survey details:** The National Longitudinal Study of Adolescent Health (Add Health) [school and home sample]. **Survey unit:** School-based and home survey of school children. **Sampling scheme:** The National Longitudinal Study of Adolescent Health (Add Health). A nationally representative survey of American adolescents (in grades 7-12).	**DATA DESCRIPTION** **Sample size used in models:** N=66,539 (school data) N=17,226 (home data) **Smoking behaviour outcomes:** Smoking participation. Separate analyses of data collected at home and in school as survey questions differed; in-school surveys had a 12 months recall period whereas in-home surveys had a 30 day recall period. 3 dichotomous outcomes for school: any smoking in past 12 months; experimental (between twice a month and once a week in past 12 months); regular (from 3 days per week to every day). For home there were 7 dichotomous outcomes; any; experimental (2 definitions: any smoking on 20 out of past 30 days; and any smoking on any day over last 29 out of 30 days; regular (2 definitions: on at least 20 out of last 30 days; every day of last 30); light regular (smoked 1 to 10 on days smoked); heavy regular (smoked more than 10 on days smoked). Transition model: from the home questionnaires only, smoking status at second data collection either, non-current smoker, experimental smoker and regular smoker (as defined previously). **Data description**: School data: 36% any smoking; 26% experimental and 13% regular smokers. 19% black; 16% Hispanic; 50% female. Home data: 28% any smoking; 16% experimental and 14% regular smokers. 17% black; 13% Hispanic; 49% female. **Cross-border issues accounted for**: No. Descriptive only. **MODELLING** **Evidence of theoretical model:** No (?)	**RESULTS** Tax elasticities ***p<0.01 **p<0.05 *p<0.10. **School data:** Participation in experimental smoking **[All data: 0.03]** Participation in regular smoking - conditional on being at least an experimental smoker **[All data: 0.03]** **Home data:** Experimental smoking (smoked on 1 to 20 days in past 30 days) **[All data: -0.09]** Regular smoking (smoked on 20 to 30 days in past 30 days) - conditional on being at least an experimental smoker **[All data: 0.05]** Light regular smoking (1-10 per day) (0=reference category for experimental category, 1=light regular smoker) **[All data: 0.25**]** Heavy regular smoking (>10 per day) (0=reference category for light regular smoker, 1=heavy regular smoker) **[All data: -0.16**]** Transition to smoking states (home data) Experimental to non-smoking **[All data: 0.05]** Non to experimental smoking **[All data: -0.1]** Regular to experimental smoking	**Authors' conclusions**. State excise taxes do not have a significant negative effect on adolescent smoking participation, both experimental and regular smoking. State excise tax, for the full data sample, also did not have a significant effect on initiation or escalation. Tax did have a significant negative effect for some sub-groups: experimental smoking by black youths; heavy regular smokers; cessation by regular smokers. For experimental smoking, black men and women are more responsive to tax than any other group. Tax also had an effect on heavy smoking participation. **Other comments** The author acknowledges that his results are mostly null results and their validity is affected by possible measurement problems, omitted variable bias and the fact that it was not possible to control for unobserved state heterogeneity. Model fit was assessed and was found to be acceptable.

Price data based on: State excise tax per pack of 20. **Source of price data:** State excise tax data per pack of 20 cigarettes was obtained from the Add Health data. **Years of data:** 1995. **Source of variation:** Across states and time.	**Empirical model** **Dependent variables**: Participation with separate models of any smoking, experimental and regular smoking; quitting smoking; and transition between smoking states. For participation use: 1. Experimental smoker: choice of experimental versus non-experimental 2. Regular smoker: choice of becoming regular smoker conditional on being at least an experimental smoker Transition models use: For non-smokers at wave 1 probability of transition to an experimental or regular smoker at wave 2. For experimental smokers at wave 1 probability of transition to quitting or to regular smoker at wave 2. **Explanatory variables:** State excise tax; school grade; gender; race/ethnicity; parental education; family structure; region of the country; percentage of adults in a state who smoked two years prior to survey; school policy banning staff from smoking; penalties for students smoking in school; 5 binary variables for presence of state vending machine restrictions; marketing restrictions; tobacco law enforcement program; localities pre-empted from enforcement by state law; state enforcement authority for vending machine restrictions; 3 indices for number of state restrictions on vending machines, advertising restrictions, strength of law enforcement; amount of state funds and also staff devoted to tobacco control; instrumental variables for the proportion of students aged 14 or over and its square and cube, also the	**[All data:-0.08]** Non to regular smoking **[All data:-0.1]** Experimental to regular smoking **[All data:0.15*]** Further analyses of quitting for those who were experimental smokers in wave one found no significant effects of tax. For those who were regular smokers, tax was significant at the 10% level for quitting with elasticities of-0.38 or -0.35 (depending on the model). **Other variables:** School policies regulating and penalising smoking at school did not affect experimental or regular smoking. Policies prohibiting smoking on school grounds had a significant negative effect on quitting. State tobacco control policies showed little effect, with only some significant effects on Hispanic smokers. Tobacco control funding or staffing also showed little relationship to smoking behaviour. **Sub-group results:** Yes. Gender and race (results reported above). **School data:** Participation in experimental smoking White: 0.04; Black: -0.30***; Hispanic: 0.25**; Men: 0.08; Women: -0.03 Participation in regular smoking - conditional on being at least an experimental smoker White: -0.01; Black: 0.14; Hispanic: 0.01; Men:	

	mean age in the school plus its square and cube. Home sample also included imputed family income; adolescent income; work status; measures of peer smoking (proportion of experimental; proportion of regular smokers in the school); parental smoking. For the transition models; duration of regular smoking and duration of experimental smoking. **Expected direction of results stated:** Yes. Tax will have a negative relationship with the probability of smoking, with a stronger relationship with regular compared with experimental smoking. For transition, that excise tax has a negative effect on initiation and a positive effect on quitting. **Unit of analysis**: Individual. **Type of analysis**: Pooled cross-sectional and cross-sectional. **Form of model:** School sample: logistic regression to estimate smoking participation and also experimental and regular smoking. Home sample: logistic regression for participation (any, experimental and regular); logistic regression to estimate probability of quitting; multinomial logistic regression to estimate probability of transition between smoking states (as 2 waves of data were available). 3 models for school analyses: one included tax plus controls; 2 included percentage of adults in state who smoked; 3 included these plus all tobacco policy variables. 2 models for home analyses: 1 included excise tax plus controls; 2 included these plus the percentage of adults smoking in a state. Analyses accounted for the complex survey design of the data. **Was the model appropriate for the type of data**: Yes.	-0.09; Women: -0.01 **Home data:** Experimental smoking (smoked on 1 to 20 days in past 30 days) White: -0.08; Black: -0.20; Hispanic: 0.33; Men: -0.11; Women: -0.08 Regular smoking (smoked on 20 to 30 days in past 30 days) - conditional on being at least an experimental smoker White: 0.06; Black: -0.10; Hispanic: 0.001; Men: -0.02; Women: 0.11* Light regular smoking (1-10 per day) (0=reference category for experimental category, 1=light regular smoker) White: 0.27***; Black: 0.22; Hispanic: 0.26; Men: 0.13; Women: 0.33** Heavy regular smoking (>10 per day) (0=reference category for light regular smoker, 1=heavy regular smoker) White: -0.18***; Hispanic: 0.44; Men: -0.22**; Women: -0.11 Transition to smoking states (home data) Experimental to non-smoking Men: -0.08; Women: 0.15 Regular to non-smoking All data: 0.31; Men: 0.47; Women: 0.07 Non to experimental smoking	

	Attempts to control for heterogeneity: Yes. By use of covariates. **Tests of model assumptions**: Yes. Using Hosmer-Lemeshow goodness of fit statistics; RESET tests of the adequacy of the logistic specifications; test of heteroscedasticity; and an omitted variables test.	White:-0.16; Black:0.36; Hispanic:0.33; Men: -0.1; Women:-0.11 Regular to experimental smoking All data:-0.08; Men: -0.54; Women:0.33 Non to regular smoking White:0.03; Black:-0.98; Hispanic:0.72; Men: 0.15; Women:-0.30 **Elasticity calculations reported:** No **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Models re-run with various definitions of experimental smoking (eg smoked 1 to 29 days in past 30 days) and regular smoking (smoked every day in past 30 days; light regular smoker (1-10 per day); heavy regular smoker (>10 per day)). Different models with and without the percentage of adult smokers; also exploration of multicollinearity between tobacco policies by modelling using single indicators and indices of a number of policies. Including the percentage of adult smokers did not affect the tax effect for the school data. Variance inflation factors were used to assess multicollinearity.	

Study details	Methods	Results	Conclusions
Ohsfeldt et al (1998)[52] **Objectives:** To test the effect of various tobacco control measures on youth cigarette demand using a 1996 nationally representative survey of US high school students. **Specific to young people:** No. Analysis of men only but reported results for ages 16 to 24. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-sectional. **Years of data:** Pooled data from September 1992, January and May 1993. **Survey details**: Current Population Survey. **Survey unit**: Household survey. **Sampling scheme:** Data from the Current Population Survey (CPS). CPS provides a nationally representative sample of over 100,000 individuals in each wave. **Price data based on**: State and local taxes. **Source of price data:** Tax data from	**DATA DESCRIPTION** **Sample size used in models:** N=165,653 (full sample) Not reported for 16 to 24 year olds. **Smoking behaviour outcomes:** Survey questions were "Do you smoke?", "What age were you when you started smoking?" (current and ex-smokers) and "how long ago did you stop smoking" (ex-smokers). 1993 survey did not ask about quitting so only uses data from the 1995 and 1997 editions. **Data description:** All males white or black (other races were excluded) aged 16 or over. 18% current cigarette smokers. **Cross-border issues accounted for:** No. **MODELLING** **Evidence of theoretical model:** Yes. A conceptual model of cigarette demand assuming the likelihood of cigarette use is affected by price, income, smoking regulations and demographic characteristics. **Empirical model** **Dependent variables**: Cigarette use (yes/no). [Only results for cigarettes are extracted here]. **Explanatory variables:** Cigarette tax; snuff tax; personal income (adjusted for across state differences in general price levels); educational attainment (high school or college/ less than high school); race; marital status; % of the population in an area who are fundamentalist Protestants and those with no active religious affiliation are used to try and capture tobacco attitudes due to religious beliefs; an index for tobacco restrictions (categorised as 1 for restrictions in private workplaces; 0.75 for no smoking in 75% of restaurant seats; 0.5 for restrictions in 4 or more areas but not	**RESULTS** **Males by age group** Tax elasticity (* if p<0.01) **[-0.22* (16 to 24)]** Results from model treating tax and smoking regulations as endogenous. **Sub-group results:** Yes, by sex which are reported above. **Elasticity calculations reported**: No. **Other variables:** The index of all smoking regulations had a negative statistically significant effect for all age groups. Restrictions on smoking in 'other' places had more effect on young men aged 16 to 24 than those aged over 24 but workplace restrictions had more effect on those aged over 24. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes, by using multiple model specifications and presenting results for all models, as well as those considered to be most appropriate for the data. Model was assessed for endogeneity of taxes and regulations on smoking. Models reject exogeneity and proceed by estimation using the instrument variable technique. No reporting of over-identifying restrictions or of suitability of instruments used.	**Authors' conclusions** Although the results are not dramatically different across age groups, in general young males are more responsive to tobacco tax rates than those over 24. There appears to be relationships between tobacco and snuff in the effect of tobacco policies, as cigarette tax increases appear to increase snuff use amongst men aged 16 to 24. **Other comments** The survey data used was problematic in that it used proxy responses for teenagers which increases bias caused by under-reporting of tobacco use. Only current cigarette use, not amount smoked, could be assessed.

the Tobacco Institute annual reports. Average excise tax for each MSA was a weighted average of state and local excise taxes. **Years of data:** 1992, 1993. **Source of variation:** Sub-state (MSA).	workplaces and restaurants; 0.25 for restrictions in 1 to 3 other places; and 0 otherwise); the components of this index were also fitted as individual variables. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Cross-sectional. **Form of model**: Logistic regression model. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By covariate adjustment. **Tests of model assumptions**: Partial tests. Some tests of exogeneity of taxes and smoking regulations.		

Study details	Methods	Results	Conclusions
Powell et al (2005)[43] **Objectives:** To examine the determinants of smoking among high school students incorporating peer effects and allowing cigarette prices and tobacco control policies to have a direct and indirect effect on smoking behaviour. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-sectional. **Years of data:** 1996 (March-July). **Survey details:** "The Study of Smoking and Tobacco Use Among Young People". **Survey unit:** School-based. **Sampling scheme:** Audits & Surveys 1996 survey data of high school students across the US from the "The Study of Smoking and Tobacco Use Among Young People" are used. **Price data based on**: Weighted average across packs. **Source of price data:** State-level	**DATA DESCRIPTION** **Sample size used in models:** Sample size for all models is 12,205. **Smoking behaviour outcomes:** Binary outcome based on "Think about the last 30 days. On about how many of those days, if any, did you smoke?" Smoking any amount on one or more of those days = current smoker. School-based peer smoking measure which is the average prevalence of smoking among all other respondents at their school. **Data description**: 27.6% of the full sample smoked in the last 30 days. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** Two-stage generalised least squares model, specifically Amemiya's Generalized Least Squares (AGLS) estimator for a dichotomous dependant variable. **Empirical model** **Dependent variables**: Smoking participation (yes/no for if smoked in the previous 30 days). **Explanatory variables:** School-based peer measures, vector of personal and family characteristics, school-based smoking policy measure and vector containing cigarette prices and tobacco control policies. **Expected direction of results stated:** Yes, that higher levels of peer smoking will increase the probability of individual youth smoking. Also that higher cigarette prices and stronger tobacco	**RESULTS** **[Smoking participation: Based on the probit model with peer effects (Model 1a) direct price elasticity of youth smoking is -0.3145 (p<0.01)**.] Based on a youth smoking participation model that does not account for peer influences the total price elasticity of youth smoking participation is -0.4888. Based on the results from the AGLS model, the total price elasticity of youth smoking participation is estimated to be -0.4982 (comprised of a direct price elasticity measure of -0.3152 and an indirect price elasticity measure that operates through peer effect of -0.1830). **Sub-group results:** African American, Hispanic and Asian youths are significantly less likely to smoke than white youths, by 16, 6 and 11 percentage points. Students who attend religious services at least weekly are likely to smoke by 9 percentage points and those who live alone are about 21 percentage points more likely to smoke. Price elasticities are not reported for these groups. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes, undertaken to gauge bias due to the variable omission of cigarette prices and tobacco control policies in the peer effects model. Omission leads to an overestimate of	**Authors' conclusions**. The key finding is that peer effects play a significant role in youth smoking decisions. Moving a high-school student from a school where no children smoke to a school where a quarter do would increase the probability that they smoke by 14.5 percentage points. **Other comments** The main aim of the paper was to assess the effects peer pressure, price was a subsidiary investigation.

average price for a pack of cigarettes from the Tax Burden on Tobacco as published by the Tobacco Institute (1996, 1997) – the weighted average of a single pack, carton, and vending machine price, including state excise taxes. **Years of data:** 1996, 1997. **Source of variation:** Across states.	control policies will have a direct and indirect negative impact on the probability of youth smoking. **Unit of analysis**: Individual. **Type of analysis**: Cross-sectional. **Form of model:** Probit regression model. Model 1 is a probit model that assumes that the peer effect measure is exogenous. Model 2 is an AGLS estimator that accounts for the potential endogeneity of the peer effect measure. Model 3 is a standard youth smoking model that does not account for peer effects. Model 1 provides the main elasticity result as tests for exogeneity of peer effects cannot be rejected. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. Control by covariates. The models control for school-level factors such as school-based restrictions on smoking and peer effects. **Tests of model assumptions**: Yes. 1. Test of exogeneity of peer smoking variable using Smith-Blundell exogeneity test. 2. Test of relevance of instruments. 3. Over-identification test of instrument validity.	peer influences on youth smoking participation. As an alternative price measure, peer youth smoking models were estimated using the state-level excise tax on a pack of cigarettes.	

Study details	Methods	Results	Conclusions
Ross & Chaloupka (2004)[44] **Objectives:** To test the effects of various tobacco control measures on youth cigarette demand. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-section. **Years of data:** 1996. **Survey details: "**The Study of Smoking and Tobacco Use among Young People". **Survey unit:** School-based. **Sampling scheme:** "The Study of Smoking and Tobacco Use among Young People" was a self-administered questionnaire survey among high school students. **Price data based on**: Weighted average across packs. **Source of price data:** The survey obtained information on students' perceived price based on survey participants (smokers and non-smokers) and a weighted average state price of a cigarette pack from	**DATA DESCRIPTION** **Sample size used in models:** 16,154 students for the probit model and 4358 for GLM. **Smoking behaviour outcomes:** Two measures were constructed. 1. Dichotomous indicator of smoking participation (1=smoked at least 1 day in last 30 days before the survey, 0 otherwise). 2. Continuous variable that describes the average number of cigarettes consumed during the 30 days before the survey. **Data description**: Average age of sample 15.75 years, 49.6% male, 15% black Of the sampled population of high school students 31.4% are smokers. Median of the monthly cigarette consumption for the sample was 45 cigarettes. **Cross-border issues accounted for**: Yes. 1. Difference between average price in state of residence and average price in lowest priced state within 25 miles. 2. Similar, but represents the difference in state excise taxes. **MODELLING** **Evidence of theoretical model:** Yes. Two-part model developed by Cragg (1971) in which the propensity to smoke and the intensity of	**RESULTS** From the probit model (*p<0.10, **p<0.05): <u>Participation</u> Models based on index of state policy variables (see explanatory variables). **[Price elasticity for state average price: -0.351*]** Price elasticity for average perceived price: -0.492** From the GLM model (*p<0.10, **p<0.05): <u>Quantity smoked for smokers</u> **[Price elasticity for state average price: -0.199 (not significant)]** <u>Total price elasticity</u>. **[Overall (price elasticity): -0.722.]** **Sub-group results:** No. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** No.	**Authors' conclusions**. Only some policies have the expected effect on youth cigarette demand represented by these models. Restrictions on smoking in restaurants have a negative effect on both smoking participation and smoking intensity (at the 10% level) in two out of four models. Smoking restrictions in shopping areas and limiting sales through vending machines may reduce smoking participation, but the results are not statistically significant. Restrictions on smoking in private workplaces and in other places and bans on free sample distributions do not have the expected results. Higher prices negatively affect both smoking prevalence and smoking intensity in all of the models. State average price is not significant in the conditional demand equation. **Other comments**

the Tobacco Institute. **Years of data:** 1996**.** **Source of variation:** State level**.**	cigarette consumption are modelled separately. **Empirical model** **Dependent variables**: Smoking participation and average consumption. **Explanatory variables:** Sociodemographic characteristics, income variables, cigarette prices, smuggling incentives for cross-border issues, and public policies including: 1) Existence of state law pre-emption over local legislation which eliminates the power of local government to regulate tobacco. 2) Active enforcement of public policies – for dummy variables to account for existence of enforcement laws. Variable created to represent the number of public policies enacted (variables are collinear when entered separately). **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Cross-sectional. **Form of model:** Generalized Linear Model and Probit Model. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes, though covariates. **Tests of model assumptions**: Yes, test of co-linearity between policy variables.		

Study details	Methods	Results	Conclusions
Ross et al (2001)[57] **Objectives:** To examine the differential effects of cigarette prices, clean indoor air laws, youth access laws and other socio-economic factors on smoking uptake among high school students. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-sectional. **Years of data:** 1996. **Survey details:** The Study of Smoking and Tobacco Use Among Young People. **Survey unit:** School-based. **Sampling scheme:** "The Study of Smoking and Tobacco Use Among Young People" is a survey of 17,287 survey participants attending 202 US high schools. **Price data based on**: Weighted average across packs. **Source of price data:** Tobacco Institute, 1997 – state cigarette price. Weighted state average of a single pack, carton, and vending machine	**DATA DESCRIPTION** **Sample size used in models:** 16,558 students were classified to one of the uptake stages. **Smoking behaviour outcomes:** Five uptake stages were defined (refer to paper for definitions). Stage 1 – low risk cognition smoker. Stage 2 - high risk cognition smoker or low risk cognition puffers. Stage 3 – high-risk cognition puffers or low-risk cognition experimenters. Stage 4 - high-risk cognition experimenters or low-risk cognition established smokers. Stage 5 – Addicted/established smokers **Data description**: About a quarter of students are in the first stage are in the first stage of smoking uptake, but over 40% belong to the two highest uptake stages. **Cross-border issues accounted for**: Yes. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Smoking uptake stage. **Explanatory variables:** Age, racial/ethnic background, religiosity, household arrangement (living with parents, with others or alone),	**RESULTS** **[No price elasticities reported.]** Coefficients for model with state average price (* p<0.01, ** p<0.05): Stage 2,3,4 or 5: -0.383** Stage 3,4 or 5: -0.387** Stage 4 or 5: -0.400** Stage 5: -0.478** Coefficients for model with average perceived price (* p<0.01, ** p<0.05): Stage 2,3,4 or 5: -0.336** Stage 3,4 or 5: -0.354** Stage 4 or 5: -0.367** Stage 5: -0.457** **Sub-group results:** No. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** No.	**Authors' conclusions**. Higher cigarette prices reduce the probability of being in a higher stage of smoking uptake. The further students are in their smoking uptake progress the more they are sensitive to cigarette prices. The compliance with youth access laws reduced the probability of being in a higher stage of smoking uptake. Preemption of local tobacco regulations by state law and the "smuggling" incentives are associated with greater probability of being in higher stages of the smoking uptake. Controlling for the state sentiment towards tobacco consumption did not substantially affect the results. **Other comments**

price, including state excise taxes. Another price measure, average perceived price, was constructed from the survey based on the question "How much does a pack of cigarettes cost in your area?". **Years of data:** 1997. **Source of variation:** Across states.	income, labor force participation, urban status, parents' marital status, parental education, parents' working status, state cigarette prices, tobacco control policy variables, pre-emption laws, state sentiment. **Expected direction of results stated:** No. **Unit of analysis**: Individual in schools. **Type of analysis**: Cross-sectional. **Form of model:** Generalized ordered logit model. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: No. **Tests of model assumptions**: No.		

Study details	Methods	Results	Conclusions
Slater et al (2007)[58] **Objectives:** To examine the differential associations of cigarette retail marketing practices on youth smoking uptake. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-section. **Years of data:** 1999-2003. **Survey details:** Monitoring the Future (MTF) survey. **Survey unit:** School-based. **Sampling scheme:** Monitoring the Future (MTF) survey uses a multistage sampling design to obtain nationally representative samples of 8th-, 10th and 12th-grade students. **Price data based on**: Average of premium brands. **Source of price data:** Measure of price is the average price of premium-brand cigarettes (Marlboro and Newport) across all stores in a	**DATA DESCRIPTION** **Sample size used in models:** Sample size for all models is 26,301. **Smoking behaviour outcomes:** Level of uptake smoking. Uptake measure based on three MTF questions: 1) never smoking, 2) smoking in the past 30 days, and 3) intention to smoke in the next 5 years. The uptake measure comprised the following categories: 1) never smoker, 2) puffer [someone who has smoked once or twice], 3) nonrecent experimenter [student who smoked occasionally, but not in last 30 days], 4) former established smoker [student who smoked regularly, but not in last 30 days], 5) recent experimenter [smoked occasionally, but not regularly in last 30 days], 6) current established smoker [smoked regularly in the past and smoked in last 30 days]. The mean for smoking uptake was 1.23 indicating that the average student was somewhere between a puffer and a nonrecent experimenter. **Data description**: The sample comprised: 53.7% never smoker; 20.7% puffer; 4.1% nonrecurrent experimenter; 3.1% former established smoker; 6.9% recent experimenter; 11.5% current established smoker. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No.	**RESULTS** **[No price elasticities reported].** Pairwise Wald tests showed significant differences in moving from threshold 1 to 2 for price (p=0.03), while the effects of price are equal across the remaining stages of uptake. For promotions there are significant differences in moving from threshold 3 to 5 and from threshold 4 to 5 (p=0.05 for both). If stores had no advertising there would be a relative 11.25% decline in puffers, and increasing advertising in stores would result in a 10.86% increase in puffers. If all stores had some type of promotions, current established smokers would experience a relative increase of 16.58% and completely eliminating promotions would yield a 13.39% relative decline in current established smokers. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** No.	**Authors' conclusions**. Point-of-sale advertising is associated with encouraging youth to try smoking, whereas cigarette promotions associated with influencing those youth already experimenting with cigarettes to progress to regular smoking, with established smokers being most influenced by promotional offers. Price-based promotional offers are appealing to young price-sensitive smokers. The beneficial effects of higher cigarette prices are undermined when youth are able to take advantage of cigarette promotions. Higher cigarette prices are associated with discouraging youth from progressing to established smoking at most levels of smoking uptake. Price was only insignificant at threshold 1, possibly because youth who first initiate tobacco are more likely to obtain cigarettes from a source other than a store. **Other comments**

community. **Years of data:** 2003. **Source of variation:** Across states and time.	**Empirical model** **Dependent variables**: Smoking uptake. **Explanatory variables:** Cigarette marketing variables, premium price, grade, sex, weekly income, living circumstances, parents educational level, race, setting, smoke-free air index, purchase, use or possession (PUP) index, youth access index. **Expected direction of results stated:** Yes. That there is a link between advertising and promotions and encouraging adolescents to initiate smoking. **Unit of analysis**: Individual. **Type of analysis**: Pooled cross-sectional. **Form of model:** Generalized ordered logit model. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: All analyses controlled for student grade, sex, race/ethnicity, whether student lives with both parents, students income, parents level of education, urbanisation, state-level tobacco control policies, and year of data collection. **Tests of model assumptions**: Yes. Test of GOP model and equal price effects across thresholds.		

Study details	Methods	Results	Conclusions
Tauras (2005)[45] **Objectives:** To inform policymakers on the impact of cigarette prices and restrictions on smoking in private worksites, restaurants, government worksites, healthcare facilities and other public places on smoking uptake. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** longitudinal. **Years of data:** 1976 to 1995. **Survey details:** The Monitoring the Future project. **Survey unit:** School-based. **Sampling scheme:** Nationally representative cross-sectional survey using random samples (between 15,000 and 19,000 per year) of high school seniors. **Price data based on**: Weighted average across packs. **Source of price data:** The 'Tax Burden on Tobacco' (Tobacco Institute, 1999). Weighted average of	**DATA DESCRIPTION** **Sample size used in models:** n=44,985 (170,684 person-years) n=21,873 (59,884 person-years) smoked in past 30 days. After excluding missing data 7,489 (5,383 people); 6,029 (4,259 people) and 7,106 (4,699 people) observations were used in the analyses of daily, moderate and heavy uptake respectively. **Smoking behaviour outcomes:** Transition in smoking status between successive waves of data collection. Daily uptake is the transition from non-daily smoking in previous data collection to smoking one or more in current wave; moderate uptake is the transition from smoking 1-5 per day to smoking 10 or more per day; heavy uptake is transition from smoking 10 per day to smoking 1 or more packs per day. Also participation: whether or not smoked in last 30 days. **Data description**: 24.96% of non-daily smokers became daily smokers; 32.73% of light smokers became moderate smokers and 32.76% of moderate smokers became heavy smokers. Approximately 92% male; mean age 24. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Time to transition from one smoking state to a higher smoking state. **Explanatory variables:** Price; dichotomous indicators for smoking restrictions in each of the following places: private worksites, restaurants, government worksites, healthcare facilities and other public places; race (white or otherwise); age; gender; marital status; attendance at	**RESULTS** The real price of cigarettes had a negative and statistically significant on all three smoking outcomes: **Price elasticity** *Duration results from discrete time hazard models* **[-0.646 (daily uptake)]** (e.g.) 10% increase in price will reduce daily uptake by 6.46%. **Other smoking restrictions** Private worksite laws and restrictions on smoking in public places were found to have negative significant effects on moderate smoking uptake by employed young adults. Real income also had a negative significant relationship with smoking progression. **Sub-group results:** Yes. -0.576 (moderate uptake) and -0.412 (heavy uptake). **Elasticity calculations reported**: No but they were calculated holding all independent variables at their mean values. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. By assessing the inclusion of state fixed effects; by repeating models on a sub-sample of those not residing in a tobacco-producing state, or Utah during the survey years Results were similar to those presented.	**Authors' conclusions**. These results support the hypothesis that increasing the price of cigarettes would decrease the numbers of young adults who progress into higher smoking intensities. As health consequences of smoking are a function of the intensity and duration of smoking, an increase in excise taxes and greater enactment of private worksite and other public place smoking, will likely reduce future death and disease caused by tobacco use in the United States. **Other comments** Use of longitudinal data and time fixed-effects to try and account for unobserved heterogeneity. A limitation of the survey data is that information for school drop-outs and those home-schooled is not available which may bias the results (although likely to be a small group).

price for the first six months of a year for a pack of 20 (including state and federal taxes). **Years of data:** Appear to be the same years as the survey data (1976 to 1995). **Source of variation:** Across states and time.	religious services; real income; years of schooling; college status; indicators for year (year fixed effects); indicators for divisional areas in the US (New England, Mid-Atlantic, East and West North Central, South Atlantic, East and West South Central, Mountain and West); 2 indicators for state-smoking sentiment (if resided in a tobacco-producing state; and if residing in Utah (high Mormon population) or not). **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: 1) To test model assumptions and attrition a two-part model was used which modelled only the first observation per person, using OLS regression. This included an attrition indicator and interactions between this and price (and policies). Interactions were not significant indicating no difference in price-responsiveness between those who dropped out of the data collection and those who provided data. 2) To obtain price effects on smoking uptake a duration analysis was undertaken. **Form of model:** A discrete time duration model using a probit model to estimate the hazard rate. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By including year fixed effects. State fixed effects were also explored but these were removed as they eliminated most of the variation in price. **Tests of model assumptions**: Yes. Tests for sample selection caused by smoker attrition from the survey. This found that attrition was not problematic for estimating price effects although smokers were more likely to drop out of the sample than non-smokers.		

Study details	Methods	Results	Conclusions
Tauras (2004)[46] **Objectives:** To examine if increased cigarette prices, as a consequence of excise tax increases, and implementation of stronger smoking restrictions in private worksites and other public places have an impact on the smoking cessation decisions of young adults. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Longitudinal. **Years of data:** 1976 to 1993. Interviews at 2 year intervals. **Survey details:** The Monitoring the Future project. **Survey unit:** School-based. **Sampling scheme:** Nationally representative cross-sectional survey using random samples (between 15,000 and 19,000 per year) of high school seniors. **Price data based on**: Weighted average across packs. **Source of price data:** The 'Tax	**DATA DESCRIPTION** **Sample size used in models:** n=Not reported. **Smoking behaviour outcomes:** Survey asked 'How frequently have you smoked cigarettes during the past 30 days?' This was used to create a dichotomous variable for smoking participation (1 if smoked in previous 30 days, 0 otherwise). **Data description**: 44.4% male and 85.9% white. Numbers residing in states with smoking restrictions: 17.3% private worksite; 26.1% restaurants; 38.9% other clean air restrictions. Mean (SD) years of schooling: 12.5 (1.76). **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No **Empirical model** **Dependent variables**: Duration - time to quit smoking, conditional on being a smoker. **Explanatory variables:** Price; three dichotomous indicators for smoking restrictions in each of: private worksites, restaurants, and other public places; gender; race (white or not); real yearly income; frequency of participation in religious services; type of community (rural or suburban); number of hours worked per week; marital status; living arrangements (parents/alone/spouse/children); number of formal school years completed; college attendance; fathers education; mothers education; mothers working status; indicator for survey year; indicators for residing in various areas of the US (New England/New Jersey or New York/East/South East/Midwest/South/Plains/Mountain/North West).	**RESULTS** The real price of cigarettes had a statistically significant positive effect on the quitting hazard in all models. Price elasticities on probability of quitting (*** sig at 1%, ** sig at 5%, * sig at 10%; two-sided): **[Main result: Model 5: 0.269* - 10% increase in price = 3% increase in quite rate]** The main model includes 3 indoor smoking restrictions and set of dummy variables representing census division areas (9 in total), plus other explanatory variables. Model 1: 0.377*** Model 2: 0.415*** Model 3: 0.466*** Model 4: 0.417*** Model 5: 0.269* Model 6: 0.274* Model 7: 0.293** Model 8:0.291** **[Average across 8 specifications of the hazard model: 0.350]** The most comprehensive model is model 5 which includes regional dummy variables. **Other smoking restrictions** Mixed results were found for the effect of clean indoor air laws. Restrictions in smoking in private worksites had a positive impact in all models but when regional fixed effects were controlled for these results were no longer statistically significant. The average hazard ratio implies that those living in states with worksite restrictions have a 4.55% greater	**Authors' conclusions**. These results support the hypothesis that increasing the price of cigarettes would increase the number of young adults who quit smoking. The estimated average elasticity of 0.35 suggests that a 10% increase in price will increase the likelihood of young adult smoking cessation by 3.5%. **Other comments** Use of longitudinal data which enables tracing if individual smoking behaviour over time. Use of regional fixed-effects to try and account for unobserved heterogeneity due to smoking attitudes in different areas of the US.

Burden on Tobacco' (Tobacco Institute). Weighted average of price for the first six months of a year for a pack of 20 cigarettes based on the price of single packs, cartons, and vending machine sales where the weights are national proportions of each type of sale (including state and federal taxes). **Years of data:** Appear to be the same years as the survey data (1976 to 93). Individuals as re-sampled a 2-yearly intervals. **Source of variation:** Across states and time.	Note: all variables are included as time-varying variables except for gender, race and parental education and not all variables were included in all models (see below). Missing value indicators used to prevent excluding cases with missing data. **Expected direction of results stated:** Yes. **Unit of analysis**: Individual. **Type of analysis**: Duration. **Form of model:** Duration using stratified Cox regression model. Group stratification was conditional on the number of previous quit attempts (each person assumed to not be at risk for a quit attempt unless a previous attempt had occurred). Eight models were estimated: model 1 with price, each clean air variable, socio-economic factors and year fixed effects; models 2 to 4 the same as this but with only one clean air indicator in each model; models 5 to 8 the same as these but also including nine dichotomous census division indicators to control for regional fixed effects. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By use of covariates. **Tests of model assumptions**: No.	probability of quitting smoking. Restrictions on smoking in restaurants only had a significant positive impact only when regional effects were not controlled for. **Sub-group results:** No. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. By using multiple models to account for multicollinearity amongst clean air laws, and to explore the effect of regional and year fixed effects. Price results remained consistent across all models.	

Study details	Methods	Results	Conclusions
Taurus & Chaloupka (1999)[47] **Objectives:** To investigate the determinants of the decision to quit smoking by young adults and to look at the effects of price, clean indoor air laws and other socio-economic factors have on smoking cessation by males and females separately. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** School-based. **Years of data:** 1976 to 1995. **Survey details:** The Monitoring the Future project (Institute for Social Research, University of Michigan). **Survey unit:** Longitudinal. **Sampling scheme:** Nationally representative cross-sectional survey using random samples (between 15,000 and 19,000 per year) of high school seniors. **Price data based on**: Weighted average across packs. **Source of price data:** The 'Tax Burden on Tobacco' (Tobacco	**DATA DESCRIPTION** **Sample size used in models:** n=4,826 (women) and n=4,752 (men). Those surveyed one year after baseline and non-smokers at baseline (those not at risk of making a transition in smoking status) were excluded from analyses. **Smoking behaviour outcomes:** Survey asked 'How frequently have you smoked cigarettes during the past 30 days?" this was used to create a dichotomous variable for smoking participation. This was tracked over time to measure duration of smoking (until quitting or censoring). As follow-ups were every 2 years, smoking in past month may not be an ideal measure of quitting status as re-initiation of smoking data were not collected. **Data description**: Mean time to quitting 3.79 years (men), 4.48 (women); 8.4% white; mean age 23.01 (men), 23.25 (women). **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Time to quitting for smokers. **Explanatory variables:** Price; age; average real yearly income from employment (deflated by CPI 1982-84); number of years of formal schooling; average number of hours worked weekly; race (white/black); college student status; frequency of participation in religious services; marital status; family structure; type of city (urban/suburban/rural). Indicators for region	**RESULTS** Cigarette price had a positive and significant ($p<0.01$ in all models) effect on the hazard of quitting. **[Average across 4 specifications of the hazard model for males and females: 1.155]** **Other variables** Smoking restrictions in private workplaces had a positive effect on employed young women, but other laws had little effect on either men or women. The effects of income were not significant for men or women. **Sub-group results:** Yes, results were only presented by gender. Estimated price elasticities were: **Men:** Model 1: 1.07 Model 2: 1.08 Model 3: 1.17 [Model 4: 1.15] Average: 1.12 **Women:** Model 1: 1.21 Model 2: 1.17 Model 3: 1.20 [Model 4: 1.17] **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. By using multiple models to account for	**Authors' conclusions**. This paper is the first piece of research to conclude that price is positively to the probability of smoking cessation for young adult men and women. Average price elasticities were 1.12 for men and 1.19 for women which indicate that large increases in cigarette taxes would lead to a significant number of young adults to quit smoking. **Other comments** Paper also contains a good review of previous research.

Institute). Weighted average of price for the first six months of a year for a pack of 20 cigarettes based on the price of single packs, cartons, and vending machine sales where the weights are national proportions of each type of sale (including state and federal taxes). **Years of data:** 1976 onwards, final date is unclear. **Source of variation:** Across states and time.	(Northeast/South/Midwest/West), year and year squared (to account for regional and time trends).State-level indicators for clean indoor air laws: 3 dichotomous indicators for the present of restrictions in private worksites, restaurants and any other public places; and index of the strength of clean air restrictions was also used (grade from 0 (none) to 4 (maximum)). To control for differences in the effect of worksite restrictions between those with and without employment an interaction term between work status and private worksite restrictions was created, when this was included in the model the clean air index excluded private worksite restrictions. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Duration. **Form of model:** Cox regression. Missing value indicators were used. Separate models for men and women. Four models were used: model 1 adjusted for price, demographic data and time; model 2 included an additional clean air index variable; model 3 replaced the clean air index with the 3 separate indicators for different restrictions; model 4 is the same as model 2 but including an interaction between work status and private worksite restrictions. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By use of covariates. **Tests of model assumptions**: No.	different measures of clean indoor air restrictions. The price results were similar across all 4 models.	

Study details	Methods	Results	Conclusions
Tauras & Chaloupka (1999)[48] **Objectives:** To provide the first detailed analysis of the impact of cigarette prices and clean indoor air laws on young adult cigarette consumption using individual fixed effect modelling of nationally representative longitudinal data. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** School-based. **Years of data:** 1976 to 1993. **Survey details:** The Monitoring the Future project. **Survey unit:** Individual. **Sampling scheme:** Nationally representative cross-sectional survey using random samples (between 15,000 and 19,000 per year) of high school seniors. **Price data based on**: Weighted average across packs. **Source of price data:** The 'Tax Burden on Tobacco' (Tobacco Institute). Weighted average of price	**DATA DESCRIPTION** **Sample size used in models:** n=Not reported. **Smoking behaviour outcomes:** Survey asked 'How frequently have you smoked cigarettes during the past 30 days?' with categorical responses: none, <1, 1 to 5, half pack, 1 ½ packs, 2 packs +. Used to create 2 variables: smoking participation (1 if smoked, 0 otherwise); average monthly consumption which is an approximation to a continuous measure using the midpoints of the category ranges multiplied by 30 (0, 15, 90, 300, 600, 900 and 1200). **Data description**: 35.3% smoked in past month; mean (SD) average consumption 1.83 (2.62). Mean (SD) age 22.8 (4.4) years. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No **Empirical model** **Dependent variables**: Participation; monthly consumption. **Explanatory variables:** Price; age; average yearly income from employment (deflated to 1982-84 prices); college student status; frequency of participation in religious services; marital status; family structure; type of city or town (urban/suburban/rural); location of residence at time of survey; year of survey; six dichotomous indicators for the presence of state smoking restrictions covering: private worksites, restaurants, health care facilities, government worksites, grocery stores and any other public place; these six variables were also used to create a clean indoor air index (ranging from	**RESULTS** The real price of cigarettes had a negative and statistically significant effect on both smoking outcomes in all models. Price elasticities across different models were: **Smoking participation:** -0.119 (year fixed effects) -0.131 (year and region fixed effects) **[-0.112 (year and state fixed effects); sig at 5%]** **Amount smoked by smokers:** -0.590 (year fixed effects) -0.689 (year and region fixed effects) **[-0.731 (year and state fixed effects); sig at 5%]** **Total price elasticity** -0.709 (year fixed effects) -0.820 (year and region fixed effects) **[-0.844 (year and state fixed effects); sig at 5%]** **Other smoking restrictions** The index of clean air laws had a negative and statistically significant impact on both the decision to smoke and the amount smoked in all models which indicates that strong limits on smoking in public places and private worksites are effective for young adults. **Sub-group results:** No. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. By using multiple models for year, state and	**Authors' conclusions**. Increases in cigarette prices would lead to significant reductions in both the number of people smoking and the frequency with which they smoke, with the estimated overall price elasticity of demand being -0.791. Restrictions on smoking in public places and private worksites were also found to be effective in reducing smoking. **Other comments** Strong paper with good description of the surveys (including their limitations), data, analysis methods and results of the various models. Use of longitudinal data and individual fixed-effects to try and account for unobserved heterogeneity.

for the first six months of a year for a pack of 20 cigarettes based on the price of single packs, cartons, and vending machine sales. **Years of data:** Appear to be the same years as the survey data (1976 to 93). **Source of variation:** Across states and time.	0 for no state restrictions to 4 for extensive restrictions). **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Panel. **Form of model:** Two part model (based on Cragg). A linear probability model was used to estimate participation and least squares regression to model average monthly consumption (outcome is ln (continuous measure of consumption)). Fixed-effect models were used. Three separate models: one with all covariates including other tobacco restrictions and two containing these variables plus regional fixed effects or state fixed effects. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By using individual fixed effect models. All time-varying variables were transformed into deviations from individual specific means and OLS regression was then applied to the transformed data. The fixed effect model allows for the model intercept to vary in order to capture differences between individuals. **Tests of model assumptions**: Yes. By tests of colinearity between clean indoor air laws, using Belsey, Kuh & Welsch diagnostics.	region fixed effects. Exploration of multicollinearity between clean indoor air laws and smoking.	

Study details	Methods	Results	Conclusions
Tauras et al (2001)[49] **Objectives:** To examine determinants of smoking initiation amongst adolescents during the rise in the prevalence of smoking in the 1990s. **Specific to young people:** Yes. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Longitudinal. **Years of data:** 1991, 1992 and 1993 with follow-ups by mail every 2 years (maximum of 3 for 8th graders and 2 for 10th graders). **Survey details:** The Monitoring the Future project. **Survey unit:** School-based. **Sampling scheme:** The Monitoring the Future project (Institute for Social Research, University of Michigan) is a nationally representative survey. **Price data based on**: Average across packs. **Source of price data:** The 'Tax Burden on Tobacco' (Tobacco Institute). Weighted average of price for the first six months of a year for a	**DATA DESCRIPTION** **Sample size used in models:** n=8,447. **Smoking behaviour outcomes:** 'How frequently have you smoked cigarettes during the past 30 days?' with categorical responses: none, <1, 1 to 5, half pack, 1 ½ packs, 2 packs +. Used to create 3 binary variables for consumption in previous 30 days: any; 1 to 5; or at least ½ pack. Only those at risk of starting smoking were included in the modelling. **Data description**: 8th and 10th grade students mean age (SD) 15.3 (1.7) years Mean (SD) no. youth restrictions per state 3.9 (1.3). 51% males, 35.2 % started smoking any cigarettes with 18.7% smoking 1 to 5/day and 9.5% at least ½ pack/day. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Hazard of starting smoking in any time period. Separate models for each of the 3 amounts smoked. **Explanatory variables:** Price; age; age-squared, gender; average yearly income; number of years of formal schooling; weekly hours worked; number of children; race; family structure; parental education; mother's work status; participation in religious services; marital status; region; year and year-squared (to account for regional and time trends); dichotomous variables for if a state has: minimum purchase age, restrictions on free tobacco samples,	**RESULTS** For each smoking outcome the reported elasticities are the average (range) of the results from the 10 models. **<u>Initiation</u>** **Any smoking:** -0.271 (-0.191, -0.340; p<0.10 in 2 models) **[-0.111 (-0.083, -0.119; p<0.10 in all models) for models including state fixed-effects]** [-0.191; not significant] – a 10% increase in price leads to a 1.9% decrease in the probability of initiation. **1 to 5 cigarettes/day:** -0.811 (-0.750, -0.890; p<0.01 in all models) -1.230 (-0.995, -1.30; p<0.01 in all models) for models including state fixed-effects [-0.811; p<0.01] **½ pack/day:** -0.955 (-0.721, -1.013; p<0.01 in all models) -1.43 (-1.34, -1.49; p<0.01 in all models) for models including state fixed-effects [-0.955; p<0.01] **Youth access restrictions** Mixed results were found for youth access restrictions. The index variable was not significant. Minimum age purchase laws had a significant (p<0.1) effect in most models. School restriction had a significant (p<0.1) effect on smoking any cigarettes but not on the other outcomes. Restricting free samples had a significant (p<0.1) effect on smoking 1-5 cigarettes/day. Minimum purchase age signs and vendor penalties had no effect on smoking initiation.	**Authors' conclusions**. This research contradicts previous findings suggesting that price and tax increases would have little effect on youth smoking initiation. The average estimates suggest that if a 10% increase in federal excise had been enacted during this study and been fully passed on to consumers, the probability of daily smoking initiation amongst would have decreased by around 10%. Minimum purchase age laws, restrictions in schools and on free samples could possibly be effective tools in decreasing smoking initiation. **Other comments** The authors state that their findings contradict previous research but do not discuss possible reasons for this.

pack of 20 cigarettes based on the price of single packs, cartons, and vending machine sales where the weights are national proportions of each type of sale (including state and federal taxes). **Years of data:** Not reported. **Source of variation:** Across states and time.	minimum age assigns on vending machines, vendor punishments, law restricting smoking in schools; index variable taking values from 0 to 7 for the amount of youth restrictions per state; number of observations an individual provided to the analysis. Missing value indicators were used. **Expected direction of results stated:** No. **Unit of analysis**: Individual. Weights were used to account for survey over-sampling. **Type of analysis**: Discrete-time duration analysis. **Form of model**: Discrete-time hazard models estimated using a weighted dichotomous probit equation. 10 models created for each outcome, one without adjustment treating other tobacco control policies as none, each individually and as an overall index. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By adjusting for covariates. **Tests of model assumptions**: No.	**Sub-group results:** No. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Multiple models adjusting for other tobacco control policies individually and as an index (to minimise collinearity from correlation of multiple anti-tobacco restrictions within a state). Price elasticities were smallest when a single index representing the total number of restrictions per state was used. Models using state fixed-effects were also used which gave larger elasticities for smoking more cigarettes, implying that when unobserved state sentiment is controlled for, cigarette prices had a greater deterrent effect on adolescents.	

Study details	Methods	Results	Conclusions
Thomson et al (2004)[59] **Objectives:** To explore the association between cigarette taxes and adolescent smoking. **Specific to young people:** Yes, children. **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Cross-sectional. **Years of data:** 1999. **Survey details:** The Growing Up Today Study, a longitudinal cohort study. **Survey unit:** Survey of US children. **Sampling scheme:** The sampling scheme is unclear as the data were obtained via another ongoing study. Participants completed annual questionnaires but only 1999 data were used in analyses. **Price data based on**: State taxes. **Source of price data:** Data from the 'Tax Burden on Tobacco' (Tobacco Institute) was used to determine the state excise tax on cigarettes (January 1999).	**DATA DESCRIPTION** **Sample size used in models:** N=10,981. **Smoking behaviour outcomes:** Responses to the question "have you ever tried or experimented with cigarette smoking, even a few puffs?" or "In the past year, have you smoked a cigarette, even a few puffs?". Those who answered yes to either were asked if they had smoked at least 100 cigarettes in their life. Those who said no were classed as experimenters and those who said yes as established smokers. **Data description:** 41% male, median age 14, 91% white. 21% experimental smokers, 9% established smokers (smoked more than 100 cigarettes). **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No **Empirical model** **Dependent variables**: Dichotomous variables for experimental smokers and established smokers. **Explanatory variables:** Tax (in all models). Model 1 also adjusted for age and gender. Model 2 also adjusted for peer smoking, parental smoking and the possession of tobacco promotional items. Model 3 also adjusted for percentage of state population living at or below the poverty level. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Cross-sectional.	**RESULTS** **[No elasticities reported.]** Three models were used in this analysis. Model 1: Tax, age, gender, and state clustering; Model 2: Model 1 + peer smoking, parental smoking and tobacco promotional item possession; Model 3: Model 1 + percentage of state population living at or below the poverty level. **Experimental smoking** Cigarette tax had a statistically significant effect on the odds of experimental smoking in all 3 models ($p<0.001$ in model 1, $p=0.01$ in model 2, $p=0.007$ in model 3). Only the effects for tax quartile 3 (median 56 cents) were not significantly different from the lowest tax category (median 17 cents). The highest tax quartile (mean 87 cents) had the lowest odd ratios of experimental smoking ranging from 0.72 to 0.90 across the models (all significant compared to the lowest tax category). **Established smoking** Cigarette tax had a statistically significant effect ($p=0.009$) on the odds of established smoking only in model 1 (adjusting for tax, age and gender). No significant effects were seen in models 2 or 3 ($p=0.15$ and 0.12 respectively). The odds of smoking decreased with increasing tax quartiles but only the results for the highest quartile were significantly lower with an odds ratio of 0.61 (95% CI: 0.43, 0.85). **Sub-group results:** No.	**Authors' conclusions**. This study provides evidence that higher state taxes on cigarettes are associated with lower odds of smoking experimentation and established smoking amongst adolescent boys and girls. Higher taxes are associated with a 20% reduced likelihood of smoking experimentation. **Other comments**

Years of data: 1999. **Source of variation:** Across states.	**Form of model:** Logistic regression models using general estimating equations. Separate models for each smoking outcome, other both genders (initial analyses stratified by gender showed no differences so both genders were combined). P-values for tests for trend across tax quartiles were calculated. The interaction between peer smoking and youth smoking was also assessed. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes, through explanatory variables. By controlling for state clustering and some factors thought to be linked to youth smoking (peer smoking, parental smoking and tobacco promotional items). State-level effects (dummy vars at state-level): Efforts were made to adjust for the effects of state funding for tobacco control programs but had little effect on results when included in the models and was ultimately excluded as the underlying data were incomplete and imprecise. **Tests of model assumptions**: Yes. Test for trend in price effects (across quintiles).	**Elasticity calculations reported**: Not applicable. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Models adjusted for different variables were used.	

Study details	Methods	Results	Conclusions
Townsend et al (1994)[24] **Objectives:** To assess the effects of price, income, and health publicity on cigarette smoking by age, sex and socio-economic group. **Specific to young people:** No, but includes 16-19, 20-24 years. **Country:** UK. **DATA** **Source of smoking data:** Survey (household). **Type of data:** Repeated cross-section. **Years of data:** 1972-1990. **Survey details:** British General Household Survey. **Survey unit:** Household survey. **Sampling scheme:** The sampling scheme was not described, but the General Household Survey (GHS) is a nationally representative sample. **Source of price data:** Data on cigarette prices were from the national income and expenditure accounts, as were data on national disposable income. **Price data based on**: National expenditure accounts. **Years of data:** 1972-1990.	**DATA DESCRIPTION** **Sample size used in models:** Not specified. **Smoking behaviour outcomes:** Average cigarette consumption per individual or person. . **Data description**: Not specified. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Average cigarette consumption per week per person for a year. **Explanatory variables:** Annual real disposable income per head, real price of cigarettes, health publicity effect, including effects of social acceptability and smoking restrictions. **Expected direction of results stated:** No. **Unit of analysis**: Is defined by group, where qit is quantity of cigarettes consumed per person in group I for year t. Groups are defined by sex and socio-economic and age group to estimate separate price elasticities. **Type of analysis**: Time series. **Form of model:** Multiple regression analysis.	**RESULTS** Men Price elasticity 16-19: 0.06 (p=ns) Price elasticity 20-24: 0.16 (p=ns) Women Price elasticity 16-19: -0.86 (p<0.01) Price elasticity 20-24: -0.96 (p<0.001) **[-0.395 – average]** **Sub-group results:** Yes. By socio-economic group, but not for young adults, also gender. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** No.	**Authors' conclusions**. Men and women in lower socio-economic groups are more responsive than those in higher socio-economic groups to changes in the price of cigarettes. **Other comments**

Source of variation: Time**.**	**Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Covariates. **Tests of model assumptions**: R^2, exclusion estimates (removing variables not significant at 5% level). Durbin-Watson statistic for serial correlation, RESET test.		

Study details	Methods	Results	Conclusions
Waller et al (2003)[20] **Objectives:** To examine the relationship between price decreases and trends in smoking prevalence and amount smoked amongst the youth of Ontario. **Specific to young people:** Yes. **Country:** Canada. **DATA** **Source of smoking data:** Survey (students/schools). **Type of data:** Repeated cross section. **Years of data:** 1977-2001. **Survey details:** The Ontario Student Drug Use Survey. **Survey unit:** School-based. **Sampling scheme:** The Ontario Student Drug Use Survey (a biennial survey since 1977) sampled students in grades 7, 9, 11 and 13, initially using a region-by-grade stratified design which was changed in 1981 to a stratified single-stage school board cluster allowing more schools and boards to be selected. **Price data based on**: Provincial Taxes.	**DATA DESCRIPTION** **Sample size used in models:** The unit of analysis was the survey year (n=13) rather than the individual. **Smoking behaviour outcomes:** If respondents answered that they smoked more than 1 cigarette in the past 12 months they were considered smokers – percentage of smokers. **Data description**: Not reported. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Smoking prevalence. A measure of the mean number of cigarettes smoked per day was estimated based on the midpoints of the daily smoker categories (1.5, 4, 8, 13 and 20). **Explanatory variables:** Not specified. **Expected direction of results stated:** No. **Unit of analysis**: Canadian province (across time). **Type of analysis**: Time-series. **Form of model:** Polynomial regression and discontinuity regression. **Was the model appropriate for the type of data**: Yes.	**RESULTS** No elasticities reported. For the whole sample smoking prevalence showed a significant discontinuity effect, with a negative slope until 1993, an upward jump at the discontinuity point, and a levelling off after 1993. A significant positive quadratic trend was also seen over the 24 years. For all daily smoking students as a whole, the mean number of cigarettes smoked per day showed a significant discontinuity effect, with an increase followed by a shallow decrease as well as a significant negative quadratic trend over the 24 years. **Sub-group results:** No. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** No.	**Authors' conclusions**. That early 1990s cigarette price decrease, and the effective reduction in price prior to that, may have played a role in increasing youth smoking in Ontario. **Other comments**

Source of price data: Taxes in Ontario, source not described. **Years of data:** 1977-2001. **Source of variation:** Time.	**Attempts to control for heterogeneity**: No. **Tests of model assumptions**: Differences between sub-groups were tested using interaction terms, Durbin-Watson test statistic was used to check for residual autocorrelation.		

Study details	Methods	Results	Conclusions
Wasserman et al (1991)[50] **Objectives:** To examine the impact of the price of smoking on the decision to start and the decision to quit smoking; and whether this impact differs by gender. **Specific to young people:** No. Separate data sources and models for adults (aged over 17 or 20 depending on survey year) and teenagers (aged 12 to 17). **Country:** USA. **DATA** **Source of smoking data:** Survey. **Type of data:** Repeated cross-sectional. **Years of data:** 1970 to 1985 (adult data); 1976 to 1980 (teenage data). **Survey details:** National Health Interview Survey (NHIS: adult data); National Health and Nutrition Examination Survey II (NHANES II: teenage data). **Survey unit**: Not stated. **Sampling scheme**: The National Health Interview Survey (NHIS: adult data) and the National Health and Nutrition Examination Survey II (NHANES II: teenage data). The	**DATA DESCRIPTION** **Sample size used in models:** n=84,301 (adults) n=1,891 (teenagers) **Smoking behaviour outcomes:** Cigarette consumption measured in packs per day, quantity for smokers and non-smokers (reported number consumed divided by 20) with non-smokers assigned a value of 0. **Data description**: Not reported. **Cross-border issues accounted for**: Yes for the adult models. A border variable was created to identify states within 20 miles of a lower-priced area (coded 1 for yes, 0 for no) and include in the models. Only results for the models without border effects (excluding cases neighbouring a lower priced area) are presented for adult analyses. For teenagers, models were estimated with and without border cases and model coefficients were unchanged so only results for the full sample are presented. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Consumption (number of packs smoked per week). **Explanatory variables:** Log price; a regulation index for the amount of smoking restrictions per state (score of 0.75 for restaurant but no private worksite restrictions; 0.50 for restrictions in 4 public places but not restaurants and worksites; 0.25 for between 1 and 3 minor restrictions and 0 for no restrictions at all); age; gender; race; family income (using continuous income data from the Current Population	**RESULTS** **Teenage (GLM results)** Price had a non-significant effect on the amount smoked per day by teenagers. **[Elasticity estimate: -0.86 (95% CI: -0.30 to 2.02) (increase in price leads to 8.6% increase in quantity).]** **Teenage (2-part model results)** Price had a non-significant effect on both participation and demand. **Other variables** The regulation index had a negative and significant effect on the amount smoked (GLM models) for both adults and teenagers, indicating that stronger clean air restrictions would decrease consumption. In the 2-part model for teenagers smoking regulations only had a significant effect on participation only. **Sub-group results:** No. **Elasticity calculations reported**: Yes. For adults the elasticity for each year was = the coefficient for log price + (the coefficient for the price and year interaction x year). Price elasticities for teenagers were not reported. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. By using a 2-part model to substantiate results from the GLM.	**Authors' conclusions**. The estimated price elasticity of adult cigarette demand is low compared to other studies, and changes over time. The teenage results suggest that teenagers may not be as responsive to price changes as shown in previous research. **Other comments** The authors also conducted analyses using 1976 NHIS data to reproduce adult results by Lewit and Coate (1982) to try and understand why their results differ from those previously published. Estimates were similar and discrepancies were thought to be due to the inclusion of the smoking regulation index in the models in this paper.

NHIS is an annual survey of the civilian non-institutionalised population, but does not contain data on children <17 (<20 depending on the year the survey was administered). **Source of price data:** Average price per state (weighted by type of sale - single package sold over the counter, carton and vending machine) from the "Tax Burden on Tobacco" (Tobacco Institute). **Price data based on**: weighted average across packs. **Years of data:** Appear to be the same as the data (1970 to 1985). **Source of variation:** Across states and time.	Survey to estimate means corresponding to the NHIS and NHANES II data); family size and year. The adult model also included variables defining birth cohorts as smoking prevalence varies by birth cohort and this cannot be fully captured by age and year effects. Interactions between price and year and income and year were also assessed for inclusion in the adult models. The teenage models did not include education but the level of education reached by the head of the household as a proxy for parental smoking habits, birth cohort and price-year and income-year interactions were also not included in the teenage models. Also included an indicator variable for presence of a law in each state that restricted sales to minors. **Expected direction of results stated:** No. **Unit of analysis**: Individual. **Type of analysis**: Pooled repeated cross-sectional. **Form of model:** GLM and two-part model. A generalised linear model (GLM) using a Poisson specification (although deviating from a true Poisson model by allowing for fractional outcomes). To confirm the results of this model a two-part model (Cragg) was also used with a logistic regression model of the decision to smoke and ordinary least squares regression of the amount smoked by smokers. Separate models for adults and teenagers. To prevent "overfitting" of the data a split sample method was used. Exploratory analyses using a random sample of 25% of NHIS cases were conducted and these were validated using a simple test (residuals were regressed on the forecasts for the remaining data not used in the model). 4 models for adults: model 1 is a base model containing price, regulations, income and year; model 2 as model 1 but including age and gender; model 3as 2 including		

	cohort effects; model the full model adjusting for all explanatory variables. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: Yes. By use of covariates. **Tests of model assumptions**: Yes. Log-scale tests of linearity for functional form of GLM.		

Study details	Methods	Results	Conclusions
Zhang et al (2006)[21] **Objectives:** To examine the impact of decreased cigarette price, resulting from tobacco tax cuts, on smoking initiation among young adults aged 20-24. **Specific to young people:** Yes. **Country:** Canada. **DATA** **Source of smoking data:** Survey. **Type of data:** Longitudinal. **Years of data:** 1994-95 (Cycle 1 - baseline) and 1996-97 (Cycle 2 - follow-up). **Survey details:** Canada's National Population Health Survey. **Survey unit**: Household survey. **Sampling scheme:** Canada's National Population Health Survey, using a stratified two-stage sampling design to select household residents across Canada: Cycle 1 (1994-95) and Cycle 2 (1996-97). **Survey unit:** Household survey. **Source of price data:** Cigarette price change was evaluated. The retail price of a carton of cigarettes	**DATA DESCRIPTION** **Sample size used in models:** 636 young adults aged 20-24 years who did not smoke at baseline and were followed-up in 1996-1997. **Smoking behaviour outcomes:** Initiation. "New smokers" – those who did not smoke at baseline who smoked at follow-up. . Two waves of data: 1st wave – baseline; 2nd wave – analysis of starters. **Data description**: There were 361 in the 5 tax-cut provinces and 275 in the 5 non-tax-cut provinces. **Cross-border issues accounted for**: No. **MODELLING** **Evidence of theoretical model:** No. **Empirical model** **Dependent variables**: Smoking initiation. **Explanatory variables:** Cigarette price change, individual characteristics (age, gender, educational attainment, income adequacy and marital status) and policy variables (smoke-free bylaws for restaurants, enforcement, signage, tobacco-control expenditures). Dummy variables for provinces. **Expected direction of results stated:** No. **Unit of analysis**: Individual.	**RESULTS** **[Initiation: Price elasticity -3.4 (95% CI=0.1-6.8) (p<0.05).]** (1% decrease in price = 3.4% increase in smoking initiation). **Sub-group results:** No. **Elasticity calculations reported**: No. **SENSITIVITY ANALYSES** **Were sensitivity analyses conducted:** Yes. Sensitivity analyses showed very similar adjusted and unadjusted odds ratios for the full sample and the three sub-groups (those with primary policy data, those with a reduced chance of being exposed to smuggled cigarettes and those remaining in their initial province of residence).	**Authors' conclusions**. Young adults are sensitive to cigarette prices. Reductions in cigarette prices will lead to increased smoking initiation amongst this group. **Other comments** Natural experiment: Canada reduced the price of cigarettes (due to tax cuts to stop smuggling of cigarettes into Canada) in south of 10 provinces. Observe smoking initiation of youths over two survey waves (cycle 1 and cycle 2).

(200 cigarettes) at baseline and follow-up was measured in 1986 dollars. This was obtained from Statistics Canada based on the retail price of cigarettes in 26 major Canadian cities until 1994. **Price data based on**: Not stated. **Years of data:** 1994-97. **Source of variation:** Across cities and time.	**Type of analysis**: Longitudinal (Natural experiment). **Form of model:** Multivariable logistic regression. **Was the model appropriate for the type of data**: Yes. **Attempts to control for heterogeneity**: No. **Tests of model assumptions**: No.		

Appendix 6: Summary of sources of study surveys

Author	Survey name	Sampling scheme description
Bishai (2005)[53]	Youth Risk Behaviour Surveys (YRBS).	Survey deployed by the Centres for Disease Control & Prevention (CDC) in 1995 as a nationally representative sample made public without geographical information, based on 35 states and 16 cities. Data in this analysis came from a sample of 20 state-level datasets (from the 35 states and 16 cities requested) with available price and demographic data. There were 29,693 observations in these 20 state level datasets. This sample is not nationally representative of US teenagers, but is similar to the national data set; also high-school dropouts were not included.
Carpenter (2007)[12]	Youth Risk Behaviour Surveys (YRBS), in conjunction with the independent state and local versions of the YRBS.	Restricted use area-identified versions of the 1991-2005 national Youth Risk Behaviour Surveys (YRBS), in conjunction with the independent state and local versions of the YRBS are used. The 2005 national YRBS consisted of a probability sample of 203 schools from public and private schools with at least one of the grades 9-12. One or two classrooms from each grade of these sample schools was administered a questionnaire.
Cawley (2003) [26]	The National Longitudinal Survey of Youth.	Data from the National Longitudinal Survey of Youth, which is a nationally representative sample of 9,022 youths aged 12 to 16 at the end of 1996. The first-wave follow-up was in 1997 and further follow-ups in 1998, 1999 and 2000. The age range of the panel used in the study was therefore 12-21 years.
Cawley (2006) [27]	The Children of the National Longitudinal Survey of Youth, 1979 cohort (CoNLSY).	The Children of the National Longitudinal Survey of Youth, 1979 Cohort (CoNLSY) consists of the biological children of female respondents of the National Longitudinal Survey of Youth, 1979 Cohort (NLSY79) who were living in their mother's household at the time of a child assessment interview and who completed an interview. The baseline survey was conducted in 1986, with respondents interviewed every even-numbered year thereafter. Because NLSY79 is a nationally representative sample of youths aged 14-21 in 1979, CoNLSY is not a nationally representative data set, but it is representative of children (aged 10-20) born to women aged 14-21 in 1979.

Chaloupka (1990) [28]	The Second National Health and Nutrition Examination Survey (NHANES2).	A national survey of 28,000 people aged 6 months to 74 years conducted from 1976-1980. Individuals were selected from 64 primary sampling units, each of which consisted of at least one county. Groups at high risk of malnutrition (low-income, pre-school children and elderly) were over-sampled.
Chaloupka (1996) [29]	Monitoring the Future (MTF).	A nationally representative survey but population coverage was not reported. The survey collected data on use of cigarettes, alcohol and illicit drugs. By special agreement a restricted data set with variables reflecting youth tobacco use and identifier's for each youth's county of residence was provided, along with socio-economic and demographic information.
Chaloupka (1999) [30]	Monitoring the Future (MTF).	Nationally representative survey of 17,000 high-school students (8th, 10th and 12th grade, ages 13 to 18). Survey was conducted in school and collected data on tobacco, alcohol and other drug use. To increase reliability, parents are not informed of child's responses.
Chaloupka (1995) [31]	The Harvard College Alcohol Study.	Nationally representative survey in 1993 of 17,592 students from 140, 4 year colleges and universities. The survey focussed on binge drinking in colleges but all respondents were asked about current/past smoking participation as well as about their average daily quantity of cigarettes consumed.
Czart (2001) [55]	The Harvard College Alcohol Study.	Nationally representative survey in 1997 of 15,699 students from 130 randomly selected 4-year colleges and universities (a resurvey of 93% of colleges from the original 1993 survey of 140 4-year colleges and universities). The survey was designed to assess binge drinking but also asked about current and past smoking behaviour.
DeCicca (2002) [8]	The National Education Longitudinal Survey (NELS).	Data on cigarette smoking by American 8th graders in 1988, with follow-up surveys 2 and 4 years later. The study administered questionnaires to 24,599 8th graders in more than 1,000 public and private schools. In 1992 94.6% of those in both the 8th (1988) and 10th (1990) grade surveys were successfully re-interviewed.
DeCicca (2000) [54]	The National Education Longitudinal Survey (NELS).	Data on cigarette smoking by American 8th graders in 1988, with follow-up surveys 2 and 4 years later. The study administered questionnaires to 24,599 8th graders in more than 1,000 public and private schools. In 1992 94.6% of those in both the 8th (1988)

		and 10th (1990) grade surveys were successfully re-interviewed. Separate analyses were undertaken for whites, Hispanics and African-Americans.
DeCicca (2006) [32]	The National Education Longitudinal Survey (NELS).	Data on cigarette smoking by American 8th graders in 1988, with follow-up surveys 2, 4, 6 and 12 years later. The study administered questionnaires to 24,599 8th graders in more than 1,000 public and private schools. Separate analyses were undertaken for whites, Hispanics and African-Americans. Data are used from the 1992 (16,730 observations) and 2000 (11,490 observations) waves to estimate the elasticities of participation and quantity smoked. Longitudinal data were also used to estimate time to smoking initiation.
Diener (2007) [19]	The Canadian Tobacco Use Monitoring Survey (CTUMS).	CTUMS (1999-2005) collects annual smoking behaviour data from Canadians aged 15 or above. Each year 20,000 people (from 10 provinces) are surveyed using random digit dialling and half sample were aged 15 to 24. The survey is a nationally representative sample and probability weights and a stratified sample design were used. For this study data were restricted to youths aged 15-17 for the 4 provinces where it is illegal to furnish tobacco products to youth under the age of 18 and those aged 15-18 in the 6 provinces where it is illegal to furnish tobacco products to youth under the age of 19.
Ding (2003) [33]	Monitoring the Future (MTF), National Health Interview Surveys (smoking history analysis).	The Monitoring the Future Project (prevalence analysis) based on data for 1976-1998; National Health Interview Surveys (smoking history analysis) which were run between 1974 and 1995, in the years 1974, 1978-1980, 1983, 1985, 1987-1988, 1990-1995. Neither survey is discussed in detail.
Douglas (1998) [34]	National Health Interview Survey.	Data in this study based on the Cancer Risk Factor Supplement from the 1987 National Health Interview Survey. The National Health Interview Surveys are a sample of the civilian, non-institutionalised population of the USA with information on social, demographic and economic aspects of illness, disability and medical service utilisation.
Emery (2001) [35]	The Teenage Attitudes and	The study used data from the second wave

	Practices Survey.	(1993) of the longitudinal teenage attitudes and practices survey (TAPS). The first wave of TAPS interviewed adolescents who were enumerated in the 1988 National Health Interview Survey. The NHIS are representative annual household interview surveys of the civilian non-institutionalised population. The first wave of TAPS was conducted in 1989, with the follow-up in 1993. The 1993 wave included 12,952 adolescents (of which 7,960 were also interviewed in 1989) from 48 states and the District of Columbia. Data were analysed using software that can account for the multistage sample design of original survey.
Evans (1998) [36]	National Health Interview Survey.	Primary data sources are two supplements from the National Health Interview Survey (NHIS): the Smoking Supplement from 1979 and the Cancer Control Supplement (CCS) from 1987. NHIS is a nationally representative multistage probability sample of the civilian, non-institutionalised population 18 years and older. The 1979 and 1987 supplements contain data on 26,271 and 22,043 individuals.
Farrelly (2001) [37]	National Health Interview Survey.	The National Health Interview Survey, a nationally representative multistage probability sample of the civilian, non-institutionalised population aged 18 and over. Data were pooled (1976-1980, 1983, 1985 and 1987-1993).
Gilleskie (2000) [38]	The National Education Longitudinal Survey (NELS).	NELS:88 is a representative sample of 8th graders (24,500 in more than 1,000 public and private schools in all 50 states) in two year waves beginning in 1988. The first follow-up in 1990 includes 17,500 students from the original cohort and the second follow-up in 1992 includes 16,500 students from the original cohort; the third wave in 1994 does not include information on smoking behaviour.
Goel (2005) [25]	Not applicable as administrative data, but is US state-level data for 1997.	Administrative data for 1997: National statistics from the Centers for Disease Control and Prevention
Gruber (2000) [39]	Monitoring the Future (MTF), Youth Risk Behaviour Survey and Vital Statistics Natality Files.	Three different data sets are used. Monitoring the Future (MTF, University of Michigan) an in-school survey of 8th, 10th and 12th grade school children from 1991-1997. Youth Behaviour Risk Survey (YRBS, Centers for Disease Control) sample of 9th to 12th graders for 1991, 1993, 1995 and 1997. Vital Statistics Natality Detail Files (VSNDF), a census of birth certificates for the US which contain data on smoking

		behaviour of teen mothers during pregnancy, available from 1991 onwards. MTF and YRBS are nationally representative in-school surveys of youth. VSNDF is focussed on one select group of teens, those having children before their 19th birthday. MTF is a more complete US survey over sample period as it covers 35 states in every year from 1991 to 1997; the author focuses on 1991 as the starting point for the analysis. YRBS only covers 10 states each year.
Hammar (2001) [23]	Not named.	The sample was identified from a study on the health effects of moist snuff undertaken as part of a previous study. The questionnaire was mailed to 935 individuals, identified as smokers in a previous study, in two counties in Sweden. The overall response rate was 57% - 527 respondents. The final sample is 385 individuals who were > 9 when they started smoking.
Harris (1999) [13]	Tobacco Use Supplements to the Current Population Survey.	The 1992-1993 Tobacco Use Supplements to the Current Population Survey is a national survey (Washington DC Chamber of Commerce, Bureau of the Census) of people aged 15-29 years. For all ages 41,396 (53.4%) respondents resided in one of 47 metropolitan statistical areas where cigarette price data were available - 34,145 complete observations on smoking status.
Katzman (2002) [40]	Youth Risk Behaviour Survey.	The Youth Risk Behaviour Surveys for 1995, 1997 and 1999 are used. This is a nationally representative sample of high school students in grades 9-12.
Kidd (2004) [22]	The National Health Survey (NHS 1990) was used for the main analyses; the National Drug Strategy Household Survey (NDSHS 1998) was used for sensitivity analyses (due to its smaller sample size).	Two sources are used: The National Health Survey (NHS 1990) was used for the main analyses; the National Drug Strategy Household Survey (NDSHS 1998) was used for sensitivity analyses (due to its smaller sample size). Both are a survey of a random sample of the Australian population containing demographic variables and retrospective data on smoking behaviour.
Lewit (1981) [41]	Cycle III of the US Health Examination Survey.	Cycle III of the US Health Examination Survey (HES III) is a random sample of 6,768 non-institutionalised youths aged 12 to 17 with one third interviewed before the Fairness Doctrine (March 1966 to June 1967) and the remainder interviewed during it (July 1967 to March 1970). Cigarette smoking information was obtained directly from youths with their parents not present at

		the interviews.
Lewit (1997) [18]	A project specific survey conducted as part of the COMMIT project.	Data were derived from two school-based surveys (in 1990 and 1992 of 9th grade students in 21 communities (two in Ontario, rest USA). The sampling frame was sampled to provide approximately 400 students per community. Public and private schools with more than 50 9th grade students were included in the sampling frame. Participation rates ranged from 84% to 100% of classes in 1990, and 76% to 100% in 1992. Parents were asked for their consent for their child to participate.
Lewit (1982) [42]	National Health Interview Survey.	The 1976 Health Interview Survey (HIS): a nationwide survey which collected data by household interview for a large sample of non-institutionalised adults. Survey conducted across different tax locations with 28,033 individuals between the ages of 20-74 from 430 nationwide survey sites. The survey population is representative of the US population.
Liang (2002) [56]	The Monitoring the Future Survey.	Data came from the 1992, 1993 and 1994 Monitoring the Future Surveys of 8th, 10th and 12th grade students conducted by the Institute for Social Research (ISR) at the University of Michigan. The sampling scheme was not reported but was stated to be nationally representative with annual data collection from 15,000 to 19,000 high school seniors.
Nonnemaker (2002) [51]	The National Longitudinal Study of Adolescent Health (Add Health).	The National Longitudinal Study of Adolescent Health (Add Health). A nationally representative survey of American adolescents (in grades 7-12) using a sampling frame of all high schools from a comprehensive database with systematic random sampling with probability proportional to school enrolment. Interviews were conducted in school, at home and also of school administrators and parents. 80 high schools and 56 matched feeder (junior high or middle) schools participated. Approximately one third of students surveyed in school were selected for data collection at home and 79.5% completed the questionnaire. 88% of these completed in-home questionnaires for wave 2 data collection one year later.
Ohsfeldt (1998) [52]	Current Population Survey.	Data from the Current Population Survey (CPS) was used for September 1992, January 1993 and May 1993. CPS provides a nationally representative sample of over 100,000 individuals in each wave. CPS

		contains detailed information on economic and demographic data for respondents as individuals and households. The CPS data contains a number of proxy responses for tobacco use, particularly for teens.
Powell (2005) [43]	"The Study of Smoking and Tobacco Use Among Young People".	Audits & Surveys 1996 survey data of high school students across the US from the "The Study of Smoking and Tobacco Use Among Young People" are used. This is a nationally representative random sample comprising 17,287 high school students from 202 public, private and parochial high schools. In addition there is a school administrator survey providing information on schools rules related to smoking, to which are merged tobacco price and policy control variables along with external Census data. The estimation sample contains 12,705 observations based on a sub-sample of high-school students for which the authors have non-missing data.
Ross (2004) [44]	"The Study of Smoking and Tobacco Use among Young People".	"The Study of Smoking and Tobacco Use among Young People" was a self-administered questionnaire survey among high school students. A total of 17,287 questionnaires were completed and processed from participants at 202 high schools (public, private and parochial). The survey oversampled schools in African American and Hispanic and high poverty communities and weights are used to account for this. The first part of the survey represented a core sample of 100 US high schools, part 2 a supplementary sample of 40 schools from areas heavily populated by African Americans and the third part a supplementary sample of 40 schools from areas heavily populated by Hispanics, with the final part a supplementary sample of 20 schools from high poverty areas.
Ross (2001) [57]	"The Study of Smoking and Tobacco Use among Young People".	"The Study of Smoking and Tobacco Use Among Young People" is a survey of 17,287 survey participants attending 202 US high schools. Half the schools were randomly selected with probability proportional to the counties' population and to the number of students enrolled in grades 9 through 12. Three supplementary schools' samples were drawn from areas heavily populated by African-Americans, by Hispanics and from high poverty areas. All students enrolled in the randomly selected classes in these schools constituted the respondents' sample.
Slater (2007) [58]	Monitoring the Future (MTF).	Monitoring the Future (MTF) survey uses a

		multistage sampling design to obtain nationally representative samples of 8th-, 10th and 12th-grade students, with modal ages of 14, 16 and 18 years. Data were collected from 109,308 students in schools participating in their second year of MTF (February 1999-June 2003).
Tauras (2005) [45]	Monitoring the Future (MTF).	Nationally representative cross-sectional survey using random samples (between 15,000 and 19,000 per year) of high school seniors. Survey focuses on use of cigarettes, alcohol and illicit drugs. High school drop-outs and home-schooled students are not included. Starting with the class of 1976, around 2,400 from each class are selected for follow-up surveys, half re-surveyed on odd numbered years and the other half on even numbers (up to 7 follow-ups). To obtain consistent time intervals (2 years apart) the baseline observation for those resurveyed one year after baseline were deleted. Retention rates were 70-80% in first follow-up and 55-62% for seventh.
Tauras (2004) [46]	Monitoring the Future (MTF).	Nationally representative cross-sectional survey using random samples (between 15,000 and 19,000 per year) of high school seniors. Survey focuses on use of cigarettes, alcohol and illicit drugs. High school drop-outs are not included. Starting with the class of 1976, around 2,400 from each class are selected for follow-up surveys, half re-surveyed on odd numbered years and the other half on even numbers (at least 7 follow-ups).
Taurus (1999) [47]	Monitoring the Future (MTF).	Nationally representative cross-sectional survey using random samples (between 15,000 and 19,000 per year) of high school seniors. Survey focuses on use of cigarettes, alcohol and illicit drugs. High school drop-outs are not included. Starting with the class of 1976, around 2,400 from each class are selected for follow-up surveys, half re-surveyed on odd numbered years and the other half on even numbers (total of 7 follow-ups). Retention rates were high with 80% retention for first follow-up and 60% for class of 1981 (modal age 32)
Tauras (1999) [48]	Monitoring the Future (MTF).	Nationally representative cross-sectional survey using random samples (between 15,000 and 19,000 per year) of high school seniors. Survey focuses on use of cigarettes, alcohol and illicit drugs. High school drop-outs are not included. Starting with the class of 1976, around 2,400 from each class are

		selected for follow-up surveys, half re-surveyed on odd numbered years and the other half on even numbers (total of 7 follow-ups). Retention rates are high with 80% return rates for those in first follow-up and 60% (for 1995 return of class of 1981).
Tauras (2001) [49]	Monitoring the Future (MTF).	The Monitoring the Future project (Institute for Social Research, University of Michigan) is a nationally representative survey. The data used for these analyses were collected on three cohorts of students enrolled in 8th and 10th grade in 1991, 1992, and 1993. In each of these years 15,000 10th graders and between 18,000-19,000 8th graders were surveyed. From each cohort 2,000 8th graders and 2,000 10th graders were selected to be followed-up via mail surveys. Students deemed to be at high risk of dropping out of school were over-sampled.
Thomson (2004) [59]	The Growing Up Today Study, a longitudinal cohort study.	The sampling scheme is unclear as the data were obtained via another ongoing study. Participants completed annual questionnaires but only 1999 data were used in analyses.
Townsend (1994) [24]	British General Household Survey.	The sampling scheme was not described, but the General Household Survey (GHS) is a nationally representative sample. Biennial data on smoking prevalence and quantity smoked was constructed for period 1972-90, by sex, age and socio-economic group.
Waller (2003) [20]	The Ontario Student Drug Use Survey.	The Ontario Student Drug Use Survey a biennial survey since 1977) sampled students in grades 7, 9, 11 and 13, initially using a region-by-grade stratified design which was changed in 1981 to a stratified single-stage school board cluster allowing more schools and boards to be selected. In 1999 schools became the primary sampling unit, as was the case in 2001. The unit of analysis in this study was the survey year rather than the individual.
Wasserman (1991) [50]	National Health Interview Survey (NHIS: adult data); National Health and Nutrition Examination Survey II (NHANES II: teenage data).	The National Health Interview Survey (NHIS: adult data) and the National Health and Nutrition Examination Survey II (NHANES II: teenage data). The NHIS is an annual survey of the civilian non-institutionalised population, but does not contain data on children <17 (<20 depending on the year the survey was administered). Data used in this analysis used data from seven of the nine smoking supplemental questionnaires (years, 1970, 74, 76, 77, 78, 79, 80, 83 and 85); 1977 and 1978 were excluded due to difficulties in obtaining data. As data on

		teenagers were not available in NHIS the NHANES II dataset was used which contains comparable smoking and socio-economic data. The period of time covered in NHANES II ranged between 1976-1980. A total of 1,960 individuals were asked smoking-related questions.
Zhang (2006) [21]	Canada's National Population Health Survey.	A stratified two-stage sampling design to select household residents across Canada: Cycle 1 (1994-95) and Cycle 2 (1996-97). Of 17,276 individuals in Cycle 1, 16,168 responded in Cycle 2 (93.6%); 636 were aged 20-24 years who did not smoke at baseline and were followed up in 1996-97. Data were weighted to reflect sample design, adjustment for non-response and post-stratification.

Appendix 7: Summary of sources of price data

Author	Country	Source of price data
Bishai (2005) [53]	USA	State excise tax data were derived from the National Cancer Institute State Cancer Legislative Database and the Tobacco Tax Council.
Carpenter (2007) [12]	USA	Price data for the state tax on a pack of cigarettes were derived from The Tax Burden on Tobacco and the Campaign for Tobacco Free Kids.
Cawley (2003) [26]	USA	Price data for the price of cigarettes in all models comes from the Tax Burden on Tobacco (Tobacco Institute). The state price is a weighted average of a pack of 20 cigarettes based on the price of single packs, cartons and vending machine sales where the weights are national proportions of each type of sale. These prices are inclusive of state level sales taxes applied to cigarettes. Cigarette price is merged based on the state of residence, or the location of the respondent's college, when applicable.
Cawley (2006) [27]	USA	Price data were derived from the Tobacco Institute's annual Tax Burden on Tobacco. Cigarette price is the state real yearly price of a box of 20 cigarettes; price is the weighted average of the price of single packs, cartons and vending machine sales. Weights are the national proportions of each type of sale. Generic cigarettes are included in the calculation and price is inclusive of state excise taxes.
Chaloupka (1990) [28]	USA	Price data were derived from the Tobacco Institute's annual reports. Weighted average statewide price for a pack of 20 cigarettes based on the price of single packs, cartons and vending machine sales, inclusive of state sales taxes, where the weights are the national proportion of each type of sale. To account for cross-border smuggling a weighted average of the "border price" and the local price was used, where "border price" is the lowest price of a pack of cigarettes within 25 miles of the county in which the individual resides. Local cigarette excise tax rates were obtained from the Municipal Tax Survey from the Tobacco Institute. Price data were deflated by a state price index calculated for 1977.
Chaloupka (1996) [29]	USA	Price data were derived from the Tax Burden on Tobacco (Tobacco Institute annual report) state level average price of pack of 20 cigarettes, based on the price of single packs, cartons and vending machine sales and includes generic cigarettes. To account for changes in relative price between 1992 and 1994, the cigarette price was deflated by the National Consumer Price Index. Includes state excise taxes.
Chaloupka (1999) [30]	USA	Price data for the average state price for pack of 20 cigarettes from 'The Tax Burden on Tobacco' (Tobacco Institute) based on the weighted average of the price of single packs, cartons and vending machine sales, including state level excise taxes and the price of generics.
Chaloupka (1995) [31]	USA	Price data were derived from the Inter-city Cost of Living Index (quarterly report of the American Chamber of Commerce Researchers Association). Price was deflated by a cost of living index, and price from the nearest city were matched to each college (250 cities are included). Price of a carton of Winston

		King-size cigarettes (price includes local and state excise taxes) were used to produce a site (city) specific measure.
Czart (2001) [55]	USA	Price data for the average state price for branded pack of 20 from 'The Tax Burden on Tobacco' (Tobacco Institute). The cigarette price is a state average cigarette price, based on the price of single cigarette packs, cartons and vending machine sales, inclusive of state-level excise taxes.
DeCicca (2002) [8]	USA	Price data is based on the state excise tax data from the 'Tax Burden on Tobacco' historical complication (1999). Taxes were converted using the consumer price index for the hazard modelling. Additional models were run using cigarette price (results not reported).
DeCicca (2000) [54]	USA	Price data were derived from the Tobacco Institute price for 1988, 1990 and 1992 merged for 1993.
DeCicca (2006) [32]	USA	Price data were derived from the 'Tax Burden on Tobacco' historical complication (2002). Average price per pack of 20 cigarettes (inclusive of state and federal taxes) in November of each year, weighted by market share. The average price is used exclusive of generic brands.
Diener (2007) [19]	Canada	Annual price indices and personal income data from the Cansim database (Statistics Canada) were used as the source of price data. The consumer price index for cigarettes and all goods were used with the real cigarette price obtained by deflating the cigarette consumer price index by the index for all goods. Mean annual cigarette price were calculated for each province.
Ding (2003) [33]	USA	The price used represents the average retail price of a pack of cigarettes throughout the USA from 'The Tax Burden on Tobacco' (Tobacco Institute), both brand name and generic substitute brands and the nominal price per pack were adjusted by the consumer price index.
Douglas (1998) [34]	USA	Price data were derived from the Tobacco Institute weighted average price per pack (including taxes) for each state for each year from 1954 to 1991, with cigarette price deflated by the yearly consumer price index.
Emery (2001) [35]	USA	Price data were derived from the average pack price per state of cigarettes from 'The Tax Burden on Tobacco' (Tobacco Institute), adjusted by the consumer price index.
Evans (1998) [36]	USA	State excise tax rate and average cigarette price were derived from the Tobacco Institute's publication 'The Tax Burden on Tobacco'.
Farrelly (2001) [37]	USA	Price data were derived from the average pack price per state from 'The Tax Burden on Tobacco' (Tobacco Institute, 1998) adjusted for inflation (constant 1982 to 1984 dollars). Price includes state taxes.
Gilleskie (2000) [38]	USA	State-level data (Tobacco Institute 1997) and measures of inflation to determine the appropriate real cigarette price, and state tax rate, for all individuals in each year.
Goel (2005) [25]	USA	Two tax (price) variables are included in the estimating equation. One is the federal and state excise tax as a percentage of the retail price per pack of cigarettes in a state. The other is the state tax on smokeless tobacco and is measured as the percentage of either the retail price, wholesale

		price, or production cost in a given state. Both appear to be derived from data for the Centers for Disease Control & Prevention.
Gruber (2000) [39]	USA	Price and taxes per state per year from 'The Tax Burden on Tobacco' (Tobacco Institute 1998). An average price from November to November the following year is used as the price measure and the tax rates as of February for the tax measure. For the natality data the tax rate from the month of birth is used.
Hammar (2001) [23]	Sweden	Price data was based on the average price of twenty cigarettes deflated by the consumer price index (at 1995 price level for period 1945-1989). Source is described as "SCB (various issues), Statistics Sweden".
Harris (1999) [13]	USA	Price data was obtained from "Infoscan: market and regional profiles 1993-Current markets" produced by Connecticut Information Resources Inc. Price data were derived from the barcode scanning of sales in large food stores in each market, including price for all brands (including discount and premium). In a subset of 22 markets there was data on the average retail price of deep-discount and generic brands.
Katzman (2002) [40]	USA	Price data were derived from the 'Tax Burden on Tobacco' (Tobacco Institute). Both real cigarette price (inclusive of taxes) and state-level excise tax on cigarettes are used.
Kidd (2004) [22]	Australia	Time series data on cigarette price from an unpublished Australian Bureau of Statistics Source was used for price data. This was a quarterly Consumer Price Index (CPI) by capital city, by expenditure class, which was converted into an annual series. This provides an index for each capital city and a weighted average of all eight capitals. This price index is based on the price per cigarette and is quality adjusted, when required, by the quantity of tobacco per cigarette. Data were merged with the smoking survey data to match the tobacco price with each person for each year of their life (however this assumes that people are still residing in the same location as when they were 18).
Lewit (1981) [41]	USA	The Tax Burden on Tobacco (Tobacco Tax Council) was the source for annual state-specific price series on cigarettes. This was measured in cents per pack, adjusted for municipal excise and retail sales taxes and deflated by the cost of living index.
Lewit (1997) [18]	USA & Canada	Nominal 1990 and 19932 cigarette price were taken for each community from "The Tax Burden on Tobacco" (The Tobacco Institute) where price reflects the average retail price of pack of 20 cigarettes inclusive of taxes. Nominal Canadian tax-inclusive price are from the Canadian Non-Smokers Rights Association. 1992 price is deflated to 1990 price using consumer price indices.
Lewit (1982) [42]	USA	Average cigarette price were calculated for each survey Primary Sampling Unit (PSU) in the Health Interview Survey (HIS) based on data from the Tobacco Tax Council using an average retail price per state by taking a weighted average of reported retail price plus applicable sales taxes of cigarettes sold by carton-lot, by the single pack over-the-counter and by single pack through vending machines. The weights are the national proportions of cigarettes sold in these ways.

Liang (2002) [56]	USA	State-level average price for a pack of 20 cigarettes from the "Tax Burden on Tobacco" (The Tobacco Institute). Price was deflated by the national Consumer Price Index for the first two quarters of the survey year. Price was categorised as low, medium and high ($1.175 and $1.315 were chosen as cut-offs to provide equal numbers in each category) due to the model used in analysis (as specifying a continuous variable could result in negative predicted probabilities).
Nonnemaker (2002) [51]	USA	Price data for state excise tax data per pack of 20 cigarettes was obtained from the Add Health data.
Ohsfeldt (1998) [52]	USA	Tobacco tax rate data are from the Tobacco Institute annual reports (1992, 1993). An average excise tax rate for each metropolitan statistical area (MSA) was a weighted average of state and local excise taxes with weights equal to each local government's share of the MSA population within a single state. State tax rate is used for respondents in non-MSA locations within a state.
Powell (2005) [43]	USA	State-level average price for a pack of cigarettes was obtained from the Tax Burden on Tobacco as published by the Tobacco Institute (1996, 1997) – the weighted average of a single pack, carton, and vending machine price, including state excise taxes.
Ross (2004) [44]	USA	The survey obtained information on students' perceived price based on survey participants (smokers and non-smokers) and a weighted average state price of a cigarette pack from the Tobacco Institute.
Ross (2001) [57]	USA	Price data were derived from the Tobacco Institute, 1997 – state cigarette price. Weighted state average of a single pack, carton, and vending machine price, including state excise taxes. Another price measure, average perceived price, was constructed from the survey based on the question "How much does a pack of cigarettes cost in your area?"
Slater (2007) [58]	USA	The measure of price used was the average price of premium-brand cigarettes (Marlboro and Newport) across all stores in a community. The price measure is deflated by the national Consumer Price Index (2003).
Tauras (2005) [45]	USA	Price data were derived from the 'Tax Burden on Tobacco' (Tobacco Institute, 1999). Weighted average of price for the first six months of a year for a pack of 20 (including state and federal taxes). Price deflated by the consumer price index taking 1982 to 84 as the base.
Tauras (2004) [46]	USA	Price data were derived from the 'Tax Burden on Tobacco' (Tobacco Institute). Weighted average of price for the first six months of a year for a pack of 20 cigarettes based on the price of single packs, cartons, and vending machine sales where the weights are national proportions of each type of sale (including state and federal taxes). Price deflated by the national Consumer Price Index taking 1982 to 84 as the base.
Taurus (1999) [47]	USA	Price data were derived from the 'Tax Burden on Tobacco' (Tobacco Institute). Weighted average of price for the first six months of a year for a pack of 20 cigarettes based on the price of single packs, cartons, and vending machine sales where the weights are national proportions of each type of sale (including state and federal taxes). Price deflated by the national

		Consumer Price Index taking 1982 to 84 as the base.
Tauras (1999) [48]	USA	Price data were derived from the 'Tax Burden on Tobacco' (Tobacco Institute). Weighted average of price for the first six months of a year for a pack of 20 cigarettes based on the price of single packs, cartons, and vending machine sales where the weights are national proportions of each type of sale (including state and federal taxes). Price deflated by the national Consumer Price Index taking 1982 to 84 as the base.
Tauras (2001) [49]	USA	Price data were derived from the 'Tax Burden on Tobacco' (Tobacco Institute). Weighted average of price for the first six months of a year for a pack of 20 cigarettes based on the price of single packs, cartons, and vending machine sales where the weights are national proportions of each type of sale (including state and federal taxes). Price deflated by the national Consumer Price Index taking 1982 to 84 as the base.
Thomson (2004) [59]	USA	The 'Tax Burden on Tobacco' (Tobacco Institute) was used to determine the state excise tax on cigarettes (January 1999). Tax was divided into quartiles to best fit the distribution of cigarette tax in the cohort. The average cost per pack of cigarettes was considered as a secondary primary variable of interest to tax.
Townsend (1994) [24]	UK	Data on cigarette price were obtained from the national income and expenditure accounts, as were data on national disposable income, which were divided by the population to give per capita disposable real income. All incomes were deflated by the retail price index.
Waller (2003) [20]	Canada	Data were derived from taxes in Ontario, but the source was not described.
Wasserman (1991) [50]	USA	The average price per state (weighted by type of sale - single package sold over the counter, carton and vending machine) was derived from the "Tax Burden on Tobacco" (Tobacco Institute). Deflated to 1967 price using the Consumer Price Index for All urban consumers.
Zhang (2006) [21]	Canada	Cigarette price change was evaluated. The retail price of a carton of cigarettes (200 cigarettes) at baseline and follow-up was measured in 1986 dollars. This was obtained from Statistics Canada based on the retail price of cigarettes in 26 major Canadian cities until 1994. From 1994 only cigarette price indices were reported. Cigarette price change was determined for each respondent by subtracting cigarette price at follow-up from the price of cigarettes at baseline. To calculate quarterly cigarette price from 1994 to 1997 the December 1994 retail price and changes in provincial cigarette price indices were used. Provincial consumer price indices were then applied to calculate constant (1986) dollar cigarette price for provinces.

Appendix 8: Study outcomes and price/tax effects

Author	Participation	Prevalence	Level of smoking for smokers	Total level of smoking	Starting smoking	Quitting smoking	Smoking initiation or uptake	Price elasticity	Tax elasticity estimates	Non-elasticity results
Bishai (2005) [53]	●		●						●	
Carpenter (2007) [12] Survey: YRBS	●							●		
Carpenter (2007) [12] Survey: YRBS – State level		●						●		
Carpenter (2007) [12] Survey: YRBS – city/local level		●						●		
Cawley (2003) [26]					●			●		
Cawley (2006) [27]					●			●		
Chaloupka (1990) [28]				●				●		
Chaloupka (1996) [29]	●		●	●				●		
Chaloupka (1999) [30]	●							●		
Chaloupka (1995) [31]	●		●	●				●		
Czart (2001) [55]	●		●							●
DeCicca (2002) [8]	●							●		
DeCicca (2000) [54]							●			●
DeCicca (2006) [32]	●		●	●				●		
Diener (2007) [19]	●							●		
Ding (2003) [33] Survey: NHIS (smoking history analysis)		●						●		
Ding (2003) [33]		●						●		

Survey: MTF										
Douglas (1998) [34]					●			●		
Emery (2001) [35]	●		●	●				●		
Evans (1998) [36]	●		●	●				●		
Farrelly (2001) [37]	●		●	●				●		
Gilleskie (2000) [38]	●							●		
Goel (2005) [25]										●
Gruber (2000) [39] Survey: MTF	●		●	●				●		
Gruber (2000) [39] Survey: YRBS	●		●	●				●		
Gruber (2000) [39] Survey: VSNF		●	●	●				●		
Hammar (2001) [23]							●			●
Harris (1999) [13]	●		●	●				●		
Katzman (2002) [40]			●					●		
Kidd (2004) [22]					●			●		
Lewit (1981) [41]	●		●	●				●		
Lewit (1997) [18]	●							●		
Lewit (1982) [42]	●		●	●				●		
Liang (2002) [56]										●
Nonnemaker (2002) [51] Survey: NLSAH – School sample	●								●	
Nonnemaker (2002) [51] Survey: NLSAH – Home sample						●				●
Ohsfeldt (1998) [52]	●								●	

Powell (2005) [43]	●							●		
Ross (2004) [44]	●		●	●				●		
Ross (2001) [57]							●			●
Slater (2007) [58]							●			●
Tauras (2005) [45]					●			●		
Tauras (2004) [46]						●		●		
Taurus (1999) [47]						●		●		
Tauras (1999) [48]	●		●	●				●		
Tauras (2001) [49]					●			●		
Thomson (2004) [59]										●
Townsend (1994) [24]				●				●		
Waller (2003) [20]		●								●
Wasserman (1991) [50]				●				●		
Zhang (2006) [21]					●			●		

Footnote: YRBS: Youth Risk Behavioural Survey; NHIS: National Health Interview Survey; MTF: Monitoring the Future; VSNF: Vital Statistics Natality Files; NLSAH: National Longitudinal Study of Adolescent Health (Add Health)

Appendix 9: Study covariate controls

Author	Gender	Age	Income	Socio	Peer effects	Ethnicity	Clean air regs	Policy vars	Youth access	Clean air index	Youth index	Other index	Tobacco state	State fixed effects
Bishai (2005) [53]	●	●				●			●					
Carpenter (2007) [12] Survey: YRBS	●	●		●		●	●							●
Carpenter (2007) [12] Survey: YRBS – State level		●				●	●							●
Carpenter (2007) [12] Survey: YRBS – city/local level		●				●	●							●
Cawley (2003) [26]	●	●	●	●		●							●	
Cawley (2006) [27]	●	●	●	●		●				●	●	●		
Chaloupka (1990) [28]	●	●	●	●										
Chaloupka (1996) [29]	●	●	●	●		●	●	●	●					
Chaloupka (1999) [30]	●	●	●	●		●		●		●	●			
Chaloupka (1995) [31]	●	●	●	●		●	●		●					
Czart (2001) [55]	●	●	●	●		●				●	●	●		
DeCicca (2002) [8]	●	●				●		●		●	●			
DeCicca (2000) [54]			●	●	●	●								●
DeCicca (2006) [32]	●	●				●					●			
Diener (2007) [19]	●	●												
Ding (2003) [33] Survey: NHIS – smoking history analysis														
Ding (2003) [33] Survey: MTF														

Douglas (1998) [34]	●	●	●	●		●								
Emery (2001) [35]	●	●	●	●		●						●		
Evans (1998) [36]	●	●	●	●		●								
Farrelly (2001) [37]	●	●	●	●		●								●
Gilleskie (2000) [38]	●	●	●	●		●								●
Goel (2005) [25]			●							●	●	●		
Gruber (2000) [39] Survey: MTF	●	●				●	●				●			●
Gruber (2000) [39] Survey: YRBS	●	●				●	●				●			●
Gruber (2000) [39] Survey: VSNF		●				●	●				●			
Hammar (2001) [23]	●			●								●		
Harris (1999) [13]	●	●	●	●		●								
Katzman (2002) [40]	●	●	●			●	●							
Kidd (2004) [22]	●					●								
Lewit (1981) [41]	●	●	●			●		●						
Lewit (1997) [18]	●	●				●			●	●	●	●		
Lewit (1982) [42]	●	●	●	●		●								
Liang (2002) [56]	●	●	●	●		●				●	●	●		
Nonnemaker (2002) [51] Survey: NLSAH – School sample	●	●		●	●	●	●		●		●			
Nonnemaker (2002) [51] Survey: NLSAH – Home sample	●	●		●	●	●								
Ohsfeldt (1998) [52]		●	●	●		●				●				
Powell (2005) [43]	●	●		●	●	●		●			●			

Ross (2004) [44]	●	●	●	●		●				●	●	●		
Ross (2001) [57]	●	●	●	●		●		●	●	●			●	
Slater (2007) [58]	●		●	●		●				●	●	●		
Tauras (2005) [45]	●	●	●	●		●	●						●	
Tauras (2004) [46]	●		●	●		●	●							
Taurus (1999) [47]		●	●	●						●				●
Tauras (1999) [48]	●		●	●		●	●							
Tauras (2001) [49]	●	●	●	●		●			●					●
Thomson (2004) [59]	●	●			●			●						
Townsend (1994) [24]	●	●	●									●		
Waller (2003) [20]														
Wasserman (1991) [50]	●	●	●	●		●			●	●				
Zhang (2006) [21]	●	●	●	●			●	●						

Footnote: YRBS: Youth Risk Behavioural Survey; NHIS: National Health Interview Survey; MTF: Monitoring the Future; VSNF: Vital Statistics Natality Files; NLSAH: National Longitudinal Study of Adolescent Health (Add Health)

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