Chapter 6
Tax, price and tobacco use among young people

Introduction

An overwhelming majority of adult smokers initiate smoking while they are adolescents or young adults. The World Bank estimates that in high-income countries, approximately eight out of 10 smokers start to smoke in their teens, while in low- and middle-income countries, most smokers start to smoke by their early twenties (Jha and Chaloupka, 1999)

According to the 1999–2007 Global Youth Tobacco Survey (GYTS), approximately 9.5% of students worldwide aged 13–15 currently smoke cigarettes (Centers for Disease Control and Prevention, 2008). The smoking prevalence rate of these students varies considerably by region, with the European Region having the highest prevalence rate at 19.2% and the Eastern Mediterranean region having the lowest smoking prevalence rate at 4.9%. Moreover, estimates from the GYTS suggest that 10.1% of students worldwide aged 13–15 use tobacco products other than cigarettes, such as smokeless tobacco, pipes, water pipes and bidis. Again, other tobacco prevalence rates by students vary considerably by region, with the Eastern Mediterranean region having the highest rate at 12.0% and the Western Pacific region having the lowest prevalence rate at 6.6%.

Youth responsiveness to prices and taxes – Theoretical foundations

Consistent with economic theory, adolescents and young adults are expected to have a larger response to price changes than older adults (see Chapter 5 for discussion of price and tax effects on adult demand for tobacco). That is, the demand for tobacco by adolescents and young adults is expected to be more price-elastic than the demand by older adults. There are several reasons for this prediction. First, as Grossman and Chaloupka (1997) point out, the fraction of disposable income spent on cigarettes by young smokers is likely to be greater than that of adult smokers. Economic theory predicts that the greater the share of disposable income a good takes up, the more responsive individuals will be to price changes. Grossman and Chaloupka (1997) also highlight the point that adolescents typically have a greater propensity to discount the future (i.e. have higher discount rates) than adults. The higher discount rates suggest that youth place a relatively greater importance on the short-term costs of smoking, such as the monetary price of cigarettes, than on the long-term costs of smoking, such as the future health consequences of smoking. Lewit *et al.* (1981) offer two additional reasons why youth are expected to be more price-elastic than adults. First, established adolescent smokers are likely to have shorter smoking histories than adults and therefore would likely respond more to price changes than long-time smokers who are more addicted. Second, adolescents are likely to be more easily influenced by their peers (i.e. friends and siblings) than are adults. That is, relative to older adults, young people are more likely to smoke if their peers also smoke. This implies that an increase in cigarette price would not only directly reduce youth smoking, but would also indirectly reduce youth smoking by decreasing peer smoking. In addition, young people's demand for tobacco can also be indirectly influenced, either positively or negatively, through observance of parental smoking. Finally, young people's responsiveness to tobacco price increases is also indirectly

influenced through access to cheap or free tobacco from social sources, such as peers and parents.

The 1989 U.S. Surgeon General's report suggests that smoking behaviour occurs on a continuum, from initiation to experimentation to regular smoking followed by dependence or addiction (U.S. Department of Health and Human Services, 1989). Cigarette prices are also likely to have a differential effect on smoking depending on where on the smoking uptake continuum the individual is. For example, individuals in the experimentation stage of smoking initiation will likely be less affected by cigarette price changes than those who are farther along the uptake continuum because those individuals in the experimentation stage typically do not yet purchase their own cigarettes and are not directly exposed to price. On the other hand, individuals who purchase their own cigarettes are likely to have a larger response to price changes than experimenters.

As described below, the empirical evidence on the demand for tobacco products among young people is consistent with economic theory. That is, youth and young adult tobacco demand has been found to be inversely related to cigarette prices, and with few exceptions, the absolute value of the price elasticity of demand is found to be larger for young people than for adults.

Youth responsiveness to prices and taxes – Review of evidence from demand studies

For the purpose of this review, generally young people refers to individuals under 30 years of age (13–18 youth; 19–30 young adults); however, some studies may provide price elasticity estimates for age groups that extend above this upper age limit.

Smoking prevalence and intensity among young smokers – United States

Numerous studies examining the determinants of youth tobacco use have been conducted over the past three decades. With few exceptions, these studies have taken advantage of natural experiments that result from government changes in tobacco product taxes and/or prices. Given the significant spatial (i.e. state and local) and temporal (i.e. over time) changes in tobacco taxes that have occurred in the United States over the past several decades, a preponderance of these studies have examined youth tobacco use in the United States. However, a growing number of studies have focused on youth tobacco use in other high-income countries, and more recently several studies have focused on low- and middle-income countries. Table 6.1 summarizes the published literature providing evidence on the effects of cigarette prices and taxes on smoking prevalence and smoking intensity among young people.

Lewit and colleagues (1981) were the first to examine the effect of cigarette prices on adolescent smoking. They employed data on 6768 youth aged 12 to 17 taken from Cycle III of the nationally representative Health Examination Survey, conducted from March 1966 through March 1970. They used a two-part model of cigarette demand in which smoking prevalence and intensity of cigarette use among smokers were estimated separately. In addition to price, they controlled for anti-smoking publicity, cigarette advertising and a variety of socioeconomic and demographic factors in their equations. Lewit and colleagues estimated that the total price elasticity of youth smoking was −1.44, an estimate that was considerably larger than the consensus estimate for adults. They found that most of the impact of price on youth smoking came through its impact on smoking prevalence, with an estimated price elasticity of smoking prevalence equal to −1.20. Price played a smaller role in altering average smoking by young smokers, with an estimated price elasticity of cigarette consumption among smokers equal to −0.25. These estimates imply that a 10% increase in the price of cigarettes would reduce youth smoking prevalence by 12% and reduce the average number of cigarettes consumed by young smokers by 2.5%.

A follow-up study by Lewit and Coate (1982) used the 1976 National Health Interview Survey to estimate smoking prevalence and intensity of smoking equations for different subpopulations, including individuals of different ages (20–25 years, 26–35 years, and 36–74 years) and genders. They found that young adults (aged 20–25 years) were the most responsive to changes in price, with an estimated total price elasticity of demand equal to −0.89. The authors estimated total price elasticities of demand for adults aged 26–35 and adults aged 36–74 to be −0.47 and −0.45, respectively. The absolute values of the price elasticities of demand for the adolescents included in this study are generally smaller than those found in Lewit *et al.* (1981), most likely because individuals in this study are older than those in Lewit *et al.* (1981). With respect to the youngest sample, those aged 20–25, males were found to significantly respond to price changes with an estimated total price elasticity of demand equal to −1.40, and females were found not to respond to prices.

Table 6.1. Summary of studies on the effects of cigarette price on young people's demand for tobacco products

Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
High-income countries					
USA (Lewit *et al.*, 1981)	Methods 1966–1970; Cycle III of the nationally representative Health Examination Survey of youth aged 12–17 (n = 6768) Model Ordinary least squares multivariate regression controlling for socioeconomic and demographic factors and antismoking and tobacco advertising	−1.44	–1.20	−0.25 Omitting price differential	
USA (Lewit and Coate, 1982)	Methods 1976; National Health Interview Survey, nationally representative sample of 19 266 individuals aged 20–74 from 416 survey sites. Model Ordinary least squares regression and variance components GLS procedure; adjusted for socioeconomic and demographic factors and region and city size characteristics. Subgroup analysis of demand by age is estimated by a FIML logit procedure	**Overall** *20–74 years* −0.221 (SE 0.126) **Restricted sample** 20–74 years −0.416 (SE 0.158) **By age** *20–25 years* −0.89 (SE 0.40) *26–35 years* −0.47 (SE 0.27) *36–74 years* −0.45 (SE 0.20) **By age and sex** *Females* *20–25 years* −0.302 (SE 0.595) *26–35 years* −0.577 (SE 0.424) *36–74 years* −0.118 (SE 0.310) **By age and sex** *Males* *20–25 years* −1.401 (SE 0.563) *26–35 years* −0.320 (SE 0.363) *36–74 years* −0.658 (SE 0.276)	**Overall** *20–74 years* −0.135 (SE 0.086) **Restricted sample** 20–74 years −0.264 (SE 0.122) **By age** *20–25 years* −0.74 (SE 0.35) *26–35 years* −0.44 (SE 0.25) *36–74 years* −0.15 (SE 0.19) **By age and sex** *Females* *20–25 years* −0.136 (SE 0.497) *26–35 years* −0.388 (SE 0.362) *36–74 years* −0.066 (SE 0.274) **By age and sex** *Males* *20–25 years* −1.276 (SE 0.476) *26–35 years* −0.292 (SE 0.318) *36–74 years* −0.246 (SE 0.235)	**Overall** *20–74 years* −0.037 (SE 0.077) **Restricted sample** 20–74 years −0.103 (SE 0.087) **By age** *20–25 years* −0.20 (SE 0.25) *26–35 years* −0.04 (SE 0.16) *36–74 years* −0.15 (SE 0.11) **By age and sex** *Females* *20–25 years* −0.025 (SE 0.395) *26–35 years* −0.134 (SE 0.250) *36–74 years* −0.077 (SE 0.170) **By age and sex** *Males* *20–25 years* −0.171 (SE 0.313) *26–35 years* −0.029 (SE 0.214) *36–74 years* −0.204 (SE 0.152)	Restricted sample: individuals whose own average price was greater than the price within the 20-mile band were removed

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Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
USA (Chaloupka, 1991)	Method 1976–1980; National Health and Nutrition Examination Survey, nationally representative sample of 28 000 individuals aged 6 mos to 74 years. Model Becker-Murphy model of rational addiction; two stage, least squares regression controlling for socioeconomic and demographic factors	**By age** *17–24 years* −0.103 to 0.05 *25–64 years* −0.454 to −0.315			Long-run price elasticities
USA (Wasserman *et al*., 1991)	Method 1970–1985; National Health Interview Survey data on 207 647 individuals from 7 of the 9 supplementary smoking questionnaires implemented between 1970 and 1985. Data on smoking among 12–1 7-year-olds from the National Health and Nutrition Examination Survey (*n* = 1891) for 1976−1980. Price data from Tobacco Institute's 1986 report The Tax Burden on Tobacco weighted average price by state. Model Estimated a generalized linear model using an iterative weighted least squares technique, adjusted for socioeconomic and demographic factors and other anti-smoking regulations	**Adults** 1970: 0.059 (SE 0.076) 1974: −0.017 (SE 0.062) 1985: −0.226 (SE 0.118)			No statistically significant difference between youth and adult smoking over time Adjustment for state policy restricting smoking
USA (Chaloupka and Grossman, 1996)	Method 1992, 1993, 1994; Data from 8th-, 10th- and 12th-grade students (ages 13–18) from the Monitoring the Future Survey (*n* = 110 717). Price data from the Tobacco Institute's report The Tax Burden on Tobacco	**Overall** −1.313 **Full Sample** *Price only model* −1.450 *Full model* −0.846	**Overall** −0.675 **Full Sample** *Price only model* –0.799 *Full model* –0.376	**Overall** –0.638 **Full Sample** *Price only model* –0.651 *Full model* –0.470	Estimates are average of the different models/samples. Price only model excludes other policy related variables, subject to omitted variables bias. Full model includes other policy variables, but likely subject to collinearity.

Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
USA (Chaloupka and Grossman, 1996) (contd)	Model Two-part model of demand: probit methods to estimate a smoking prevalence equation and least squares methods to estimate consumption by smokers, adjusted for socioeconomic and demographic factors and other anti-smoking regulations	**Restricted sample** *Price only model* −1.702 *Full model* −1.254	**Restricted sample** *Price only model* –0.923 *Full model* –0.602	**Restricted sample** *Price only model* –0.779 *Full model* –0.652	Restricted sample excludes individuals living within 25 miles of a state with lower cigarette prices
USA (Chaloupka and Wechsler, 1997)	Method 1993; Nationally representative sample of 16 570 students from 140 US Colleges and Universities from the Harvard College Alcohol Study. Site-specific cigarette price from the 1993 American Chamber of Commerce Researchers Association Quarterly Inter-City Cost of Living Index Model Ordered level consumption: Ordered probit specification. For 'categorically continuous' consumption: two-part model of demand – probit methods to estimate smoking prevalence and least squares method for the smoking intensity equation. Adjusted for socioeconomic and demographic factors, regional and institutional characteristics	**Overall** −1.11 **Full sample** −1.249 **Restricted sample** −1.009 Estimates are averages of the different models/samples	**Overall** −0.520 **Full sample** −0.536	**Overall** −0.729 **Full sample** −0.472	Two measures of consumption: ordered level consumption (0 = non-smoker, 1 = light smoker etc) and a 'categorically continuous' measure 0, 0.5, 5, 10, 15, 20, 30). Restricted sample excludes all students attending a college/university within 20 miles of a state with lower cigarette excise taxes/ price
USA and Canada (Lewit *et al.*, 1997)	Method 1990 and 1992; two cross-sectional school-based surveys of 9th-grade students (aged 13–16) from 21 North American communities representing 15 432 individuals as part of the COMMIT Project Model Mutivariate logistic		**Price elasticity of smoking prevalence** *Full sample* −0.87 *By gender* Boys −1.51 Girls −0.32 **Price elasticity of intention to smoke**		

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Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
USA and Canada (Lewit *et al.*, 1997) (contd)	regression models including cigarette price, exposure to COMMIT interventions, age, race, gender, year and state level policy interventions as independent variables		*Full sample* −0.95 *By gender* Boys – 0.92 Girls −0.99		
USA (Centers for Disease Control and Prevention, 1998)	Method Pooled data from 1976–1980, 1983, 1985, 1987–1993 National Health Interview Surveys (*n* = 355 246). Price data from the Tobacco Institute. Model Two-part model of demand: probit model to estimate smoking prevalence and Ordinary Least Squares to estimate smoking intensity, controlled for year, region, socioeconomic and demographic factors	**Overall** −0.25 **By gender** *Males* −0.26 *Females* –0.19 **By age** *18–24 years* –0.58 *25–39 years* –0.42 *40+ years* –0.10	**Overall** −0.15 **By gender** *Males* −0.18 *Females* −0.09 **By age** *18–24 years* −0.37 *25–39 years* −0.25 *40+ years* −0.06	**Overall** −0.10 **By gender** *Males* −0.08 *Females* −0.10 **By age** *18–24 years* −0.21 *25–39 years* −0.17 *40+ years* −0.04	
USA (Evans and Farrelly, 1998)	Method 1979, 1987; nationally representative cross-sectional (pooled surveys) data on adults 18 years and over from the National Health Interview Survey supplements 1979 (Smoking) and 1987 (Cancer Control) (*n* = 48 314). Model Two-part model: 1) probit (smoking prevalence); 2) simple linear regression OLS (smoking intensity). Analyses adjusted for socioedemographic variables.	**Tax** *18–24 years* −0.798 *25–39 years* −0.759	**Tax** *18–24 years* −0.575 *25–39 years* −0.434	**Tax** *18–24 years* −0.223 *25–39 years* −0.325	
USA (Chaloupka and Pacula, 1999)	Method 1992, 1993, 1994; Data from 8th-, 10th- and 12th-grade students (ages 13–18) from		**Males** – 0.928*** *White* – 0.861***		Statistically significant at ***1%, **5%, and *10%

Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
USA (Chaloupka and Pacula, 1999) (contd)	the Monitoring the Future Survey (*n* = 110 717). Price data from the Tobacco Institute's report The Tax Burden on Tobacco Model Probit maximum likelihood specification		*Black* – 1.646*** **Females** – 0.595** *White* – 0.451** *Black* – 0.453 **Whites** – 0.639*** **Blacks** – 1.108*		
USA (Dee, 1999)	Method 1977–1992 pooled representative data on high school seniors from 44 US states from the Monitoring the Future Surveys (*n* = 255 560) Model Weighted least squares estimates of reduced form equations for smoking prevalence. Analyses control for demographic variables, year and state fixed effects, socioeconomics and macroeconomic covariates, race and gender-specific year fixed effects and state-specific time trends.		**Estimates based on pooled data from 1977–1992** 0.0592 to −0.0644 **Estimates based on data from 1985–1992** −0.098 to −0.112		Estimates using pooled data from 1977–1992 suggest that cigarette taxes appear to have implausibly signed or statistically imprecise effects on teen smoking prevalence; richer specifications using data from 1985–1992 provide relatively weak statistical significance in some models
USA (Harris & Chan, 1999)	Method 1992–1993; Tobacco Use Supplements to the Current Population Survey. Model Two-stage model of demand: probit specification for the prevalence equation and OLS equation for the smoking intensity equation. Probit equations and conditional regressions with two price variables: average price of premium and average price of discount brands. Model 1 enters each price variable separately and	**By age** *15–17 years* −0.996 (SE 0.487) *18–20 years* −0.779 (SE 0.306) *21–23 years* −0.644 (SE 0.263) *24–26 years* −0.657 (SE 0.212) *27–29 years* −0.329 (SE 0.190)	**By age** *15–17 years* −0.831 (SE 0.402) *18–20 years* −0.524 (SE 0.258) *21–23 years* −0.370 (SE 0.188) *24–26 years* −0.202 (SE 0.175) *27–29 years* −0.095 (SE 0.157) **Separate equations** *Premium* 15–17 years −1.023 (SE 0.517) 18–20 years −0.735 (SE 0.328)	**By age** *15–17 years* −0.165 (SE 0.276) *18–20 years* −0.255 (SE 0.165) *21–23 years* −0.274 (SE 0.184) *24–26 years* −0.455 (SE 0.120) *27–29 years* −0.234 (SE 0.107) **Separate equations** *Premium Brands* 15–17 years −0.237 (SE 0.371) 18–20 years −0.410 (SE 0.217)	

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Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
USA (Harris & Chan, 1999) (contd)	Model 2 includes both in a single equation		21–23 years −0.529 (SE 0.236) 24–26 years −0.297 (SE 0.222) 27–29 years −0.123 (SE 0.199) *Discount brands* 15–17 years −0.533 (SE 0.366) 18–20 years −0.091 (SE 0.236) 21–23 years −0.059 (SE 0.175) 24–26 years −0.069 (SE 0.162) 27–29 years −0.178 (SE 0.146) **Single equation** *Premium* 15–17 years −1.069 (SE 0.836) 18–20 years −1.601 (SE 0.526) 21–23 years −1.106 (0.364) 24–26 years −0.911 (SE 0.350) 27–29 years −0.716 (SE 0.305) *Discount brands* 15–17 years 0.041 (SE 0.591) 18–20 years 0.799 (SE 0.376) 21–23 years 0.563 (SE 0.270) 24–26 years 0.577 (SE 0.254) 27–29 years 0.575 (SE 0.224	21–23 years −0.492 (SE 0.176) 24–26 years −0.550 (SE 0.156) 27–29 years −0.427 (SE 0.138) *Discount Brands* 15–17 years −0.152 (SE0.247) 18–20 years −0.057 (SE 0.153) 21–23 years −0.104 (SE 0.129) 24–26 years −0.320 (SE 0.110) 27–29 years −0.114 (SE 0.099) **Single equation** *Premium Brands* 15–17 years −0.151 (SE 0.668) 18–20 years −0.987 (SE 0.366) 21–23 years −1.070 (SE 0.295) 24–26 years −0.524 (SE 0.267) 27–29 years −0.808 (SE 0.225) *Discount Brands* 15–17 years −0.069 (SE0.445) 18–20 years 0.504 (SE 0.258) 21–23 years 0.525 (SE 0.216) 24–26 years −0.023 (SE 0.187) 27–29 years 0.346 (SE 0.162)	
USA (Tauras and Chaloupka, 1999)	Method 1976–1993; Panel data nationally representative cross-sectional surveys of 8th-, 9th- and 10th-grade	−0.711	−0.104	−0.607	Consumption is 'categorically continuous' assuming the following values: 0, 15, 90, 300, 600, 900 and 1200

Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
USA (Tauras and Chaloupka, 1999) (contd)	students (ages 13–18) from the Monitoring the Future Survey (approximately 50 000 persons). Price data from the Tobacco Institute's report The Tax Burden on Tobacco Model Two-part, individual fixed effects model of cigarette demand: linear probability model used to estimate smoking prevalence equations and least squares techniques to estimate smoking intensity				
USA (Emery *et al.*, 2001)	Method 1993; Nationally representative data for youths aged 10–22 from the second wave of the longitudinal teenage attitudes and practices survey (n = 12 952). Price data from the Tobacco Institute. Model Two-part model of cigarette demand. Smoking intensity modelled separately for current smokers (smoked in last 30 days) and established smokers (smoked in last 30 days and at least 100 cigarettes in lifetime) separately	**Current smokers 14+ years** −1.70 **Established smokers 14+ years** −2.24	**Current smokers 14+ years** −0.83 **Established smokers 14+ years** −1.56 **Experimenters 10+ years** non-significant	**Current smokers 14+ years** −0.87 *Established smokers 14+ years* −0.68	
USA (Farrelly *et al.*, 2001)	Method Pooled data from 1976–1980, 1983, 1985, 1987–1993 National Health Interview Surveys (n = 354 228). Price data from the Tobacco Institute. Model Two-part model of demand: probit model to estimate smoking prevalence and Ordinary Least Squares to estimate smoking intensity, controlled for year, region, socioeconomic and demographic factors, and state-specific effects	**Total sample** −0.28 **By gender** *Males* −0.18 *Females* –0.32 **By age** *18–24 years* –0.55 *25–39 years* –0.53 *40+ years* –0.00	**Total Sample** −0.13 **By gender** *Males* −0.03 *Females* –0.19 **By age** *18–24 years* –0.30 *25–39 years* –0.25 *40+ years* –0.02	**Total sample** –0.15 **By gender** *Males* –0.18 *Females* −0.13 **By age** *18–24 years* –0.25 *25–39 years* –0.28 *40+ years* –0.06	Only significant estimates of price elasticity of smoking prevalence and intensity are included in the total price elasticity estimates

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Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
USA (Gruber and Zinman 2001)	Method 1991–1997; 3 data sets: Monitoring the Future Surveys of 8th-, 10th-, and 12th-grade students (n = 336 665), Youth Risk Behavior Surveys of 9th–12th grade students (n = 53 278) and Vital Statistic Natality data on teenage mothers during pregnancy (n = 1985). State-level price and tax from the Tobacco Institute Model Regression, controlled for demographic factors, state clean air laws and youth access restrictions		**MTF data** −0.66 **YRBS data** −1.5 **Natality data** −0.38		
USA (Ross and Chaloupka, 2003)	Method 1996; Cross-sectional data for 17 287 high school students from 202 schools. Three measures of price: perceived price from smokers and non-smokers, Tobacco Institute price data and ACCRA cost-of-living index price data. Model Two-part model of cigarette demand: probit specification for smoking prevalence equation, ordinary least squares for smoking intensity, controlling for state-level smoke-free air laws and youth access laws and the possibility of smuggling	**Using average state prices** −0.67 **Using perceived prices** −1.02	**Using average state prices** −0.351 **Using average perceived prices** −0.492	**Using average state prices** −0.138 **Using perceived prices** −0.521	
USA (Farrelly *et al.*, 2004)	Method 1988 and 1993; Longitudinal data for 3675 smokers aged 25–64 from the 1988 Community Intervention Trial (COMMIT). Model			**Smokers' ages** *25–34 years* −0.235 *35–44 years* −0.115 *45–64 years* −0.110	Smokers respond to higher cigarette prices by reducing aintensity, but also by switching to cigarettes with higher levels of tar and nicotine

Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
USA (Farrelly *et al.*, 2004) (contd)	Linear regression of average daily cigarette consumption adjusted for age, race, sex, marital status education income clean air laws index, nicotine and tar. State average cigarette price				
USA (Ross and Chaloupka, 2004)	Method 1996; Cross-sectional data for 17 287 high school students from 202 schools. Two measures of price: perceived price from both smokers and non-smokers, and Tobacco Institute price data Model Two-part model of cigarette demand: probit specification for smoking prevalence equation, generalized linear model for smoking intensity, controlling socioeconomic and demographic factors as well as for state-level smoke-free air laws and youth access laws and the possibility of smuggling	**Using average state price** −0.722 to −0.763 **Using perceived price** −0.997 to −1.003	**Using average state price** –0.393* **Using perceived price** −0.414**	**Using average state price** –0.052 **Using perceived price** −0.543*	**, * Significant at 5% and 10% level based on two-tailed test after its standard error was adjusted for clustering
USA (Sloan and Trogdon, 2004)	Method 1990–2002; repeated cross-sectional data on a nationally representative sample of adults (n = 1 762 686) from the Behavioural Risk Factor Surveillance System survey. Model Probit specification to estimate smoking prevalence elasticity controlling for socioeconomic and demographic factors		**18–20 years** −0.27 (0.14) **21–24 years** −0.12 (0.08) **25–44 years** −0.10 (0.05) **45–64 years** −0.10 (0.07) **65+ years** −0.25 (0.08)		
USA (DeCicca *et al.*, 2005)	Method 1988–2000; nationally representative panel micro data from the National Education Longitudinal Survey of 8th graders followed up 2, 4 and 12 years		**Model 1** *2000 tax rate* −0.610 **Model 2** *1992 tax rate* −1.137		

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Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
USA (DeCicca *et al.*, 2005) (contd)	later. (*n* = 11 326) Model Probit model of smoking prevalence. Model 1 uses contemporaneous smoking and tax data; Model 2 incorporates past tax data. Model 3 compares those who move states and those who stay in the same state. All three models are estimated with and without correcting for attrition.		*2000 tax rate* −0.119 *Full sample* −0.610 *Movers* −0.214 *Stayers* −0.692 Corrected for attrition **Model 1** *2000 tax rate* −0.678 **Model 2** *1992 tax rate* −1.126 *2000 tax rate* −0.183 **Model 3** *Full sample* −0.678 *Non-switchers* −0.369 *Switchers* −0.739		
USA (Tauras *et al.*, 2005)	Method 1997–2001; National Longitudinal Survey of Youth 1997 Cohort. Nationally representative sample of 9022 youths aged 12–16, first wave in 1997, annual follow-up for 4 years. Price data from Tobacco Institute. Model Two-part model of cigarette demand using a fixed effects approach that controls for unobserved individual level heterogeneity and individual invariant year-specific unobserved heterogeneity	−0.827	−0.311	−0.516	
USA (Carpenter and Cook, 2008)	Method 1991–2005; National representative data from the Youth Risk Behavior Survey		**National** −0.56 (−0.106) **State/local** −0.25 (−0.047)		State and local versions of YRBS only sources of youth smoking information designed to be representative

Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
USA (Carpenter and Cook, 2008) (contd)	(*n* = 101 633) and aggregate data from independent state and local versions of the YRBS representative at the state/local level (*n* = 278, representing over 750 000 youths) Model 1) For national data: Two-way fixed effects model, controlling for demographics and area and year fixed effects, using standard logit regression 2) For state and local data: separate weighted Ordinary Least Squares regressions 3) Model including a direct measure of anti-smoking sentiment using national data				of the sampled state or locality
USA (DeCicca *et al*., 2008a)	Method 1992 and 2000; National Education Longitudinal Study, two waves as cross-sections: 1992 (*n* = 16 730) and 2000 (*n* = 11 490). State cigarette data from Tax Burden on Tobacco Model Two part model of cigarette demand: probit model of smoking prevalence and ordinary least squares model of smoking intensity, controlling for state anti-smoking sentiment, youth access restrictions, socioeconomic and demographic variables	**1992 to 2000 data** −1.065 to −1.244* **Including direct measure of anti-smoking sentiment** +0.104 to −0.629	**1992 to 2000 data** −0.763 to −0.586 **Including direct measure of anti-smoking sentiment** +0.082 to −0.111	**1992 to 2000 data** −0.302 to −0.658	* Statistically significant at 1%. Price elasticities estimated including anti-smoking sentiment not statistically significant. 'Categorical continuous' variable constructed for consumption based on conditional categorical means
USA (DeCicca *et al*., 2008b)	Method 1988–2000; 1988, 1992 and 2000 waves of the National Education Longitudinal Study (*n* = 10 336) including youths aged 18–26 years. Model Myopic addiction model using probit specifications,		**Model 1** −0.49* **Model 2** 0.13		* Statistically significant

Table 6.1. Summary of studies on the effects of cigarette price on young people's demand for tobacco products

Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
USA (DeCicca *et al.*, 2008b) (contd)	controlling for socioeconomic and demographic factors and anti-tobacco sentiment. Three models estimated: 1) using intrastate variation in cigarette excise taxes, 2) including a direct measure of anti-tobacco sentiment 3) using variation in state excise taxes faced by youths who moved state between study waves				
USA (Franz, 2008)	Method 1993–2000; Nationally representative cross-sectional data for adults 18+ years from the Behaviour Risk Factor Surveillance System Survey (n = 1 million) Method Two models were considered: 1) a simple OLS and 2) a two-part model. Analyses controlled for socioeconomic and demographic factors. Price was the state average real cigarette price	**Overall** −0.374 *18–29 years* −0.518 *30–39 years* −0.360 *40–64 years* −0.327 *65+ years* −0.458	**Overall** −0.193 *18–29 years* −0.289 *30–39 years* −0.176 *40–64 years* −0.201 *65+ years* −0.331	**Overall** −0.191 *18–29 years* −0.184 *30–39 years* −0.192 *40–64 years* −0.158 *65+ years* −0.154	
USA (Fletcher *et al.*, 2009)	Method 1994–2002; data from the first wave of the national Longitudinal Study of Adolescent Health; nationally representative sample of 7th- to 12th-grade students in 1994 followed up one and six years later (about 90 000). State level excise tax used. Model OLS, Poisson, and negative binomial regression used to estimate tax response. Finite mixture models used to estimate differential response by 'type' (light and heavy smokers). Analyses	**Baseline estimates** *OLS* −0.189** *Poisson* −0.090** *Negative binomial* −0.111** **Finite Mixture Models** *Poisson* Light smokers −0.128* Heavy smokers −0.055 *Negative binomial* Light smokers −0.185** Heavy smokers −0.057			Tax elasticities. Study suggests two attributes are associated with adolescent types: self-control and future discount rates. Adolescents with lower self-control and higher future discount rates are less responsive to tax than counterparts with higher self-control and lower discount rates

Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
USA (Fletcher *et al.*, 2009) (contd)	controlled for race, gender, age, family income, parental education and employment, family structure, religiosity and rural/urban				
United Kingdom (Townsend *et al.*, 1994)	Method 1972–1990; nationally representative random sample of British adults from the Biennial General Household Survey. Model Multiple regression analysis		**By gender** *Men* (95% CI) −0.47 (−0.83 to −0.10) *Women* −0.61 (−0.89 to −0.33) **By age and gender** *Men* 16–19 years 0.06 (SE 0.32) 20–24 years 0.16 (SE 0.26) 25–34 years −0.73 (SE 0.16)** 35–49 years −0.35 (SE 0.17) 50–59 years −0.66 (SE 0.37) 60+ years −0.29 (SE 0.13) *Women* 16–19 years −0.86 (SE 0.22)** 20–24 years −0.96 (SE 0.20)*** 25–34 years −0.85 (SE 0.09)*** 35–49 years −0.93 (SE 0.13)*** 50–59 years −0.92 (SE0.16)*** 60+ years −0.59 (SE 0.26)*		** P < 0.05* *** P < 0.01* **** P < 0.001*
Canada (Dupont and Ward, 2002)	Method 1994–1998; National Population Health Data, nationally representative longitudinal data for individuals aged 14–18 during cycle 1. Price data from Statistics Canada Model Two-part model of cigarette demand: smoking propensity	**In 1994** −0.919 In 1998 −0.121	**In 1994** −0.914 In 1998 0.434	**In 1994** −0.005 In 1998 −0.555	

Table 6.1. Summary of studies on the effects of cigarette price on young people's demand for tobacco products

Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
Canada (Dupont and Ward, 2002) (contd)	estimated using a probit function and smoking intensity estimated using linear regression				
Canada (Sen and Wirjanto, 2010)	1992 to 1999; pooled data from 1992–1996 Waterloo Smoking Prevention Programme; 1991 General Social Survey; 1994 Youth Smoking Survey; 1996/97 and 1998/99 National Population Health Surveys, 1999 Canadian Tobacco Use Monitoring Survey Model Probit and OLS estimation controlling for gender and employing province and year effects		Price elasticity of smoking participation −0.10	Price elasticity of daily smoking −0.14	
27 European countries (Schnohr *et al.*, 2008)	Method 2001/02; Health Behaviour in School Aged Children: pooled, cross-sectional data from 92 217 youths aged 13 and 15 years from 27 countries. Price and policy data from 2003 the WHO Regional Office for European Tobacco Control Database Model Regression analysis with daily smoking as the outcome and the stepwise inclusion of national tobacco policy, adult tobacco epidemiology and macro-economic variables. Multilevel modeling to determine the effects of each group of variables. Analyses adjusted for age and stratified by gender		**Univariate** 0.91 (0.83–1.00) **Model 1** 0.86 (0.78–0.95) **Model 2** 0.91 (0.80–1.04) **Model 3** 0.94 (0.81–1.10)		Odds ratio of daily smoking (95% confidence interval). No significant relationships between price and youth smoking prevalence, possibly as a result of inability to adequately control for intercountry factors correlated with price

Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
Low- and middle-income countries					
South Africa (van Walbeek, 2002)	Method 1993–2000; All Media and Products survey—national repeated cross-sectional surveys of between 14 000–30 000 individuals 16 years and over. Model Regression	Not estimated	**Percentage change in estimated smoking prevalence** *Total sample* −16.9% *By age* 16–24 years −22.0% 25–34 years −17.6%	**Percentage change in aggregate cigarette consumption** −26.0% *Percentage change in average consumption* *Total sample* −24.2%	Percentage change in real price of cigarettes 92.7% No estimation of price elasticity by age in models controlling for other determinants of demand
Ukraine (Krasovsky et al, 2002)	Method National survey data on individuals 14 years and over (n = 2700) Model Ordinary least squares regression, adjusted for socioeconomic and demographic factors			**Total sample** −0.4 *4–17 years* Low income −0.65 Medium income −0.7 High income −0.52 *18–28 years* Low income −0.37 Medium income −0.42 High income −0.24 *29+ years* Low income −0.28 Medium income −0.33 High income −0.15	Self-reported price, endogenous Cigarette consumption derived from reported monthly cigarette expenditure divided by reported pack price. No information on statistical significance of estimates
Myanmar (Kyaing, 2003)	Method 1980–2001; Survey data from 75 townships Model Two part demand model: Logit model to estimate smoking probability and OLS regression to estimate consumption equation	**Total sample** −1.619 **By age** *15–24 years* –2.41 *25–34 years* –1.596 *35–44 years* –1.398 *45–54 years* –1.263 *55–64 years* –1.253 *65+ years* – 1.167	**Total sample** −1.277 **By age** *15–24 years* –1.992 *25–34 years* –1.231 *35–44 years* –1.08 *45–54 years* –0.943 *55–64 years* –0.856 *65+ years* –0.887	**Total sample** −0.342** **By age** *15–24 years* –0.418** *25–34 years* –0.365** *35–44 years* –0.318** *45–54 years* –0.32** *55–64 years* –0.397** *65+ years* –0.28**	Prices for smoking households based on expenditures and cigarette/ cheroots, home rolled tobacco consumption and used to predict prices for non-smoking households – endogenous **: $P < 0.01$

Table 6.1 Summary of studies on the effects of cigarette price on young people's demand for tobacco products

Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
Nepal (Karki *et al.*, 2003)	Method 2000; Smoking Behaviour Survey, nationally representative data on 1438 households and 5957 individuals Model Two part demand model: Logit model to estimate smoking probability and OLS regression to estimate consumption equation	**Total sample** −0.882 **By age** *15–24 years* –1.879 *25–34 years* –0.945 *35–44 years* –0.686 *45–54 years* –0.605 *55–64 years* –0.682 *65+ years* –1.1	**Total sample** −0.459 **By age** *15–24 years* –1.32 *25–34 years* –0.449 *35–44 years* –0.306 *45–54 years* –0.263 *55–64 years* –0.355 *65+ years* –0.459	**Total sample** −0.423** **By age** *15–24 years* –0.599* *25–34 years* –0.496** *35–44 years* −0.38** *45–54 years* –0.342** *55–64 years* –0.327** *65+ years* –0.641**	Prices for smoking households based on expenditures and cigarette/bidi consumption and used to predict prices for non-smoking households—endogenous *: $P < 0.10$ **: $P < 0.01$
Thailand (Sarntisart, 2003)	Method 2000 Household Socioeconomic Survey data for 11 968 households from 9 regions and 4 rural areas Model Linear expenditure system model using pooled estimation			**Total sample** −0.3925 **By age** *8–17 years* –0.3075 *18–29 years* −0.3880 *30–39 years* −0.4616 *40–49 years* −0.2447 *50–59 years* −0.2875 *60 and older* −0.0000	Individual smoking consumption estimated based on consumption of smoking households with individuals of different ages and data on age of initiation
China and the Russian Federation (Lance *et al.*, 2004)	Method 1993–1997; longitudinal data for respondents over 13 years of age from nine Chinese provinces from the Chinese Health and Nutrition Survey (n = 8557). Russian data from the 1996, 1998 and 2000 waves of the Russian Longitudinal Monitoring Survey of adults over 13 (n = 10 638 men) Model Two-part demand model: logit	**China** *Pooled* −0.082 *Community fixed effects* −0.007 *Pooled cross-section* < 20 years −0.257 21–24 years –0.053 25–54 years −0.025 55+ years −0.199	**China** *Pooled* −0.019 *Fixed effects A* −0.045 *Fixed effects B* −0.034 *Pooled cross-section* 21–24 years 0.141 25–54 years 0.093 55+ years −0.044	**China** *Pooled* −0.063 *Fixed effects A* −0.056 *Fixed effects B* −0.027 *Pooled cross-section* 21–24 years 0.564 25–54 years 0.389 55+ years 0.180	*$P < 0.1$; **$P < 0.05$

Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
China and the Russian Federation (Lance *et al.*, 2004) (contd)	specification for prevalence equation and linear regression for the smoking intensity equation. Pooled cross-sectional specifications and including community fixed-effects	*Community fixed effects* < 20 years 0.077 21–24 years 0.122 25–54 years −0.004 55+ years −0.149	*Fixed effects A* 21–24 years 0.141 25–54 years 0.092 55 +years −0.061 *Fixed effects B* 21–24 years 0.070 25–54 years 0.030 55+ years −0.130	*Fixed effects A* 21–24 years 0.571 25–54 years 0.404 55+ years 0.187 *Fixed effects B* 21–24 years −0.041 25–54 years −0.578 55+ years −0.573	
		The Russian Federation *Pooled* −0.132 *Community fixed effects* −0.050 < 20 years −0.345 21–24 years −0.237 25–54 years −0.072 55+ years −0.111 *Community fixed effects* < 20 years −0.199 21–24 years −0.142 25–54 years −0.003 55+ years −0.042	**The Russian Federation** *Pooled* −0.106 *Fixed effects A* −0.101 *Fixed effects B* −0.050 21–24 years −0.003 25–54 years 0.005* 55+ years 0.004 *Fixed effects A* 21–24 years −0.002 25–54 years 0.005* 55+ years 0.004 *Fixed effects B* 21–24 years −0.002 25–54 years 0.005 55+ years 0.002	**The Russian Federation** *Pooled* −0.026 *Fixed effects A* −0.026 *Fixed effects B* −0.000 21–24 years −0.002 25–54 years 0.025* 55+ years 0.035* *Fixed effects A* 21–24 years −0.003 25–54 years 0.024* 55+ years 0.032* *Fixed effects B* 21–24 years −0.002 25–54 years 0.025* 55 + years 0.029*	
Russian Federation, Moscow (Ross, 2004b)	Method 1999; data from the Global Youth Tobacco Survey on 7th-, 8th-, 9th-and 10th-grade students (aged 11–17) (*n* = 4074). School-level measure of average cigarette price.	−1.15 to −1.16	−0.47 to −0.51	−0.64 to −0.69	

Table 6.1. Summary of studies on the effects of cigarette price on young people's demand for tobacco products

Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
Russian Federation, Moscow (Ross, 2004b) (contd)	Model Two-part model of cigarette demand: probit model to estimate smoking prevalence equation and Ordinary Least Squares to estimate smoking intensity equation, controlling for socioeconomic factors and school anti-smoking policies				
Ukraine (Kiev), (Ross, 2004a)	Method 1999; Global Youth Tobacco Survey data for 4156 individuals from 100 schools in Kiev city Model Probit model used to estimate smoking prevalence equation		−0.29 to −0.51	−1.43 to −1.83	Average school price calculated based on reported price from smoking students
India (Joseph, 2010)	Method 2000–2004; Global Youth Tobacco Survey data from 26 of 28 states and two of the seven Union Territories on youth aged 13–15 years. Average price data from users and non-users to construct school/state/ territory level prices Model Two-part model of cigarette demand; probit model to estimate smoking prevalence equation and Ordinary Least Squares to estimate smoking intensity equation	−0.4	**Total sample** −0.4053 **By gender** *Women* −0.6081 *Men* −0.2852	**Total sample** Insignificant **By gender** *Women* −0.4072 *Men* −0.2408	
20 LMICs (Kostova *et al.*, 2010	Method 1999–2006; Data from the Global Youth Tobacco Survey, average age 14 years (n = 349 930). Price data from the Economist Intelligence Unit World Cost of Living Survey. Model	−1.8	**Local brand prices** −0.56** to −0.96*** **Foreign Brand Prices** −1.540***to −0.904** **By smoking intensity** *Very light smokers (1–15 cigs/mo)* 0.396*** to 0.528***	**Local brand prices** −1.13***to −1.21*** **Foreign brand prices** −1.22***to −1.22	**P < 0.05 ***P < 0.01

Publication (location, author, year)	Methods and Model	Total price elasticity of demand	Price elasticity of smoking prevalence	Price elasticity of smoking intensity	Comments
20 LMICs (Kostova *et al.*, 2010 (contd)	Two-part model of cigarette demand: smoking prevalence estimated using a logit model, smoking intensity estimated with a generalized linear model with a normal distribution and a log link. Analyses include country fixed effects, a measure of local anti-smoking sentiment and control for the prevalence of cigarette advertising, anti-tobacco media outreach, and compliance with youth access restrictions.		*Light to medium smokers* *(15 –100 cigs/mo)* −0.437 ***to −0.339*** *Medium smokers* *(100–300 cigs/mo)* −0.900***to −0.687*** *Heavy smokers* *(300+ cigs/mo)* −1.144***to −0.868***		

In the early 1990s, two studies were published in the US (Chaloupka, 1991 and Wasserman *et al.*, 1991) and one in the United Kingdom (Townsend *et al.*, 1994) that cast doubt on the early studies by Lewit and colleagues by finding that young people were not more price-elastic than adults. Chaloupka (1991) used data from the National Health and Nutrition Examination Survey conducted from 1976 to 1980 to estimate the cigarette demand equations. Applying Becker and Murphy's theoretical model of rational addiction (discussed in Chapter 4), Chaloupka found young adults (aged 17–24) to be insensitive to changes in price, whereas individuals aged 25–64 showed a significant long-run response to a change in price, with an estimated long-run price elasticity of demand in the range of – 0.46 to – 0.32.

Wasserman and his colleagues (1991) used data on 1891 adolescents aged 12–17, taken from the Second National Health and Nutrition Examination Survey conducted between 1976–1980, and data on adults taken from several waves of the National Health Interview Surveys conducted in the 1970s and 1980s to estimate cigarette demand equations. They focused on the effects of cigarette prices while controlling for state policies restricting smoking in public places and a host of other socioeconomic and demographic variables. Consistent with Chaloupka's (1991) results, Wasserman and colleagues found no statistically significant difference in the price elasticity of demand between youth and adult smokers. Moreover, there were no statistically significant effects of price on youth smoking. They attribute much of the difference between their findings and those of previous studies (i.e. Lewit and colleagues) to the inclusion of a measure reflecting

the magnitude of restrictions on smoking in public places and its correlation with cigarette prices. When Wasserman *et al.* excluded the smoking restrictions measure from their models, they obtained similar price elasticities to those from the early studies. They argued that the price elasticity estimates were subject to an omitted variables bias when the smoking restrictions measure was not included.

A series of papers starting in the mid-1990s supported the early findings of Lewit and his colleagues that young people are more price-responsive than older people. These studies were based on data covering a period with greater variation in tax and price, which allowed more precise estimates of the impact of price. For example, Chaloupka and Grossman (1996) used data on more than 110 000 8th-, 10th-, and 12th-grade students taken from the 1992, 1993 and 1994 Monitoring the Future Surveys (MTFS) to estimate smoking prevalence and smoking intensity demand equations. They calculated a total price elasticity for youth smoking of −1.31. However, in contrast to Lewit and his colleagues' finding that most of the impact of a price change was on smoking prevalence, Chaloupka and Grossman (1996) found that the effect was about evenly split between prevalence and number of cigarettes consumed by young smokers. This study controlled for other smoking-related interventions, such as restrictions on smoking in public places and schools, as well as youth access restrictions, and refuted the argument by Wasserman *et al.* that previous studies reporting price effects were subject to an omitted variables bias.

Using the same MTFS data as Chaloupka and Grossman (1996), Chaloupka and Pacula (1999) estimated separate demand equations by demographic characteristics including gender and race/ethnicity. While price was found to have a negative and significant impact on both male and female smoking prevalence, the magnitudes of the price effects were very different. Chaloupka and Pacula found that the prevalence price elasticity of demand for young men was nearly twice as large, in absolute value, as that for young women. Specifically, they estimated that the prevalence price elasticity of demand for males was −0.93 and for females was −0.60. Moreover, they found that smoking prevalence for African American adolescents was more price elastic (−1.11) than for white adolescents (−0.64).

Chaloupka and Wechsler (1997) used data extracted from the 1993 Harvard Alcohol Study to estimate the effects of cigarette prices and restrictions on cigarette smoking among college students in the US. The authors estimated a total price elasticity of demand of –1.11 for college students. The authors also concluded that relatively stringent restrictions on smoking in public places reduce smoking prevalence rates among college students, while some restrictions on public smoking reduce the quantity of cigarettes smoked.

A Centers for Disease Control and Prevention (CDC) report authored by Farrelly and Bray (Centers for Disease Control and Prevention, 1998) used data from the 1976–1980, 1983, 1985, and 1987–1993 National Health Interview Surveys to estimate cigarette demand equations in the United States for various subpopulations. In their analyses they estimate separate demand equations for different age groups, including young adults aged 18–24 years, adults aged 25–39 years, and adults aged 40+ years; the total price elasticities of demand obtained were –0.58, –0.42 and −0.10, respectively. Indeed, the estimated total price elasticity of demand for young adults is more than double the −0.25 estimate of the total price elasticity of demand for all respondents.

In a follow-up paper, Farrelly and his colleagues (2001) employed the same data as Farrelly and Bray (Centers for Disease Control and Prevention, 1998), but included state-specific effects in their model to control for state-level, time-invariant heterogeneity, such as sentiment towards tobacco. The findings from these analyses are similar to those of Farrelly and Bray; total price elasticity of demand was estimated to be −0.55 for young adults aged 18–24 and −0.53 for individuals aged 25–39. However, the authors found no significant effects of price on smoking prevalence or smoking intensity among individuals aged 40+.

Lewit and his colleagues (1997) used data from cross-sectional surveys of 9th-grade students in 1990 and 1992 in the 21 US and Canada sites that were a part of the Community Intervention Trial for Smoking Cessation (COMMIT), to examine the impact of cigarette prices on youth smoking prevalence and intentions to smoke. The authors estimated that the prevalence price elasticity of demand for 9th graders was −0.87 and that intentions to smoke in the future among non-smoking 9th graders were somewhat more price elastic, with an estimated elasticity of −0.95. The authors also found strong gender differences, with the estimated prevalence price elasticities of demand for boys and girls estimated at −1.51 and −0.32, respectively. The estimated price coefficients in the girls equations were not significantly different from zero.

Harris and Chan (1999) studied the relationship between cigarette

smoking and price among individuals aged 15–29 using data from the 1992–1993 Tobacco Use Supplements to the Current Population Survey. They partitioned their sample into five age groups: 15–17 years, 18–20 years, 21–23 years, 24–26 years and 27–29 years. The authors found that the price elasticity of smoking prevalence declined in absolute value with age: −0.83 for ages 15–17; −0.52 for ages 18–20; −0.37 for ages 21–23; −0.20 for ages 24–26; −0.10 for ages 27–29. However, the price elasticity of smoking intensity rose in absolute value with age (up to age 23): −0.17 for ages 15–17; −0.26 for ages 18–20; −0.27 for ages 21–23; −0.46 for ages 24–26; −0.23 for ages 27–29. This is consistent with the evidence from uptake studies (discussed below), which shows that price has less of an impact on people at the earliest stages of smoking uptake and has a more significant effect on those at later stages who are more established smokers. Nevertheless, the total price elasticity of demand fell in absolute value with age: −1.0 for ages 15–17; −0.78 for ages 18–20; −0.64 for ages 21–23; −0.66 for ages 24–26; −0.33 for ages 27–29. The estimated total price elasticities of demand in Harris and Chan (1999) confirm that an inverse relationship exists between age and the absolute value of the total price elasticity of cigarette demand.

Tauras and Chaloupka (1999) employed data on cigarette use from the 1976 through 1995 longitudinal surveys of high school seniors as part of the Monitoring the Future programme. Individuals from each cohort between 1976 and 1993 were tracked over time, with a maximum number of seven follow-up surveys conducted on individuals. An individual fixed effects model was used to estimate the determinants of smoking prevalence and intensity of cigarette use among smokers. The authors found that increases in cigarette prices lead to significant reductions in both the number of young adults who smoke and the intensity with which they smoke. The estimated total average price elasticity of demand was found to be −0.79, with price having a smaller effect on smoking prevalence than on average consumption by smokers.

Almost all the research conducted over the last decade confirms the early findings of Lewit and colleagues of an inverse relationship between price response and age. For example, using a single cross-section collected in 1996 for The Study of Smoking and Tobacco Use Among Young People, Ross and Chaloupka (2003) examined the effect of cigarette prices on smoking among high-school students in the United States. In their analyses, the authors assessed the use of several alternative measures of cigarette prices, including average state prices and perceived prices among the students, while controlling for both state-level smoke-free air laws and youth-access laws. In their preferred specifications, they estimated total price elasticities of demand of −0.67 when using average state prices and −1.02 when using perceived prices among youth. A subsequent analysis by Ross and Chaloupka (2004) using the same data, but explicitly controlling for the level of compliance with respect to youth-access laws, resulted in similar price elasticity estimates.

Gruber and Zinman (2001) controlled for both state and year fixed effects in their analyses of youth smoking. They employed three separate data sets from the 1990s in their analyses: (1) Monitoring the Future Surveys (MTFS) of 8th-, 10th-, and 12th-grade students; (2) Youth Risk Behavior surveys (YRBS) of 9th- to 12th-grade students; and (3) the Vital Statistics Natality Detail Files (Natality) of mothers during pregnancy. They found consistent evidence that youth smoking responds to changes in cigarette prices, particularly among older adolescents. The prevalence price elasticities ranged from −0.38 in the Natality data to −1.5 in the YRBS data, with the most reliable estimate of −0.66 coming from the 1991–1997 MTFS data. Based on their estimated elasticities, Gruber and Zinman conclude that the "Marlboro Friday" price reductions in 1993 explained 26 percent of the rise in youth smoking observed in the US during the mid-1990s. "Marlboro Friday" refers to Friday, 2 April 1993, when Philip Morris announced a 20% price reduction to their Marlboro cigarette brand to fight off generic competitors.

Tauras and colleagues (2005) investigated the impact of cigarette prices and tobacco control policies on youth and young adult smoking prevalence and intensity of cigarette use among smokers during the late 1990s through early 2000s, which was a period characterized by significant changes in cigarette prices and taxes. They employed the first five waves of data (1997–2001) from the National Longitudinal Survey of Youth 1997 Cohort (NLSY97). Controlling for unobserved year and individual characteristics, they found a strong negative impact of cigarette prices and taxes on young people's smoking prevalence and intensity of cigarette use among smokers. Specifically, they estimated the total price elasticity of cigarette demand to be −0.83. The estimated smoking prevalence price elasticity of demand and the elasticity of smoking intensity were −0.31 and −0.52, respectively.

Sloan and Trogdon (2004) used data from the Behavioural Risk Factor Surveillance System from the 1990s and early 2000s to estimate smoking

prevalence equations among young adults (aged 18–20 years) and older adults (aged 21 years+). Employing both state and year fixed effects, the authors concluded that young adult smoking prevalence was the most price-elastic, with an estimated smoking prevalence elasticity of demand of −0.27. Furthermore, the authors found evidence that the absolute value of the price elasticity of smoking prevalence declined monotonically with age, with the exception of individuals aged 65 years and older.

DeCicca and colleagues (2008a) developed a direct measure of state-specific smoking sentiment using a factor analysis procedure that employed data from the Tobacco Use Supplements to the Current Population Surveys during the 1990s. They merged this tobacco sentiment measure with survey data on youth smoking from the 1992 and 2000 waves of the National Education Longitudinal Study (NELS). The authors found price to have a strong, significant negative impact on smoking prevalence and intensity of cigarette use by young smokers. Between 1992 and 2000, the estimated price elasticities of smoking prevalence and intensity of cigarette use among smokers ranged from −0.76 to −0.59 and from −0.30 to −0.66 respectively. Moreover, even after controlling for the new direct measure of smoking sentiment, price was found to have a strong negative influence on the intensity of cigarette use by young smokers in the 2000 cross-section. However, when the direct measure of smoking sentiment was included in the smoking prevalence equations, the price effects lost statistical significance. Using the 2000 wave of data, they tested models that used this newly developed measure of sentiment and compared it to models using alternative approaches to dealing with antismoking sentiment. The strong negative impact of price on average smoking was robust to all the methods of dealing with unobserved state-level sentiment towards tobacco. Moreover, in all of the models except the model that included the new measure of sentiment, price was found to have a negative and significant impact on smoking prevalence among youth. Given the findings when the direct measure of antismoking sentiment was included in the models, DeCicca and colleagues questioned the adequacy of other proxies to control for antismoking sentiment. However, some caution should be used in interpreting models that include direct measure of antismoking sentiment, as there is likely to be reverse causality in this type of estimation strategy. That is, the amount of smoking within a state is likely to have an impact on the level of antismoking sentiment within a state, resulting in simultaneity bias.

Carpenter and Cook (2008) addressed the concerns of DeCicca and colleagues (2008a) in a recent paper that used national, state, and local Youth Risk Behavior Surveillance System data from 1991 to 2005. The authors tested three alternative methods of dealing with antismoking sentiment. First, they estimated a cross-sectional model that relied on intrastate variation in cigarette taxes to identify the impact of price on youth smoking. Second, they estimated a fixed effects model that controlled for area (i.e. state or local municipality) fixed effects and year fixed effects. Finally, they employed the same direct measure of antismoking sentiment used by DeCicca and colleagues (2008a). They found consistent evidence of a significant negative effect of cigarette taxes on smoking prevalence in the cross-sectional and fixed effects approaches. Importantly, using DeCicca and colleagues' measure of antismoking sentiment, they found a strong negative effect of tax on smoking prevalence among youth, alleviating the concerns raised by DeCicca and colleagues. Using the tax effects from the national and state samples, Carpenter and Cook (2008) estimated price elasticities for youth smoking prevalence of −0.56 in the national sample and −0.25 in the state sample.

To assess the impact of price on youth smoking based on the intensity of smoking, Liang and Chaloupka (2002), used data from the 1992, 1993 and 1994 Monitoring the Future surveys of 8th-, 10th-, and 12th-grade students in a Threshold of Change model. The authors grouped the youth into five categories of smoking intensity including: no consumption; less than daily smoking; light daily smoking (defined as one to five cigarettes per day); moderate daily smoking (defined as one-half pack per day); and heavy daily smoking (defined as one pack or more per day). The authors found that higher prices were associated with lower smoking in all cases, but that the greatest impact of the higher prices was on smoking at the heaviest levels of intensity.

Smoking prevalence and intensity among young smokers – Other high-income countries

An early study from the United Kingdom by Townsend and colleagues (1994) used data on cigarette smoking from the 1972–1990 British General Household Surveys to assess the effects of cigarette prices on smoking prevalence by gender and age and by gender and socioeconomic group in the United Kingdom. They concluded that smoking prevalence among

young females (aged 16–19 and aged 20–24) was responsive to changes in cigarette prices, whereas young males' smoking prevalence was not. The estimated price elasticities of smoking prevalence for females aged 16–19 and aged 20–24 were −0.86 and −0.96, respectively. Interestingly, the authors concluded that there were no statistically significant differences in the estimated price elasticities of demand among women in these two age groups and women who were aged 25–59 years.

A Canadian study by Waller and colleagues (2003) used data from the Ontario Student Drug Use Survey to examine the impact of decreases in Canadian cigarette taxes (and consequently prices) in the early 1990s on youth smoking prevalence. They found that youth smoking prevalence had been falling steadily in the years leading up to the tax decrease, despite the increase in cigarette smuggling into Canada in the late 1980s and early 1990s. However, the tax cuts in 1994 led to a significant rise in youth smoking prevalence. Subsequent price increases led to further reductions in prevalence. Dupont and Ward (2002), using the National Population Health Data for the period 1994–1998, reached a similar finding for the effects of Canadian tax increases in the mid-1990s. They estimated that the price elasticity of smoking prevalence for Canadian youth was −0.91.

One recent cross-sectional study by Schnohr and colleagues (2008) pooled data from 27 European countries to examine the effects of prices and tobacco control policies on youth daily smoking prevalence. Data on prices and policies were obtained from the 2003 WHO Regional Office for Europe Tobacco Control Database and were merged with data on smoking prevalence from the 2001/2002 Health Behaviour in School-Aged Children (HBSC) study. In contrast to the US studies, the authors found no significant relationships between price and youth smoking prevalence in their multilevel analyses of these merged data. The researchers suggest that the lack of relationship between price and prevalence may result from their inability to adequately control for inter-country factors correlated with price and youth smoking and their inability to capture the full impact of recent changes in taxes and prices.

Smoking prevalence and intensity among young smokers – Low- and middle-income countries: cross-sectional studies

There are a limited but growing number of studies that investigate the response to price and tax changes among youth in low- and middle-income countries. With few exceptions, the findings from these studies are consistent with those from high-income countries: young people are more price-elastic than the population in general. For example, Krasovsky and colleagues (2002) estimated differences in the price elasticity of cigarette demand by age and income in the Ukraine. The estimated price elasticities of average smoking for younger smokers were found to be larger in absolute value than the estimated elasticities for older smokers at each income level. van Walbeek (2002) used regression techniques on repeated cross-sectional surveys of between 14 000 and 30 000 individuals aged 16 and over to estimate the percentage change in aggregate cigarette consumption and smoking prevalence by age in South Africa. Van Walbeek observed a 26% decrease in aggregate consumption and a 17% decrease in estimated smoking prevalence, with greater reductions in the younger age groups (22%; 16–24 years), largely attributable to a 92.7% increase in the real price of cigarettes. A reduction in smoking prevalence explained 40% of this decrease in consumption, and the greatest reduction in smoking prevalence was observed among the younger cohort (aged 16–34), suggesting that youth are more responsive to price than adults. Karki and colleagues (2003) estimated the joint demand for cigarettes and bidis by age in Nepal. They found that young people (aged 15–24 years) were more than twice as responsive to changes in price than the overall population, and that in general the absolute value of the price elasticity of demand fell with increasing age. Kyaing (2003) estimated price elasticities of smoked tobacco products in Myanmar. The price elasticity estimates for young people were estimated to be approximately 50% greater than the estimated price elasticity for the overall population.

Several studies from low- and middle-income countries have made use of Global Youth Tobacco Survey data, which collects uniform data from school-aged children across several countries. Ross (2004a) estimated cigarette demand equations for students in the Ukraine. Using a two-part model of cigarette demand, Ross estimated the price elasticities for smoking prevalence to be in the range of −0.29 to −0.51, with considerably higher estimates of smoking intensity ranging from −1.42 to −1.83. In addition, Ross (2004b) estimated the price elasticity of demand for students in Moscow, Russian Federation. The average estimated price elasticity of demand for tobacco among Moscow youth in this study was −1.15, an estimate well above those produced in the limited studies of the impact of price on adult smoking in the Russian Federation.

Recent work by Kostova *et al.* (2010) used data on 349 930 youths (average age 14 years) from 20 low- and middle-income countries taken from Global Youth Tobacco Surveys conducted between 1999 and 2006. They estimated a total price elasticity of −1.8 for cigarette and found that price is an important determinant of both smoking prevalence and smoking intensity, with estimated price elasticities of −0.63 and −1.2 respectively. Finally, Joseph (2010) estimated the impact of price on youth tobacco demand using data from 73 356 Indian youths aged 13–15 from the Global Youth Tobacco Survey conducted between 1999 and 2006. This study estimated a total price elasticity of demand for cigarettes of −0.4, with price influencing the decision to smoke more strongly than the intensity of smoking. Similar to studies from the USA, Joseph (2010) found that price had a greater impact on smoking prevalence among girls (−0.61) than among boys (−0.28).

Longitudinal studies

Lance *et al.* (2004) also estimated the price elasticity of demand for cigarettes in the Russian Federation; however, they found elasticity estimates smaller than those of Ross (2004b). They used three waves of longitudinal data on Russian men aged 13 and over from the Russian Longitudinal Monitoring Survey conducted between 1992 and 2000. Among young Russian men aged 13–19, the total price elasticity of demand was in the range of −0.35 and −0.20. In the same study, Lance and colleagues examined three waves of longitudinal household data on Chinese men aged 13 and over from the China Health and Nutrition Survey conducted in 1989, 1993 and 1997. Similarly, they found relatively small price effects for the sample of young Chinese men, with a total price elasticity estimate of −0.26, which becomes insignificant when including community fixed effects. Total elasticity estimates for age interactions show the same pattern across the Chinese and Russian samples: the elasticity falls and then rises with age. The authors suggested that higher elasticity estimates for the younger and older cohorts may reflect the effect of prices on initiation and cessation decisions.

To summarize, the small but growing number of studies from low- and middle-income countries is generally consistent with studies conducted in high-income countries—price has a negative impact on consumption among young people, and the young are more price-elastic than the population in general.

Smoking transitions among young people

Many researchers examining the influence of price on adolescent smoking prevalence believe that much of the effect of price reflects the impact of price on smoking initiation. Similarly, many researchers believe the effects of price on youth and adult smoking is dominated by the effect of price on smoking escalation and cessation. As discussed in the next two sections, several studies have attempted to directly quantify the effect of price on smoking initiation among youth (Table 6.2) and the impact of price on smoking escalation and cessation among young people (Tables 6.3, 6.4). The earliest of these studies on smoking transitions relied on cross-sectional data with retrospective information on smoking. Many of the more recent studies have used longitudinal data that tracks an individual's smoking behaviour and other determinants over time.

Smoking initiation
Cross-sectional studies

Douglas and Hariharan (1994) were among the first to model smoking initiation (see Table 6.2). They employed cross-sectional data from the 1978 and 1979 National Health Interview Survey: Smoking Supplement, and used a split population duration model to estimate the probability that an individual would start smoking. They concluded that increases in cigarette excise taxes had no influence on individuals' decisions to start smoking. In a follow-up paper, Douglas (1998) used one year of cross- sectional data, the 1987 National Health Interview Survey: Cancer Risk Factor Supplement, to investigate the determinants of the decisions to start and quit smoking in the context of an economic model of addiction. He estimated several alternative parametric duration models in his assessment of smoking initiation. Douglas concluded that current, future, and past prices of cigarettes had an insignificant effect on the probability of initiation. The effects of price on smoking cessation are discussed in detail in Chapter 5.

Forster and Jones (2001) used cross-sectional data to investigate the determinants of smoking initiation and cessation in the United Kingdom. In particular, Forster and Jones (2001), using data from the British Health and Lifestyle Survey, relied on retrospective information on cigarette smoking to approximate the length of time each individual smoked and abstained from smoking. They found cigarette taxes to be a statistically significant but relatively weak determinant of youth smoking initiation. The effects of tax on smoking cessation are discussed in detail in Chapter 5.

Table 6.2. Summary of studies on the effect of cigarette price on smoking initiation among young people

Publication (author, year)	Methods (location, time period; study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulation	Comments
High- income countries						
USA (Douglas and Hariharan, 1994)	1978/79; National Health Interview Survey: Smoking Supplement (*n* = 10 219). Price data from the Tobacco Institute (1992)	Split population duration model of the decision to start smoking, with 'failure' defined as the decision of a never smoker to start smoking	Price elasticity of age of smoking initiation (% change in the probability of ever smoking associated with a 1% change in price variable) Price elasticity of age of smoking initiation (% change in the age of starting smoking associated with a 1% change in price variable)	**Price 18** –0.014 (SE 0.229) **Price 15–18** 0.001 (SE 0.312) **Price 18** 0.009 (SE 0.028) **Price 15–18** 0.001 (SE 0.038)		Includes two price variables: 'Price 18' which is the log real cigarette price, when the respondent is age 18 and 'Price 18–15' which is the change in log real cigarette price between ages 15 and 18.
USA Douglas, 1998)	1987; National Health Interview Survey: Cancer Risk Factor Supplement (*n* = 8754)	Ordered probit split-sample duration model with lagged duration dependence and time-varying covariates (cigarette price and regulation)	Smoking initiation hazard elasticity (% change in the probability of starting smoking in a given time period, conditional on being a non-smoker until then, for each % change in price)	**Without controlling for state regulation** *Past price* 0 0.60 (SE 0.53) *Present price* –0.30 (SE 0.70) *Future price* –0.58 (SE 0.53)	**Controlling for state regulation** *Past price* 0.55 (SE 0.51) *Present price* –0.30 (SE 0.75) *Future price* –0.57 (SE 0.54)	Findings for the impact of price on starting hazard using the split population model are statistically insignificant.
USA (DeCicca *et al.*, 2000)	1988–1992; Data from 3 waves (1988, 1990 and 1992) of the National Education Longitudinal Survey (*n* = 10 893). Price data from the Tobacco Institute (1993)	Discrete time hazard model of smoking onset	Price elasticity of smoking initiation	**White Youth** 0.000053 **Hispanic Youth** –0.0086** **African-American Youth** –0.0059		** Statistically significant
USA (Tauras *et al.*, 2001)	1991–1993; Three cohorts of nationally representative longitudinal data on students in 8th, and 10th grades in 1991, 1992, 1993 with 2–3 waves for each cohort from the Monitoring the Future Survey. Price data from the Tobacco Institute	Discrete-time hazard model using weighted dichotomous probit equations to estimate the probability that an individual starts smoking in a given time period, conditional on being a non-smoker at the start of the time period.	Price elasticity of smoking initiation	**No State-fixed effects** *Any smoking* –0.271 *Smoking at least 1–5 cigarettes per day* –0.811* *Smoking at least ½ pack per day* –0.955*	**With State-fixed effects** *Any smoking* –0.111 *Smoking at least 1–5 cigarettes per day* –1.23* *Smoking at least ½ pack per day* –1.43*	* Significant at 1% level

Table 6.2. Summary of studies on the effect of cigarette price on smoking initiation among young people

Publication (author, year)	Methods (location, time period; study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulation	Comments
USA (DeCicca *et al.*, 2002)	1988–1994; panel micro data from the National Education Longitudinal Survey of 1988 which surveys eighth graders with follow-up 2 and 4 years later (*n* = 13 989)	Ordered probit model using cross-sectional data Discrete time hazard model using panel data Analyses controlled for socioeconomic status, school and parent characteristics, as well as three measures of smoking-related state legislation.	Price elasticity of smoking prevalence Price elasticity of smoking onset between 8th and 10th grade or 8th and 12th grade	**Cross-sectional results** *10th grade* –1.31 *12th grade* –0.72 *Onset between 8th and 10th grade* From –1.3 to –0.9 *Onset between 8th and 12th grade* From –0.72 to –0.46 (not statistically significant)		This study finds weak or non-existent tax effects in models of the onset of smoking between 8th and 12th grades, models of onset of heavy smoking between 8th and 12th grades, and discrete time hazard models that include state fixed effects.
USA (Glied, 2002)	1979–1994; representative microdata from the National Longitudinal Survey of Youth. Youth aged 14–23 in 1979 followed up annually (*n* = 2295). Price variable represents the mean price of cigarettes when the respondent was 14	Cross-sectional analysis	Tax elasticity of later smoking initiation	**1984 (age 19–28)** –0.74* **1992 (age 27–35)** 1.10 **1994 (age 29–37)** 1.34	**Women** *1984* –0.87 *1992* 1.55 *1994* 1.03 **Men** *1984* –1.22 *1992* 0.29 *1994* 1.23 **Low income** *1984* –1.35 *1992* 1.05 *1994* 1.75	* $P < 0.10$
USA (Cawley *et al.*, 2004)	1997–2000; four waves of the National Longitudinal Survey of Youth: nationally representative, longitudinal data on youths aged 12–16 as of the first wave (*n* = 9022). Price data from the Tobacco Institute	Discrete time duration method, using a probit specification to estimate the hazard rate	Price elasticity of smoking initiation	**Males** *Less stringent smoking initiation* –0.86 *More stringent smoking initiation* –1.49	Price was found to be an insignificant determinant of smoking initiation among females	Uses two measures of smoking initiation: less stringent, transition from non-smoker to any positive quantity of cigarettes, and more stringent, transition from non-smoker to frequent smoker defined as smoking at least 15 of last 30 days

Publication (author, year)	Methods (location, time period; study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulation	Comments
USA (Cawley *et al.*, 2006)	1988–2000; Children born to female respondents of the National Longitudinal Survey of Youth, 1979 Cohort	Simple latent variable model, controlling for smoke-free air laws, youth access laws, socioeconomic and demographic factors	Price elasticity of smoking initiation	**Males** –1.20	Price was found to be an insignificant determinant of smoking initiation among females	
USA (DeCicca *et al.*, 2008a)	1988–2000; Pooled data from four waves (1988, 1990, 1992 and 2000) of the National Education Longitudinal Survey (*n* = 37 937)	Discrete time hazard model, with a dependent variable representing the conditional probability of starting to smoke in a given period, assuming the individual was a non-smoker at the start of the period	Price elasticity of smoking initiation	**No State-fixed effects** –0.0015*** **State-fixed effects** –0.0005		*** Significant at 1% (two-tailed tests)
USA (DeCicca *et al.*, 2008b)	1988–2000; 1988, 1990, 1992 and 2000 waves of the National Education Longitudinal Study (*n* = 10 336) including youths aged 18–26 years.	Myopic addiction model using probit specifications, controlling for socioeconomic and demographic factors and anti-tobacco sentiment. Three models estimated: 1) using intrastate variation in cigarette excise taxes, 2) including a direct measure of anti-tobacco sentiment, and 3) using variation in state excise taxes faced by youths who moved state between study waves	Price elasticity of smoking initiation	**Model 1** –0.17* **Model 2** 0.08*	**Model 3** *Movers* 1.69 *Stayers* –0.7	* Statistically significant
United Kingdom (Forster and Jones, 2001)	1984; Cross-sectional data from the British Health and Lifestyle Survey; representative sample of adults 18+ years living in England, Scotland and Wales in 1984 with retrospective smoking data. (*n* = 9003)	Split-population duration model, using probit specification yields to model the likelihood of smoking initiation	Tax elasticity of the age of starting smoking	**Men** 0.164 **Women** 0.081		
Spain (López Nicolás, 2002)	1993, 1995, 1997; Pooled, nationally representative cross-sectional data from the Spanish National Health.	Hazard functions for duration to smoking initiation are estimated using a log logistic split population model	Price elasticity of time to smoking initiation (% change in time starting at the mean age of smoking initiation for	**Men** 0.069 (2.68) **Women** 0.076 (2.60)		Survival and hazard functions compared to those from a Kaplan–Meier estimate of the survival function and

Table 6.2. Summary of studies on the effect of cigarette price on smoking initiation among young people

Publication (author, year)	Methods (location, time period; study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulation	Comments
Spain (López Nicolás, 2002) (contd)	Survey with retrospective information on smoking. Price data from National Statistics Office		each% change in price)			a standard log logistic function. Results from preferred specification presented here. t-statistics in parentheses
France (Peretti-Watel, 2005)	1999; Cross-sectional nationally representative data for individuals aged 12–75 from the French Health Barometer Survey with retrospective smoking data (*n* = 13 685)	Using a life course perspective, examined smoking cessation by distinguishing 6 cohorts of individuals: Born 1969–1978, 1959–1968, 1949–1958. Each cohort experienced a different pattern of price changes during the critical period just preceding and proceeding regular smoking initiation.	Life course smoking prevalence and cessation by cohort	Cigarette price has had no or little impact on regular smoking initiation in France.		Life course perspective cannot separate the effects of price from other factors that vary across cohorts (tobacco control policy, cultural trends, etc.)
Canada (Auld, 2005)	1994; nationally representative data from the Youth Smoking Survey on youths aged 15–19 (*n* = 9139). Province-specific tobacco product price indexes deflated by CPI as reported by Statistics Canada were used.	Maximum likelihood estimation controlling for year of birth, self-reported health status, education, employment, social interactions and perceived non-pecuniary costs of smoking	Point elasticity of smoking prevalence with respect to contemporaneous prices changes	**Early initiation** –1.268 (SE 0.633) **Prevalence in late adolescence if early initiator** 0.012 (SE 0.031) **Prevalence in late adolescence if not early initiator** –0.615 (SE 0.100)		Early initiation, defined as respondents who had smoked one whole cigarette every day for seven consecutive days and were 14 or younger when they started such smoking behaviour. The sample includes youths who have dropped out of school
Canada (Zhang *et al.*, 2006)	1994 to 1997; longitudinal data from Statistics Canada's National Population Health Survey for young adults aged 20–24 who were non-smokers at baseline (*n* = 636)	Multivariate logistic regression analysis using bootstrap weights controlling for sociodemographic and tobacco control variables	Price elasticity of smoking initiation	3.36 (95% CI: 0.07 to 6.75)		This study examines the impact of decreasing taxes. Elasticity estimate should be interpreted as the change in the probability of initiating smoking associated with a 1% decrease in cigarette tax
Canada (Sen and Wirjanto, 2010)	1992 to 1996; longitudinal data from the Waterloo Smoking Prevention Project	Probit and OLS estimation controlling for gender and employing province and year effects	Tax elasticity of smoking initiation and persistence	–0.20 to –0.50		

Publication (author, year)	Methods (location, time period; study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulation	Comments
Canada (Sen and Wirjanto, 2010) (contd)	(WSPP) on students in grades 8–12 (n = 591)					
Australia (Kidd and Hopkins, 2004)	1990; Cross-sectional data from the National Health Survey 1990 and 1998 aged 27–37 (n = 9402) with retrospective data on smoking. Price data from the Australian Bureau of Statistics	Split population hazard models	Price elasticity of smoking initiation	**27–37 years** *Men* 0.16** *Women* 0.12*	**18–26 years** *Men* 0.11 *Women* 0.14*	**P < 0.05 *P < 0.10 Price appears to be a significant determinat of smoking for 27–37 year olds in 1990; however, sensitivity analysis across age groups and data source raise question of the robustness of these findings
Low- and middle-income countries						
Viet Nam (Laxminarayan and Deolalikar, 2004)	1992–93 and 1997–98; data on 4300 households and 17 780 individuals aged 15 and older from two waves of the Viet Nam Living Standards Survey. Price data from commune-level surveys	Multinomial logit model to estimate the effect of both individual attributes and choice attributes (related to cigarettes and rustic tobacco) on the decisions of individuals to initiate use	Price elasticity of smoking initiation	**Cigarettes** –1.175* **Rustic tobacco** –1.558		While the price elasticity of initiation is estimated for the entire population in the survey, much of the initiation is likely to have occurred among relatively young individuals. Estimates suggest tat cigarettes and rustic tobacco are economic substitutes, but estimates are not statistically significant. *P < 0.05

Several more recent studies from high-income countries have used retrospective data on smoking collected in nationally representative surveys of adults to look at the impact of prices on smoking initiation. In particular, studies have been conducted in Australia (Kidd & Hopkins, 2004), France (Grignon & Pierrard, 2002; Peretti-Watel, 2005), Spain (López-Nicolás, 2002), and Germany (Göhlmann, 2007). These studies produced mixed findings on the effects of price on initiation, while generally finding that higher taxes and prices significantly increase the likelihood that adult smokers quit (see Chapter 5 for discussion of cessation results). In addition to the aforementioned measurement error problems that are inherent in using retrospective data to look at smoking transitions, the lack of variation in price over time in many of these countries adds an additional challenge to estimating price effects.

Lastly, Madden (2007) used cross-sectional data from the Saffron Survey, with retrospective information on Irish women, to examine the effects of cigarette taxes on smoking initiation and cessation. With regard to smoking initiation, Madden (2007) found that an inverse relationship exists between cigarette taxes and smoking initiation, with the strongest effect of taxation on Irish women with intermediate levels of education, and weaker tax effects for those with the least education.

Previous studies on smoking transitions have made significant contributions to the literature by modelling the decisions to start and quit smoking; however, these cross-sectional studies are subject to at least two potential measurement errors. First, the use of retrospective information on smoking is likely to suffer from errors in recall about the age at which individuals began and quit smoking. Given that it is a more recent outcome, the recall bias should be smaller when looking at cessation than initiation. Indeed, most of the aforementioned studies find evidence that higher cigarette prices significantly increase the probability of smoking cessation (and consequently reduce the duration of smoking). Second, studies that rely on cross-sectional data likely suffer from a price-matching problem. The smoking transition studies discussed above are based on previous prices/taxes that an individual would have paid for cigarettes in the individual's current location of residence. If an individual lived in a different location in the past, that individual would have been matched with the incorrect cigarette price/tax. Moreover, a price-matching problem will exist if there is imperfect recall on the timing of initiation or cessation. That is, the assumed prices at the time of initiation and cessation will be incorrect due to imperfect recall. The measurement errors in both the dependent and independent variables will bias estimates of the effect of prices on the smoking transitions towards zero.

Smoking initiation
Longitudinal studies

Several recent econometric studies have employed longitudinal data to examine the impact of economic factors such as prices and taxes on smoking initiation and uptake. In general, these studies do not suffer from the cross-sectional limitations discussed above.

In a series of papers, DeCicca and colleagues (2000; 2008a; 2008b) investigated the influence of price and tax on smoking initiation among adolescents and young adults. Initially, DeCicca and colleagues (2000) examined the determinants of smoking initiation by individuals of different race and ethnicities using data extracted from the 1988, 1990 and 1992 National Educational Longitudinal Survey (NELS). After controlling for state and year fixed effects, they found price to have a dramatic negative impact on smoking initiation decisions among Hispanics and African Americans, while having no influence on smoking initiation decisions among Whites. The authors estimate that a price increase of $1.50 would decrease smoking initiation rates by Hispanics and African Americans to approximately 1%. However, the authors caution that the African Americans prediction is based on an insignificant price coefficient estimate. These estimates should be viewed with caution because the use of state fixed effects relies on within-state variation in price over time. During the short time period under investigation, there may be insufficient within state variation in the price variable.

DeCicca *et al.* (2008a) used data from the 1988, 1990, 1992 and 2000 waves of the NELS to examine the influence of cigarette prices on smoking initiation decisions among adolescents and young adults. The authors found price to have a strong and significant negative influence on smoking initiation when state fixed effects were omitted from the model. However, when state fixed effects were included in the regressions, the price effects failed to reach significance at conventional levels. They concluded that unobserved state-level heterogeneity (possibly anti-smoking sentiment), not price, was driving young people's smoking initiation decisions. Further, DeCicca *et al.* (2008b) used data from the 1992 and 2000 waves of the NELS to examine the influence of cigarette excise taxes on smoking initiation of

young adults (individuals who start smoking between the ages of 18 and 26). They used three identification strategies in their equations. First, they used intra-state variation in cigarette excise taxes to identify the impact of price on smoking initiation. Second, they included the direct measure of anti-smoking sentiment developed by DeCicca *et al.* (2008a) in their smoking initiation equations. Finally, they used variation in cigarette taxes faced by young adults who moved across state lines between 1992 and 2000 versus young adults who remained in the same state in these two years. Cigarette taxes were found to have a significant negative impact on young adult smoking initiation using identification strategy 3 for only those who remained in the same state in both years. Given this, the authors concluded that cigarette prices have little impact on smoking initiation. These results should be viewed with some caution. First, the study was conducted on a sample of individuals who initiate smoking later in life (non-smokers in high school but smokers by modal age 26). In the United States, most adult ever-smokers initiate smoking well before the age range investigated by DeCicca and colleagues (2008b), and the smoking initiation decisions of an older cohort may be quite different than those of younger cohorts. Second, anti-smoking sentiment may be an endogenous variable being simultaneously determined with smoking. Moreover, in the models that rely solely on intrastate variation in taxes, the authors found only weak evidence of a negative effect of taxes on smoking prevalence (i.e. price effect fails to reach 5% significance levels of a two-tailed test).

Among the first studies to examine the impact of price on youth smoking initiation using longitudinal data was that of Tauras and colleagues (2001). They employed data from three cohorts of students enrolled in 8th and 10th grade in 1991, 1992 and 1993 as part of the longitudinal component of the Monitoring the Future project. The authors examined three measures of smoking initiation based on alternative smoking thresholds. The measures of initiation included the transitions from not smoking any cigarettes in the immediate previous wave of data to: smoking any positive amount in the current wave; daily smoking, defined as smoking at least 1–5 cigarettes per day on average in the current wave; and heavy daily smoking, defined as smoking at least a half a pack per day on average in the current wave. After controlling for youth access laws and region fixed effects, the authors found that the average price elasticity of initiation based on any smoking, at least 1–5 cigarettes per day on average, and at least ½ pack per day on average were –0.27, −0.81, and –0.96, respectively. These estimates imply that youth smoking initiation is indeed responsive to changes in cigarette prices, with the price response being positively related to higher thresholds of smoking initiation.

Cawley and colleagues (2004) used more recent data to investigate the determinants of youth smoking initiation in the United States. In particular, they employed the first four waves (1997–2000) of the National Longitudinal Survey of Youth 1997 Cohort (NLSY97). In their analysis, the authors employed two alternative measures of smoking initiation. The first measure indicates a transition from not smoking in the immediate previous wave of data to smoking any positive quantity of cigarettes in the current wave of data (termed “less stringent initiation”). The second measure (termed “more stringent initiation”), reflects the transition from not smoking in the immediate previous wave of data to being a frequent smoker in the current wave of data, as measured by having smoked at least 15 days of the past 30 days. Given the notion that some youth, particularly girls, may use cigarette smoking as a weight suppressant, which might make their smoking behaviour less responsive to prices and tobacco control policies, they estimated separate models for adolescent boys and girls. While controlling for smoke-free air laws, youth access laws, and anti-smoking sentiment by a dichotomous indicator for tobacco-producing state residence, the authors concluded that male adolescent smoking initiation was very responsive to changes in cigarette prices, with the average price elasticity of less stringent smoking initiation estimated to be −0.86 and the average price elasticity of more stringent smoking initiation estimated to be −1.49. Female smoking initiation was found not to be significantly related to cigarette prices, but was found to be very responsive to weight concerns.

A follow-up paper on youth smoking initiation by Cawley and colleagues (2006) found very similar findings to Cawley *et al.* (2004) despite using a longitudinal data set that spans a much larger time period. Specifically, the authors used data from the 1988–2000 Children of the National Longitudinal Survey of Youth, 1979 Cohort (CoNLSY). After controlling for smoke-free air laws and youth access laws, cigarette prices were found to have a negative impact on smoking initiation in all models that were estimated; however, the price coefficients were significantly different from zero in

only the male equations. The price elasticity of male smoking initiation based on any cigarettes consumed was estimated to be −1.20. The findings from Cawley and colleagues suggest that the gender-specific differences in the impact of price on initiation may account for the mixed findings in the effects of price on smoking initiation contained in some of the previous studies.

Zhang *et al.* (2006) explored the effect of decreasing prices on young adult smoking initiation. They used longitudinal data from Canada's National Population Health Survey from 1994 to 1997 to examine the impact of decreased cigarette prices, resulting from tobacco tax reductions, on smoking initiation among young adults in Canada. After controlling for smoke-free air laws, tobacco control expenditures, and socioeconomic and demographic factors, the authors found that lower cigarette prices were significantly associated with a higher likelihood of initiating smoking. Specifically, the authors found that the price elasticity of initiation was -3.36, suggesting that a 1% decrease in price, increases smoking initiation among young adults by 3.36% in Canada.

In another study examining the impact of decreasing prices in Canada, Sen and Wirjanto (2010) used longitudinal data from the Waterloo Smoking Presentation Project to explain the impact of a large reduction in cigarette excise taxes in Canada on adolescent smoking initiation decisions. The authors found the tax decrease to have a significant impact on youth smoking initiation in multivariate regression. In particular, the tax elasticity of smoking initiation based on any cigarettes smoked in the 30 days before the survey was −0.5, and the tax elasticity of smoking initiation based on daily smoking in the 30 days before the survey was −0.2. In addition, they estimated the tax elasticity of smoking prevalence using various data sources, and found tax elasticities ranging from −0.10 to −0.14.

Smoking uptake

Cross-sectional studies

Emery *et al.* (2001) used data from the 1993 Teenage Attitudes and Practices Survey to look at the differential impact of price on experimentation with cigarettes (defined as having ever smoked or tried a cigarette, but not having smoked at least 100 cigarettes in their lifetime) and current smoking (defined by smoking in the past 30 days) and established smoking (smoking in the past 30 days and had smoked at least 100 cigarettes in their lifetime) among 10- through 13-year-olds and 14- through 22-year-olds. They found that price did not have a statistically significant impact on experimentation in either age group. Price was found to have a significant effect on the likelihood of being a current smoker, with an elasticity of −0.83, and the likelihood of being an established smoker, with an elasticity −1.56. Also, price was found to have a significant effect on cigarette consumption among current and established smokers, with elasticities of −0.87 and −0.68, respectively (Table 6.3).

Using the survey entitled The Study of Smoking and Tobacco Use Among Young People conducted in 1996, Ross and her colleagues (2006) applied a generalized ordered logit model to examine the differential impact of price and tobacco control policies on the five stages of smoking uptake ranging from a low-risk cognition non-smoker, defined as individuals who have neither experimented with smoking nor smoked a whole cigarette and definitely will not smoke next year and will not smoke a cigarette offered to them by a friend, to an established smoker, defined as individuals who have consumed more than 100 cigarettes in their lifetime. They found price to have a significant impact on progression from each stage to the next, and consistent with Liang and Chaloupka (2002), they found price to have a greater impact on the likelihood of progressing to later stages of uptake. The authors suggest that the greater impact of price on later stages of smoking uptake reflects the changes in young smokers' sources for cigarettes as they progress to higher intensities of smoking. Specifically, smokers at earlier stages of uptake smoke relatively few cigarettes and are more likely to rely on social sources for these cigarettes. As they progress to more regular smoking, they begin to buy their own cigarettes and are more directly influenced by prices.

Finally, Slater *et al.* (2007) combined data on cigarette prices and point-of-sale cigarette marketing collected around schools that participated in the 1999 through 2003 Monitoring the Future surveys to examine the effects of prices, price-related promotions, and advertising on youth smoking uptake. Using a generalized ordered logit equation, Slater and colleagues found that price had its greatest impact on later stages of smoking uptake, a finding consistent with previous studies. In addition, they found that point-of-sale promotions related to price (e.g. multipack discounts and other retail value added promotions) had little effect on early stages of uptake, but were strongly associated with later stages beyond experimentation.

Table 6.3. Summary of studies providing data on the effects of price on youth smoking uptake

Publication (author, year)	Methods (location, time period; study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulations	Comment
High-income countries						
USA (Emery *et al.*, 2001)	1993; Nationally representative data for youths aged 10–22 from the second wave of the longitudinal teenage attitudes and practices survey (n = 12 952). Price data from the Tobacco Institute.	Two-part model of cigarette demand. Smoking intensity is modelled separately for current smokers (smoked in last 30 days) and established smokers (smoked in last 30 days and at least 100 cigarettes in lifetime)	Price elasticity of smoking prevalence		**Experimenters 10 – 13 years and 14+ years** non-significant	
USA (Liang and Chaloupka, 2002)	1992–1994; Monitoring the Future Surveys (n = 110 717), nationally representative data on 8th-, 10th- and 12th-grade students (aged 13–18)	Threshold of Change model (generalized version of the ordered logit model), controlled for state level smoke-free air laws, youth access restrictions, price differentials within 25 miles and socioeconomic and demographic variables.	Price elasticity of smoking uptake (the probability of progressing to a higher intensity of smoking based on a % increase in the price of cigarettes (95% CI)	**Equal effect odds ratio** *Medium price* 1.060 (1.017, 1.105)** *High Price* 1.146 (1.091, 1.204)	**Varying effects odds ratio** *Medium Price* Threshold 1 1.057 (1.014, 1.102)** Threshold 2 1.051 (1.001, 1.104)* Threshold 3 1.094 (1.027, 1.165)** Threshold 4 1.128 (1.035, 1.229)** *High Price* Threshold 1 1.132 (1.077, 1.188)*** Threshold 2 1.190 (1.124, 1.260)*** Threshold 3 1.255 (1.169, 1.348)*** Threshold 4 1.307 (1.186, 1.439)***	Categories of smoking intensity: no consumption, less than daily smoking, light daily smoking (1–5 cigarettes/day), moderate daily consumption (10 cigarettes per day), and heavy consumption defined as 20 or more per day). Price categories: high, medium and low. *P < 0.1, **P < 0.01, ***P < 0.001
USA (Tauras, 2005)	1976–1993; Nationally representative data on 8th-, 10th- and 12th-grade students (13–18 years) contained in baseline surveys from the 1976–1993 components of the Monitoring the Future Survey, with follow up through 1995.	Discrete time duration method, using a probit specification to estimate the hazard rate of progressing to a higher smoking intensity. Analyses controlled for socioeconomic and demographic factors as well as anti-smoking sentiment	Price elasticity of smoking uptake	**Daily uptake** –0.646 **Moderate uptake** –0.576 **Heavy uptake** –0.412		Three measures of smoking progression: 1) daily uptake, 2) moderate uptake (transition from light smoking 1–5 cigarettes/day to 10 or more cigarettes/day, 3) Heavy uptake (from moderate smoking to 1+ packs/day.

Table 6.3. Summary of studies providing data on the effects of price on youth smoking uptake

Publication (author, year)	Methods (location, time period; study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulations	Comment
USA (Ross *et al.*, 2006)	1996; Cross-sectional data from students in grades 9–12 attending 202 US high schools in 1996 from 'The Study of Smoking and Tobacco Use Among Young People' (*n* = 17 287). State cigarette prices from the Tobacco Institute and an average school price calculated using self-reported price were used.	Generalized ordered logit model	Regression coefficients reflecting the effect of price on probability of progressing to higher stages of smoking uptake, corrected for within-cluster dependence (Standard errors)	**State average price** *Stage 2,3,4, or 5* –0.383** (0.143) *Stage 3,4, or 5* –0.387** (0.137) *Stage 4 or 5* –0.400** (0.138) *Stage 5* –0.478** (0.183) **Average perceived price** *Stage 2,3,4, or 5* –0.336** (0.106) *Stage 3,4, or 5* –0.354** (0.100) *Stage 4 or 5* –0.367** (0.107) *Stage 5* –0.457** (0.162)		** $P < 0.05$, based on two-tailed test
USA (Slater *et al.*, 2007)	1999–2003; Annual, nationally representative cross-sectional data on 26 301 8^{th}-, 10^{th}- and 12^{th}-graders, aged 14, 16 and 18 respectively. Price data calculated as the average price of a premium brand collected through a retail audit of community tobacco vendors	Generalized ordered logit analyses with weighted data that controlled for demographic and socioeconomic factors, state level tobacco control policies, and year, and accounted for clustering at the community level	Price elasticity of smoking uptake, reflecting the probability that an adolescent will move on to the next level of smoking for every dollar increase (95% confidence intervals)	**Threshold 1** 0.87 (0.74–1.02) **Threshold 2** 0.76 (0.64–0.89)** **Threshold 3** 0.77 (0.65–0.92)* **Threshold 4** 0.81 (0.67–0.98)* **Threshold 5** 0.79 (0.63–0.98)*		** $P < 0.001$ * $P < 0.05$

Smoking uptake
Longitudinal studies

One study used longitudinal data to examine smoking transitions other than initiation or cessation. Tauras (2005) examined the impact of cigarette prices on smoking uptake transitions among youth and young adults in the United States. He examined the transition from non-daily to daily smoking and the transitions from light smoking intensity (defined as 1–5 cigarettes per day) and moderate smoking intensity (defined as smoking 10 cigarettes per day on average) to higher intensities of smoking. Tauras (2005) employed baseline surveys from the 1976 through 1993 Monitoring the Future Surveys with follow-up surveys on individuals through 1995 in the analyses. He controlled for anti-smoking sentiment using a variety of techniques: including separate indicators for whether or not the individual resided in a tobacco-producing state or resided in Utah, where there is a large Mormon population whose religious beliefs ban tobacco use; including census division fixed effects to capture division differences in smoking sentiment; and estimating the smoking progression equations on a subsample of the respondents who did not reside in either a tobacco-producing state or the state of Utah during the time that the surveys were being conducted. Tauras (2005) found cigarette prices to have a strong negative impact on all the smoking transitions that were estimated. In particular, the estimated mean price elasticities of daily uptake, moderate uptake and heavy uptake were –0.65, –0.58 and –0.41, respectively. These findings indicate that increases in cigarette prices will prevent many young adults from progressing into higher intensities of smoking.

To summarize, studies that rely on cross-sectional data and retrospective information on smoking find mixed results for the effects of price on smoking initiation, likely due to measurement error in the timing of initiation and in the price measure. Studies that rely on longitudinal data and do not suffer from cross-sectional limitations generally find that price has a negative and significant impact on youth smoking initiation. Finally, higher cigarette prices have been found to decrease the probability of transitioning into higher intensities of smoking. Evidence suggests that price has greater impact at later stages of the uptake process than at the experimentation stage.

Smoking cessation
Cross-sectional studies

Using an experimental framework, Ross and colleagues (2005) examined the expected smoking reaction to a future price increase among smokers in high school in the USA. The authors used cross-sectional data collected in 1996 for the project The Study of Smoking and Tobacco Use Among Young People that contained information on individual's current smoking status and expected smoking behaviour after hypothetical changes in cigarette price. Four different price changes were examined including an increase by US$0.50, by US$1, by US$2, and by US$4. After controlling for smoke-free air laws and youth access laws, the authors found hypothetical increases in cigarette prices to have a strong positive impact on youth smoking cessation decisions. In particular, the estimated price elasticity of cessation ranged from 0.895 to 0.930 (Table 6.4).

Tworek and colleagues (2010) used cross-sectional data from the 1991–2006 Monitoring the Future Surveys to examine smoking cessation behaviours among 8th-, 10th- and 12th-grade regular smokers. After controlling for demographic characteristics, smoke-free air laws, and youth access laws, the authors found increases in cigarette price to be positively associated with smoking cessation behaviours. In particular, the authors calculated that a $1 per pack increase in the price of cigarettes increases: the odds of wanting to quit smoking by 30%; the odds of an ever-regular smoker not smoking in the past 30 days by 20%; the odds of a high school ever-regular smoker who has made at least one quit attempt, not smoking in the past 30 days by 30%.

Smoking cessation
Longitudinal studies

A few studies have used longitudinal data to examine the impact of price on adolescent and young adults' decisions to quit smoking. Tauras and Chaloupka (2001) were the first to model smoking cessation decisions using longitudinal data. In particular, the authors used data extracted from the 1976–1993 cohorts of the Monitoring the Future project with follow-up surveys through 1995. The authors used a semi-parametric Cox regression to assess the probability that smokers would make a transition from smoking in the previous wave of data to non-smoking in the current wave. After controlling for smoke-free air laws, region of residence, socioeconomic and demographic characteristics, the authors concluded that the likelihood of making a smoking cessation attempt among both men and women increased significantly as cigarette prices rose.

Table 6.4. Summary of studies on the effect of cigarette price on smoking cessation among young adults

Publication (author, year)	Methods (location, time period, study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulations	Comments
High income countries						
USA (Douglas, 1998)	1987; National Health Interview Survey: Cancer Risk Factor Supplement (*n* = 8754)	Ordered probit split-sample duration model with lagged duration dependence and time-varying covariates (cigarette price and regulation)	Smoking cessation hazard elasticity (% change in the probability of quitting smoking in a given time period, conditional on being a smoker at the start of the time period, for each% change in price)	**Without controlling for state regulation** *Past price* –0.07 (SE 0.52) *Present price* –1.05 (SE 0.82) *Future price* 1.31 (SE 0.51)**	**Controlling for state regulation** *Past price* 0.08 (SE 0.51) *Present price* –0.98 (SE 0.81) *Future price* 1.07 (SE 0.52)*	* $P < 0.10$ ** $P < 0.01$
USA (Tauras and Chaloupka, 2001)	1975–1995; Panels formed from the nationally representative cross-sectional surveys of 8th-, 10th- and 12th-grade students from the Monitoring the Future Surveys	Semi-parametric Cox duration models to estimate the probability that smokers would make a transition from smoking in the previous wave to non-smoking in the current wave. Analyses controlled for socioeconomic and demographic factors, year effects, clean air laws and youth access restrictions	Price elasticity of smoking cessation	**Females** 0.24* to 1.00* **Males** –0.10 to 1.30	**Females** *Smokers at 18* 0.57* *Smokers at 23* 0.82* *Smoke at least 1 cigarette in 30 days* 0.51* *Smoke at least 1–5 cigarettes/day* 0.88* **Males** *Smokers at 18* Not significant *Smokers at 23* 1.06* *Younger smokers who have smoked any cigarettes in 30 days* Not significant *Younger smokers who smoke 1–5 cigarettes per day* Not significant *Older smokers who have smoked any cigarettes in 30 days* 0.89* *Older smokers who smoke at least 1–5 cigarettes per day* 1.23*	* Statistically significant

Publication (author, year)	Methods (location, time period, study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulations	Comments
USA (Glied, 2002)	1979–1994; representative microdata from the National Longitudinal Survey of Youth. Youth aged 14–23 in 1979 followed up annually (*n* = 5823). Price variable represents the mean price of cigarettes when the respondent was 14	Cross-sectional analysis controlled for race, sex, age, marital status in year of interview, grade of school completed by interview, AFQT score. Includes only those who reported smoking in 1984 or earlier	Tax elasticity of smoking cessation: effect of taxes at age 14 on quitting by follow up in 1992 or 1994	**1992–94** 0.16	**Women** 0.02 **Men** 0.19 **Low income** –0.04 **Those who moved State since age 14** 0.17	
USA (Tauras, 2004)	1975–1995; Panels formed from the nationally representative cross-sectional surveys of 8th-, 10th- and 12th-grade students from the Monitoring the Future Surveys	Semi-parametric Cox duration models to estimate the probability that smokers would make a transition from smoking in the previous wave to non-smoking in the current wave. Models allow for the possibility of multiple quit attempts. Analyses controlled for socioeconomic and demographic factors, year effects, clean air laws and youth access restrictions	Price elasticity of smoking cessation	Range 0.269 to 0.466 Average 0.350		
USA (Ross *et al.*, 2005)	1996; cross-sectional data collected for The Study of Smoking and Tobacco Use Among Young People containing information on smoking status and expected behaviour after a hypothetical change in cigarette price	Probit regression model to estimate an equation for the probability of future smoking cessation among current smokers as a function of future cigarette prices. Analyses controlled for socioeconomic and demographic factors	Price elasticity of smoking cessation	**Model using average future perceived price** 0.90 **Model using average future state price** 0.93		
USA (DeCicca *et al.*, 2008b)	1988–2000; 1988, 1992 and 2000 waves of the National Education Longitudinal Study (*n* = 10 706) including youths aged 18–26 years.	Myopic addiction model using probit specifications, controlling for socioeconomic and demographic factors and anti-tobacco sentiment.	Price elasticity of smoking cessation	**Model 1** 0.93* **Model 2** 0.47	**Model 3** *Movers* 1.49 *Stayers* 0.82	* Statistically significant

Table 6.4. Summary of studies on the effect of cigarette price on smoking cessation among young adults

Publication (author, year)	Methods (location, time period, study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulations	Comments
USA (DeCicca *et al.*, 2008b) (contd)		Three models estimated: 1) using intrastate variation in cigarette excise taxes, 2) including a direct measure of anti-tobacco sentiment, and 3) using variation in state excise taxes faced by youths who moved state between study waves				
USA (Franz, 2008)	Method 1993–2000; Nationally representative cross-sectional data for adults 18+ years from the Behaviour Risk Factor Surveillance System Survey (*n* = 1 million)	Model Two models were considered: 1) a simple OLS and 2) a two-part model. Analyses controlled for socioeconomic and demographic factors. Price was the state average real cigarette price	Price elasticity of smoking cessation	**Overall** 0.375 **18–29 years** 0.493 **30–39 years** 0.424 **40–64 years** –0.398 **65+ years** 0.202		
USA (Tworek *et al.*, 2010)	1991–2006; nationally representative cross-sectional surveys of 8th-, 10th- and 12th-grade students from the Monitoring the Future Surveys (*n* = 12 073 to 78 584 depending on outcome variable)	Hierarchical generalized linear modeling controlling for student characteristics (age, gender, race/ethnicity, parental education, total income and work status) and state policies and year effects	Price elasticity of wanting to quit Price elasticity of any quit attempt Price elasticity of non-continuation of smoking Price elasticity of discontinuation of smoking	1.003 (CI: 1.001 – 1.005)* 1.001 (CI: 1.000 – 1.003) 1.002 (CI: 1.001 – 1.003)** 1.003 (CI: 1.000 – 1.005)*		* $P < 0.05$ ** $P < 0.01$ Non-continuation of smoking is defined as ever-regular smokers who have not smoked in the past 30 days Discontinuation of smoking was defined as ever-regular smokers who have made at least one quit attempt and who have not smoked in the past 30 days
United Kingdom (Forster and Jones, 2001)	1984; Cross-sectional data from the British Health and Lifestyle Survey; representative sample of adults 18+ years living in England, Scotland and Wales in 1984 with retrospective smoking data (*n* = 9003)	Split-population duration model, using probit specification yields to model the likelihood of smoking initiation	Tax elasticity of quitting smoking	**Men** –0.60 **Women** –0.46		

Publication (author, year)	Methods (location, time period, study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulations	Comments
Spain (López Nicolás, 2002)	1993, 1995, 1997; Pooled, nationally representative cross-sectional data from the Spanish National Health Survey with retrospective information on smoking. Price data from National Statistics Office	Hazard functions for duration to smoking cessation are estimated using a log logistic split population model	Price elasticity of smoking duration (% change in the duration to smoking cessation for each % change in price)	**Men** –1.32 (t-value –2.23) **Women** –1.50 (t-value –2.11)		Estimates compared with those from the Cox proportional hazard model and the Gamma model; estimates from the preferred specification presented here.
Poland (Ross & Prezwozniak, 2004)	1999; cross-sectional data on school-aged children from the Global Youth Tobacco Survey examining the reported reaction to price increases	Descriptive analysis	Percentage of respondents reporting reaction (95% confidence interval)	**Demand reduced/ altered** 55.8 (± 3.9) **Successfully quit** 26.0 (± 3.8) **Attempted to quit** 10.2 (± 2.2) **Smoked fewer cigarettes** 15.0 (± 2.8) **Smoked cheaper cigarettes** 4.8 (± 1.7) **Consider quitting** 20.4 (± 3.4) **No reaction** 23.6 (± 3.7)	**Demand reduced/ altered** *Urban* 47.9 (± 5.3) *Rural* 66.9 (± 5.1) *Women* 51.6 (± 5.9) *Men* 59.6 (± 5.7) **Successfully quit** *Urban* 16.8 (± 4.5) *Rural* 38.8 (± 5.8) *Women* 27.7 (± 6.3) *Men* 24.6 (± 5.1) **Attempted to quit** *Urban* 9.5 (± 2.9) *Rural* 11.3 (± 3.4) *Women* 8.2 (± 2.7) *Men* 12.0 (± 3.3) **Smoke fewer cigarettes** *Urban* 16.8 (± 3.6) *Rural* 12.4 (± 4.1) *Women* 13.6 (± 3.1) *Men* 16.2 (± 4.1)	

Table 6.4. Summary of studies on the effect of cigarette price on smoking cessation among young adults

Publication (author, year)	Methods (location, time period, study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulations	Comments
Poland (Ross & Prezwozniak, 2004) (contd)					**Smoke cheaper cigarettes** *Urban* 4.6 (± 2.0) *Rural* 5.1 (± 3.1) *Women* 2.2 (± 1.7) *Men* 6.9 (± 2.7) **Consider quitting** *Urban* 21.3 (± 3.4) *Rural* 19.2 (± 5.5) *Women* 20.2 (± 4.7) *Men* 20.6 (± 4.4) **No impact** *Urban* 31.0 (± 5.6) *Rural* 13.2 (± 3.6) *Women* 19.8 (± 4.3) *Men* 28.2 (± 5.3)	
France (Peretti-Watel, 2005)	1999; Cross-sectional data nationally representative data for individuals aged 12–75 from the French Health Barometer Survey with retrospective smoking data (n = 13 685)	Discrete time hazard model of smoking cessation, using logistic regression with time constant variables including gender, education and age of initiation and time variant variables including age, parenthood and price	Price elasticity of smoking cessation (the probability of quitting smoking for each% increase in price)	**Aged 21–50** *Men* 1.007 P < 0.001 *Women* 1.009 P < 0.001	**Men and Women** *Cessation at age 20 or before* 1.005 *P* = 0.174 *Cessation between 21 and 30 years* 1.017 *P* < 0.001 *Cessation after age 30* 1.011 *P* < 0.001	

The estimated price elasticity of smoking cessation ranged from 0.34 and 1.00 for women and between −0.10 and 1.30 for men, implying that a 10-percent increase in cigarette price raises the probability of making a cessation attempt by up to ten percent.

Tauras (2004) expanded on the original study to look at longer-term cessation effects related to price. Once again using the aforementioned longitudinal component of the Monitoring the Future surveys, he employed a stratified Cox regression to model multiple quit attempts among young adults. After controlling for smoke-free air laws, US Census division indicators (i.e. indicators for the region of the country where the respondent resided), socioeconomic and demographic characteristics, he found a positive and significant effect of cigarette prices on smoking cessation, confirming the earlier findings. He concluded that a 10% increase in the price of cigarettes increases successful cessation by young adults by approximately 3.5%.

DeCicca *et al.* (2008b) used data from the 1992 and 2000 waves of the NELS to examine the influence of cigarette excise taxes on smoking cessation decisions of young adults in the USA. When they used intra-state variation in cigarette excise taxes to identify the impact of tax on smoking cessation, they found young adults to be very responsive to changes in cigarette excise taxes. The estimated price elasticity of cessation in this model was 0.93. In an alternate specification, they included the direct measure of anti-smoking sentiment, discussed above, and estimated the price elasticity of cessation to be 0.47, but this estimate was based on an insignificant parameter estimate for price. Finally, the authors used variation in cigarette taxes faced by young adults who moved across state lines between 1992 and 2000 versus those young adults who remained in the same state in these two years. In this specification, cigarette taxes were found to have a positive impact on young adult smoking cessation for only those who moved to a different state between 1992 and 2000. The price elasticity of cessation among movers was relatively large (1.49), and the authors concluded that despite the lack of significance on price in this specification (due most likely to the small sample size, n = 321), price is likely to play a strong role in the smoking cessation decisions of young adults.

Smoking cessation
Evidence from low- and middle-income countries

Only one study examining the impact of price on smoking cessation in a low- or middle-income country context was identified. While data to calculate direct or indirect price elasticity of demand was unavailable, Ross and Prezwozniak (2004) used data from the first Global Youth Tobacco Surveys on school-aged children in Poland to examine the reported response of youths to a tobacco price increase. They found that 56% of respondents reported changing their smoking behaviour in response to a price change through successfully quitting (26.0%), attempting to quit (10.2%), reducing their consumption (15.0%) or smoking cheaper cigarettes (4.8%). These data clearly indicate that higher real cigarette prices can reduce cigarette demand among teenage students in Poland.

To summarize, higher cigarette prices have been found, using both cross-sectional and longitudinal data, to significantly affect youth and young adult smoking cessation behaviours. In particular, higher prices have been found to increase the probability of quitting, increase the probability of making a cessation attempt, and increase the desire to quit smoking among youth and young adults.

Effect of tax and price on other tobacco product use among young people

While numerous studies on the economic determinants of youth cigarette demand have been published over the past few decades, there have been few econometric studies published on the impact of taxes on other tobacco products (Table 6.5).

High-income countries

Chaloupka and his colleagues (1997) were the first to estimate the effects of taxes on youth smokeless tobacco demand in the United States. They used data on the prevalence and intensity of smokeless tobacco use taken from the 1992, 1993 and 1994 Monitoring the Future surveys described above to examine the impact of smokeless tobacco taxes and other tobacco control policies. They found higher taxes for smokeless tobacco products to be associated with reductions in both the likelihood and intensity of smokeless tobacco use among teenage boys. Using an estimate of the pass-through of tax to price and the share of smokeless tobacco price that is accounted for by tax, the authors estimated a total price elasticity of smokeless tobacco demand in the range from −0.44 to −0.75, with the impact on prevalence accounting for most of the total elasticity.

Tauras and colleagues (2007) used data extracted from the 1995–2001 National Youth Risk Behavior Surveys (YRBS) to examine the impact of smokeless tobacco taxes on smokeless tobacco use among male high school students.

Table 6.5. Summary of the studies providing evidence on the effects of other tobacco product prices on use among young people

Publication (author, year)	Methods (location, time period; study design and sample size (M/F)	Model	End Point	Main results	Subpopulations	Comment
High- income countries						
USA (Chaloupka *et al.*, 1997)	1992–1994; nationally representative data on males in 8th, 10th and 12th grades from the Monitoring the Future Surveys (*n* = 19 581)	Two-part model of smokeless tobacco demand: probit methods to estimate the smoking prevalence equation and ordinary least squares to estimate the smoking intensity for smokeless tobacco. Analyses controlled for socioeconomic and demographic variables, cross-border purchasing effects and youth access restrictions	Price/tax elasticity of smokeless tobacco prevalence Price/tax elasticity of smoking intensity for smokeless tobacco Price/tax elasticity of demand for smokeless tobacco	**Price** *Prevalence* –0.523 to –0.346 *Smoking intensity* –0.233 to –0.092 *Total price elasticity* –0.746 to –0.438	**Tax** *Prevalence* –0.068 to –0.045 *Smoking intensity* –0.029 to –0.012 *Total tax elasticity* –0.097 to –0.057	
USA (Ohsfeldt *et al.*, 1997)	1985; Cross-sectional data on men aged 16 years and over from the Current Population Survey (*n* = 100 000)	Multivariate regression model adjusted for total family income, marital status, race, ethnicity, employment status and occupation	Price elasticity of smoking prevalence	**Cigarettes** *Overall* –0.05 *16–24 years* –0.07 *25+ years* –0.05 **Snuff** *Overall* –0.27 *16–24 years* –0.31 *45+ years* –0.13 **Chewing tobacco** *Overall* –0.13		Cross-elasticities analysed
USA (Ohsfeldt *et al.*, 1999)	1992–1993; nationally representative cross-sectional (pooled surveys) data from the Current Population Survey. Analysis restricted to 165 653 male adults either white or black 16 years and older	Multivariate regression model. Adjusted for index of smoking regulation, age, education, ethnicity and marital status. Prices of cigarettes and snuff were mutually adjusted	Price elasticity of smoking prevalence	**Cigarettes** *Overall* –0.15* *16–24 years* –0.22* *25–44 years* –0.11* **Snuff** *Overall* –0.01*		Cross-price elasticities analysed *: $P < 0.01$

Publication (author, year)	Methods (location, time period; study design and sample size (M/F)	Model	End Point	Main results	Subpopulations	Comment
USA (Ohsfeldt *et al.*, 1999) (contd)				*16–24 years* –0.24* *25–44 years* –0.05*		
USA (Ringel *et al.*, 2005)	1999–2000; nationally representative data on students in grades 6–12 (age 9–17 years) from the National Youth Tobacco Survey (*n* = 33 632)	Logistic regression models of the probability of current cigar use, defined as having used cigars in the past 30 days. Analyses controlled for socioeconomic and demographic factors as well as smoke-free air laws and youth access restrictions	Prevalence price elasticity for cigars	–0.336*	**Males** –0.349* **Females** –0.240*	* $P < 0.05$
USA (Tauras *et al.*, 2007)	1995–2001; data from the National School-based Youth Risk Behavior Surveys on males aged 13–18 years (*n* = 25 155)	Two part model of smokeless tobacco demand: probit methods to examine smokeless tobacco prevalence and generalized linear model with log link and Gamma distribution to examine smoking intensity among smokeless tobacco users	Tax elasticity of smokeless tobacco prevalence Tax elasticity of smokeless tobacco Cigarette cross-price elasticity of prevalence Cigarette cross-price elasticity of smoking intensity	–0.197 to –0.121 –0.085 to –0.044 –0.715 –0.413		
Low- and middle-income countries						
India (Joseph, 2010)	2000–2004; Global Youth Tobacco Survey data from 26 of 28 states and two of the seven Union Territories on youth aged 13–15 years. Average price data from users and non-users to construct school/state/territory level prices	Two-part model of cigarette demand; probit model to estimate smoking prevalence equation and Ordinary Least Squares to estimate smoking intensity equation	Price elasticity of smoking prevalence and smoking intensity	**Overall price elasticity** *Bidis* –1.40 **Smoking prevalence elasticity** *Bidis* –2.70 *Gutka* –0.58	**Prevalence elasticities** *Women* Bidis –2.91 Gutka –1.12 *Men* Bidis –2.475 Gutka –0.270	Smoking prevalence elasticity estimates for gutka use not statistically significant, nor are smoking intensity estimates for both gutka and bidis

The estimates from this study clearly indicate that higher smokeless tobacco taxes would significantly reduce the number of male students who use smokeless tobacco and the number of days those users use smokeless tobacco. The estimated tax elasticities of smokeless tobacco prevalence ranged from −0.20 to −0.12, whereas the estimated tax elasticities with respect to the number of days using smokeless tobacco ranged from −0.09 to −0.04. Moreover, the authors found cigarette prices to have a significant negative impact on both smokeless tobacco prevalence and on the number of days male high school students use smokeless tobacco. The estimated cross-price elasticity of smokeless tobacco prevalence was −0.72, and the cross-price elasticity of the number of days of use of smokeless tobacco was −0.41. These estimates indicate that a 10% increase in the price of cigarettes would decrease smokeless tobacco prevalence by more than 7% and would decrease the number of days using smokeless tobacco by more than 4% among male high school students. Moreover, these estimates indicate that smokeless tobacco products and cigarettes are economic complements in consumption for young males. In contrast, research on adult smokeless tobacco use in the United States has found that smokeless tobacco and cigarettes are substitutes among adults (e.g. Ohsfeldt *et al.*, 1999). Tauras and colleagues (2007) suggested that the complementarity they observed is likely the result of young male tobacco users being at relatively early stages of uptake, where they are still experimenting with different types of tobacco products.

Finally, Ringel and colleagues (2005) used data from the 1999 and 2000 waves of the National Youth Tobacco Survey to estimate the impact of cigar prices on cigar demand among adolescents in grades 6 through 12. After controlling for smoke-free air laws and youth access laws, the researchers found the price of cigars to be inversely related to the prevalence of youth cigar use. In particular, the price elasticity of youth cigar smoking prevalence was estimated to be −0.34.

Low- and middle-income countries

Joseph (2010) estimated the impact of price on youth tobacco demand using data from 73 356 Indian youths aged 13–15 years from the Global Youth Tobacco Survey conducted between 1999 and 2006. This study suggests that price has a stronger effect on the decision to smoke than on the intensity of smoking among Indian youth, and that the effect holds true across three tobacco types: bidis, gutka and cigarettes. In particular, bidis have the highest participation price elasticity (−2.70), followed by gutka (−0.58) and cigarettes have the lowest participation elasticity at −0.40.

To summarize, evidence from the USA finds higher smokeless tobacco taxes to decrease adolescent and young adult smokeless tobacco use. Additional evidence from the USA finds a negative relationship between cigar prices and cigar use among individuals in grades 6 through 12. Finally, recent research from India suggests that youth consumption of bidis and gutka is responsive to changes in the prices of these products.

Indirect effects of tax and price on youth tobacco demand and related outcomes – High-income countries

Some studies have examined the indirect effect of price on tobacco use among young people by accounting for peer, parental or sibling influences or the source of cigarettes (i.e. buying or borrowing) (Table 6.6). Powell *et al.* (2005) used survey data from The Study of Smoking and Tobacco Use Among Young People, conducted in 1996, to quantify the importance of peer effects on smoking among high school students. Specifically, Powell and colleagues (2005) allowed cigarette prices to have both a direct effect and an indirect effect, via a social multiplier, on youth smoking prevalence. The price elasticity of youth smoking prevalence was estimated to be −0.50, with the peer effect playing a significant role in the smoking decision process. That is, the aforementioned price elasticity comprised a direct prevalence price elasticity of −0.32 and an indirect prevalence price elasticity (measuring the social multiplier effect) of −0.18. These estimates suggest there is a rather large social multiplier effect with respect to price changes and youth smoking prevalence.

Extending the work of Powell *et al.* (2005), Harris and González López-Valcárcel (2008) tested for the possibility that peer influences have asymmetric effects. They examined cigarette smoking among individuals aged 15–24 years using the 1992–1999 Current Population Surveys. The authors found that sibling smoking status is a significant determinant of own smoking status, but asymmetries in effect size exist. In particular, they found that each additional smoking sibling raises the probability of smoking by 7.6%, while each non-smoking sibling decreases the probability by 3.5%. Consistent with Powell *et al.* (2005), Harris and González López-Valcárcel (2008) found a strong indirect impact of cigarette price on youth smoking prevalence.

Table 6.6. Summary of studies providing evidence on indirect effects on youth smoking of an increase in cigarette prices

Publication (author, yr, country)	Methods (location, time period; study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulations	Comment
High income countries						
USA (Powell *et al.*, 2005)	1996; Nationally representative, cross-sectional data on high school students from The Study of Smoking and Tobacco Use Among Young People (*n* = 12 705)	Two-stage generalized least squares estimator for a dichotomous dependent variable (youth smoking prevalence), controlled for socioeconomic and demographic factors and state-fixed effects	Total price elasticity of smoking prevalence Direct prevalence price elasticity Indirect (peer effects) prevalence price elasticity measuring the social multiplier effect	–0.4982 –0.3152 –0.1830		
USA (Powell and Chaloupka, 2005)	1996; Nationally representative, cross-sectional data on high school students from The Study of Smoking and Tobacco Use Among Young People (n = 11 237)	Standard model of consumer demand theory using probit specification to estimate parental influences on demand for cigarettes by youth	Price elasticity of smoking prevalence	**Model accounting for parental influences** –0.27 **Sensitivity analysis without accounting for parental influences** –0.34		Price elasticity estimates based on estimation models that do not account for parental influences tend to capture both the direct price effect and the indirect price effect that operates through the effect of price on parental smoking behaviour
USA (Ross *et al.*, 2005)	1996; cross-sectional data collected for The Study of Smoking and Tobacco Use Among Young People containing information on smoking status and expected behaviour after a hypothetical change in cigarette price	Probit regression model to estimate an equation for the probability of future smoking cessation among current smokers as a function of future cigarette prices. Analyses controlled for socioeconomic and demographic factors	Proportion of respondents who plan to engage in compensatory behaviour in response to a hypothetical price rise. Standard deviations are shown in parentheses	**All future smokers** *Switch to a cheaper brand* 0.29 (0.45) *Buy fewer cigarettes* 0.45 (0.50) *Offer less to friends* 0.60 (0.49) *Buy singles instead of packs* 0.15 (0.35) *Buy packs instead of cartons* 0.37 (0.48) *Buy cartons instead of packs* 0.26 (0.44) *Supplement cigarettes with smokeless tobacco* 0.07 (0.25)	**Light future smokers** *Switch to a cheaper brand* 0.25** (0.43) *Buy fewer cigarettes* 0.43* (0.50) *Offer less to friends* 0.49** (0.50) *Buy singles instead of packs* 0.20** (0.40) *Buy packs instead of cartons* 0.34** (0.47) *Buy cartons instead of packs* 0.13** (0.33) *Supplement cigarettes with smokeless tobacco* 0.07 (0.25)	* Difference between light and heavy smokers is significant at the 5% level ** Difference between light and heavy smokers is significant at the 1% level

Table 6.6. Summary of studies providing evidence on indirect effects on youth smoking of an increase in cigarette prices

Publication (author, yr, country)	Methods (location, time period; study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulations	Comment
USA (Ross *et al.*, 2005) (contd)					**Heavy future smokers** *Switch to a cheaper brand* 0.32** (0.47) *Buy fewer cigarettes* 0.47* (0.50) *Offer less to friends* 0.72** (0.45) *Buy singles instead of packs* 0.08** (0.27) *Buy packs instead of cartons* 0.40** (0.49) *Buy cartons instead of packs* 0.39** (0.49) *Supplement cigarettes with smokeless tobacco* 0.06 (0.24)	
USA (Katzman *et al.*, 2007)	1995–2001; nationally representative data on high school students in grades 9–12 from the biennial National Youth Risk Behavior Surveys (n = 49 169)	Multinomial logit model to determine the impact of price on the probability of being a non-smoker, a borrower or a buyer of cigarettes. Ordinary least squares used to estimate the smoking intensity and price elasticity of smoking intensity among borrowers and buyers of cigarettes	Regression coefficients and marginal effects of price and tax changes for whether a teen is a non-smoker, borrower or buyer. Price (tax) elasticity of smoking intensity for borrowers and buyers (demand defined as number of cigarettes smoked on days smoking) Price (tax) elasticity of smoking intensity among borrowers and buyers (smoking intensity defined as number of days smoked)	**All respondents** *Price (tax) Coefficient* Borrowers –0.328–(0.419) Buyers –0.494–(−0.632) *Price (tax) Marginal effects* Non-smoker 0.079 (0.101) Borrower –0.020–(0.026) Buyer –0.059 –(0.075) *Price (tax) elasticity of smoking intensity* Borrowers –0.306 –(0.028) Buyers –0.504–(0.108) *Price (tax) elasticity of smoking intensity* Borrowers –0.833 –(0.155) Buyers –0.320 –(0.074)	**Ever smokers** *Price (tax) Coefficient* Borrowers –0.342 –(0.444) Buyers –0.509 –(0.670) *Price (tax) Marginal effects* Non-smoker 0.107 (0.140) Borrower –0.024 –(0.030) Buyer –0.084–(0.110)	

Publication (author, yr, country)	Methods (location, time period; study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulations	Comment
USA (Harris & González López-Valcárcel, 2008)	1992–1999; data on a pooled sample of 49 898 households with 1–4 siblings from the 1992–1999 US Current Population Surveys	Estimates a youth smoking prevalence equation controlling for sibling smoking status	Social multiplier for the deterrent effect of price	1.60		
Low- and middle-income countries						
India (Joseph, 2010)	2000–2004; Global Youth Tobacco Survey data from 26 of 28 states and two of the seven Union Territories on youth aged 13–15 years. Average price data from users and non-users to construct school/state/ territory level prices	Amemiya's generalized least squares estimator. Model 1 Probit model with no peer effects, Model 2 assumes that the peer measure is exogenous, and Model 3 has the AGLS estimator that accounts for the endogeniety of the peer measure and helps disaggregate the direct price effect and the indirect price effect	Prevalence price elasticity	**Cigarettes** *Model 1* –0.4056** *Model 2* –0.1779*** *Model 3 (Direct)* –0.3017*** Model 3 (indirect) –0.0564*** **Bidis** *Model 1* –2.727** *Model 2* –0.8679** *Model 3 (Direct)* –1.3460** *Model 3 (indirect)* –0.5513*** **Gutka** *Model 1* –0.6915* *Model 2* 0.0789 *Model 3 (Direct)* 0.0800 *Model 3 (indirect)* –0.1026	**Women** *Cigarettes* Model 1 –0.6019** Model 2 –0.3474** Model 3 (Direct): –0.4027** Model 4 (Indirect): –0.1195** *Bidis* Model 1 –2.9325** Model 2 –0.8480 Model 3 (Direct): –1.3044* Model 3 (Indirect): –0.5306** *Gutka* Model 1 –1.1152** Model 2 –0.3495 Model 3 (Direct) –0.4853* Model 3 (Indirect) 0.0103*** **Men** *Cigarettes* Model 1 –0.2823* Model 2 –0.0939 Model 3 (Direct) –0.2408** Model 3 (Indirect) –0.0271** *Bidis* Model 1 –2.4860*** Model 2 –0.8760**	* $P < 0.10$ ** $P < 0.05$ *** $P < 0.01$

Table 6.6. Summary of studies providing evidence on indirect effects on youth smoking of an increase in cigarette prices

Publication (author, yr, country)	Methods (location, time period; study design and sample size (M/F)	Model	Endpoint	Main results	Subpopulations	Comment
India (Joseph, 2010) (contd)					Model 3 (Direct) –1.4297** Model 3 (Indirect) –0.5037*** *Gutka* Model 1 –0.3118 Model 2 0.2836* Model 3 (Direct) –0.1699 Model 3 (Indirect) –0.1514***	
	2000–2004; Global Youth Tobacco Survey data from 26 of 28 states and two of the seven Union Territories on youth aged 13–15 years. Average price data from users and non-users to construct school/state/territory level prices	Probit specification to model the decision to smoke. Model 1, Basic model; Model 2, includes household influence	Prevalence price elasticity	**Overall** *Cigarettes* Model 1 –0.1397 Model 2 –0.1392 *Bidis* Model 1 –1.2272*** Model 2 –1.2497** Gutka Model 1 –0.3082 Model 2 –0.2867	**Women** *Cigarettes* Model 1 –0.1690 Model 2 –0.1560 *Bidis* Model 1 –0.7631 Model 2 –0.6010 Gutka Model 1 –0.6588 Model 2 –0.3934 **Men** *Cigarettes* Model 1 –0.1341 Model 2 –0.1432 *Bidis* Model 1 –1.5776** Model 2 –1.6999** *Gutka* Model 1 –0.2095 Model 2 –0.2628	* $P < 0.10$ ** $P < 0.05$ *** $P < 0.01$

In particular, the deterrent effect of an increase in cigarette price on youth smoking prevalence was approximately 60% greater than the sum of the deterrent effect of price on each individual separately.

This study yields a social multiplier effect of price on smoking prevalence of 1.60, which is consistent with the implied social multiplier of 1.56 estimated by Powell *et al.* (2005).

Using the same data as Powell *et al.* (2005), Powell and Chaloupka (2005) examined the indirect effects of price on youth smoking that worked through parental smoking. As Chaloupka (2003) discussed, higher cigarette prices may have an indirect influence on youth smoking by both reducing parental modelling of smoking and by reducing availability of cigarettes to youth who might otherwise steal cigarettes from their parents. Powell and Chaloupka's estimates support Chaloupka's (2003) assertion that the indirect influence of price on youth smoking that works through parents accounts for about one fifth of the total impact of price on youth smoking prevalence.

In addition to examining the effect of future cigarette price increases on smoking cessation decisions among high school students, the aforementioned study by Ross and colleagues (2005) also examined expected compensatory behaviour after a future price increase. The authors estimated that 60% of future smokers intend to offer fewer cigarettes to their friends for free if price was increased. This implies that the availability of cigarettes through social sources would be diminished after a price increase, and that the full price of cigarettes would be indirectly increased by reducing the number of distributional channels available to high school students. The results also indicate that 45% of continuing smokers plan to buy fewer cigarettes after a price increase. The analysis further shows that nearly 21% of future smokers who do not expect to change their smoking intensity after the price increase also expect to buy fewer cigarettes. This implies that some future smokers believe that they can obtain cigarettes from alternative sources, although as discussed above, getting them for free from their peers will become more difficult. In addition, the analysis showed that price increases in the future will also result in other compensatory behaviours such as switching to cheaper brands of cigarettes, switching to smokeless tobacco products, supplementing cigarettes with smokeless tobacco products, and finally switching the usual quantity purchased (i.e. singles, packs, or cartons).

Other studies have examined the impact of cigarette prices on other outcomes such as sharing of tobacco products, risk perceptions, compensatory behaviours and attitudes towards tobacco products (Table 6.7). For example, Katzman and colleagues (2007) used data from the National Youth Risk Behavior Surveys (YRBS) conducted from 1995 through 2001 to explore the relationships between cigarette taxes/prices and youth acquisition of cigarettes. The YRBS data contained information on how cigarettes were acquired, including whether young smokers bought their own cigarettes or obtained them from social sources. As expected, Katzman and colleagues found that higher cigarette taxes/prices reduce the prevalence and intensity of smoking. The authors also found that acquisition patterns were significantly affected by higher taxes/prices. In particular, in models based on their full sample, they estimated that a US$1.00 increase in the price of cigarettes raises the probability of being a non-smoker by 7.9 percentage points, reduces the probability of buying cigarettes by 5.9 percentage points, and decreases the probability of borrowing cigarettes by 2.0 percentage points. Their finding that higher taxes and prices significantly reduce smoking among buyers while having less of an impact on borrowers is consistent with studies described in the smoking uptake section indicating that price has a larger impact of price on youth at later stages of the smoking uptake process.

Tauras and Chaloupka (2004) used data from the 1991–2000 nationally representative surveys of 8th-, 10th-, and 12th-grade students as part of the Monitoring the Future Surveys to examine the determinants of youth attitudes and beliefs about smoking. After controlling for smoke-free air laws, youth access laws, state spending on tobacco control efforts, and a host of socioeconomic and demographic characteristics, higher cigarette prices were found to be positively and significantly related to the prevalence of youths who agree that there is a great risk in smoking one or more packs a day, and the prevalence of youths who agree that smoking should be banned in public places. Moreover, Tauras and Chaloupka concluded that higher cigarette prices were found to be negatively and significantly related to the prevalence of youth who think the harm associated with smoking is exaggerated, the prevalence of youth who think they can smoke one or more packs a day and quit smoking, and the prevalence of youth who think that smoking is not dangerous because they can quit.

One Canadian study examined cigarette brand preference as a function of price among youth in Canada. Leatherdale and colleagues (2009) used nationally representative data from youths in 5th through 12th

grade in 10 Canadian provinces to identify factors associated with smoking premium brands (any cigarettes sold for the traditional price per carton), newly emerging discount brands (cigarettes sold for CAD$10–$12 less than premium brands), and native brands (tax-exempt cigarettes sold to aboriginals, or counterfeit cigarettes). While almost half of the young people in this study preferred the premium brands, half were accessing cheaper cigarettes. The study suggests that youth with less spending money and those who smoke more were more likely to access these cheaper sources of cigarettes.

Indirect effects of tax and price on youth tobacco demand and related outcomes – Low- and middle-income countries

Similar to the study by Powell *et al.* (2005), Joseph (2010) estimated the direct and indirect effects of price through peers on young adult tobacco use prevalence and intensity. Using data on 73 356 Indian adolescents aged 13–15 years taken from the Global Youth Tobacco Survey, Joseph found a significant impact of price on youth demand for cigarettes, bidis and gutka, as well as a significant indirect effect through peers on demand for all three tobacco products (Table 6.6).

To summarize, higher tobacco product prices have been found to have a direct negative impact on youth tobacco use and to have an indirect negative impact through peer and parental effects. These findings suggest that there is a sizeable social multiplier effect with respect to price changes and youth tobacco use. Moreover, higher tobacco prices have been found to change the attitudes and perceptions about tobacco among youths, alter the availability of tobacco through social sources, and increase the likelihood that young individuals engage in compensatory behaviours.

Table 6.7. Summary of studies providing evidence on other outcomes related to an increase in cigarette prices

Publication (author, year)	Methods (location, time period; study design and sample size (M/F)	Outcomes	Main results	Comments
High-income countries				
USA (Biener *et al.*, 1998)	1993–1994; Reported reactions to a price increase were assessed through telephone interviews with a representative sample of Massachusetts adults and teenagers (aged 12–17). Only smoking respondents included in the analysis (n = 1999). Descriptive statistics indicate response to price increase. Multinomial logistic regression used to test hypothesis that lower-income smokers would be more responsive to price than higher income smokers and that heavier smokers would be more likely to cut costs rather than attempt to quit when compared to lighter smokers	Possible reactions to price were typified as: 1) Cut costs associated with continued smoking (switching to a cheaper brand or reducing number smoked) 2) Quit smoking 3) No response to price increase. Regression coefficients for all possible pairs of above outcomes in a multinomial set	% (95% CI) Adults Cut costs 19.0 (15.1, 23.7) Consider quitting smoking 35.0 (29.6, 39.6) No response 46.0 (40.9, 51.1) Teenagers Cut costs 26.0 (10.4, 42.0) Consider quitting smoking 21.0 (9.3, 31.9) No response 53.0 (36.8, 69.6)	Among young smokers (aged 12–17), those from lower-income groups were significantly more likely than their more affluent counterparts to cut the costs associated with continued smoking in response to a tax/price increase rather than doing nothing or considering quitting smoking
USA (Tauras and Chaloupka, 2004)	Probit methods to estimate attitudes and beliefs equations. Analyses controlled for socioeconomic and demographic factors as well as year effects	Twelve dependent variables on attitudes and beliefs about smoking, 6 expected to be positively affected and 6 negatively affected by tobacco control policies.	Cigarette prices have a positive and significant impact on the 'great risk' and 'public smoking ban' outcomes and a negative and significant impact on the 'harm exaggerated', 'smoke 1+ packs daily and quit', 'smoking is not dangerous – you can quit' and 'don't mind being near smokers' outcomes. Price was found to be an insignificant determinant of 'smoking reflects bad judgement', 'dirty habit', 'disapprove of adults smoking', 'prefer to date non-smoker', 'smokers enjoy life' and 'cigarettes are easily accessible' outcomes	
Canada (Leatherdale *et al.*, 2009)	2006–2007; Nationally representative data for 5th – 12th grade students from the Canadian Youth Smoking Survey. Two logistic regression models were used: Model 1 estimates the odds of smoking discount cigarettes versus premium cigarettes and Model 2	Odds of smoking discount cigarettes versus premium cigarettes (95% CI) Odds of smoking native cigarettes versus premium cigarettes (95% CI)	**Factors associated with smoking discount versus premium cigarettes** *a. Smoking status* Occasional smoker 1.00 Daily smoker 1.55 (1.14 to 2.10)**	* $P < 0.05$ ** $P < 0.01$ *** $P < 0.001$

Table 6.7. Summary of studies providing evidence on other outcomes related to an increase in cigarette prices

Publication (author, year)	Methods (location, time period; study design and sample size (M/F)	Outcomes	Main results	Comments
Canada (Leatherdale *et al.*, 2009) (contd)	estimates the odds of smoking native cigarettes versus premium cigarettes		*b. Aboriginal status* Non-aboriginal 1.00 Aboriginal 0.028 (0.19 to 0.43)*** *c. Weekly spending money* $C0 1.00 $C1 to $C10 0.39 (0.19 to 0.79)** $C11 to more 0.84 (0.48 to 1.48) *d. Average cigarettes/day* Few puffs to 1 cigarette 1.00 2–3 cigs 2.11 (1.01 to 4.00)* 4–10 cigs 4.02 (2.00 to 8.10)*** 11 or more cigs 2.87 (1.34 to 6.12)* **Factors associated with smoking native versus premium brands** *a. Sex* Girl 1.00 Boy 1.72 (1.24 to 2.40)** *b. Smoking Status* Occasional smoker 1.00 Daily smoker 1.45 (1.02 to 2.06)** *c. Aboriginal status* Non-aboriginal 1.00 Aboriginal 0.56 (0.37 to 0.84)** *d. Weekly spending money* $C0 1.00 $C1 – $C10 0.72 (0.39 to 1.32) $C11 or more 0.34 (0.20 to 0.56)***	

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