WORLD BANK GROUP
Poverty & Equity

tobacconomics
Economic Research Informing Tobacco Control Policy

A Toolkit for

Estimating the Distributional Impact of Tobacco Taxes

INSTITUTE FOR HEALTH RESEARCH AND POLICY
UIC

Suggested Citation: Chaloupka F., Fuchs Tarlovsky A., Gonzalez Icaza M.F., Rodriguez-Iglesias G., Vulovic V., (2022). Toolkit for Estimating the Distributional Impact of Tobacco Taxes. A Tobacconomics Toolkit. Chicago, IL: Tobacconomics, Health Policy Center, Institute for Health Research and Policy, University of Illinois Chicago. www.tobacconomics.org

Authors: This Toolkit was written by Frank Chaloupka, PhD, Professor Emeritus at the Institute for Health Research and Policy, University of Illinois Chicago; Alan Fuchs Tarlovsky, PhD, Lead Economist at the World Bank Group; Maria Fernanda Gonzalez Icaza, Economist at the World Bank Group; German Rodriguez-Iglesias, MS, Senior Economist at the Institute for Health Research and Policy, University of Illinois Chicago; and Violeta Vulovic, PhD, Senior Economist at the Institute for Health Research and Policy, University of Illinois Chicago. It was peer-reviewed by Rijo M. John, PhD, Associate Professor, Rajagiri College of Social Sciences, Kerala, India; and Nisreen Salti, PhD, Associate Professor, Department of Economics, American University of Beirut, Lebanon.

This Toolkit is funded by Bloomberg Philanthropies.

Contribution statement: Authors are listed alphabetically. The authors confirm contribution to the toolkit as follows: F.C. provided critical review on drafts and the final version of the document. A.F.T. and M.F.G.I. co-authored Chapter 4 and provided country case-studies on the ECBA and the previous version of this toolkit. A.F.T. provided expertise on empirical applications of the ECBA. G.R.I. drafted Chapters 2-4. V.V. drafted Chapters 1-3. All authors provided comments on the entire document.

About Tobacconomics: Tobacconomics is a collaboration of leading researchers who have been studying the economics of tobacco control policy for nearly 30 years. The team is dedicated to helping researchers, advocates and policymakers access the latest and best research about what's working—or not working—to curb tobacco consumption and its economic impacts. As a program of the University of Illinois Chicago, Tobacconomics is not affiliated with any tobacco manufacturer.Visit **www.tobacconomics.org** or follow us on Twitter **www.twitter.com/tobacconomics**.

About World Bank: With 189 member countries, staff from more than 170 countries, and offices in over 130 locations, the World Bank Group is a unique global partnership: five institutions working for sustainable solutions that reduce poverty and build shared prosperity in developing countries. The World Bank Group is one of the world's largest sources of funding and knowledge for developing countries. Its five institutions share a commitment to reducing poverty, increasing shared prosperity, and promoting sustainable development.

Improving Our Toolkit: The Tobacconomics team is committed to making this toolkit as clear and useful as possible. We would like your feedback on whether you found this toolkit useful in your research and, if so, we would appreciate learning about your experience on any successful implementation. We would also like to hear whether you have encountered any issues in applying the methodologies presented in the toolkit, and your thoughts on how to improve it.

For any comments or questions about the toolkit and its content, please email us at info@tobacconomics.org. We very much look forward to hearing from you.

Table of Contents

Introduction

1

A growing body of evidence across countries demonstrates that substantially increasing prices of tobacco products through higher taxes is the single most effective way to reduce tobacco use. Consumption of tobacco products in low- and middle-income countries is generally more responsive to price changes than in high-income countries, with elasticity estimates from the low- and middle-income countries clustering around -0.5 and those from high-income countries clustering around -0.4 (US National Cancer Institute & World Health Organization, 2016). Different socioeconomic groups within countries may respond differently to price increases. While the evidence remains inconclusive for some countries, empirical calculations show that groups with lower socioeconomic status have relatively stronger responses to tobacco price changes than groups with higher socioeconomic characteristics.

The economic rationale for imposing an excise tax on tobacco products is based on multiple arguments. First, as tobacco consumption generates negative externalities, a tobacco excise tax can correct these distortions by internalizing costs. Second, excise taxes can address individual and socially harmful consumption of tobacco products due to internalities—behavioral studies find that individuals tend to overconsume certain goods such as tobacco or alcohol due to a lack of self-control or false beliefs (Bernheim & Rangel, 2004; Mullainathan et al., 2012; Chetty, 2015). Smoking is not only detrimental to the health of those who smoke but also has a negative impact on those around them. Hence, if high taxes can make smokers either quit or reduce their consumption, the effects on the finances and health of smokers and those around them can be positive. Finally, since demand for tobacco is relatively inelastic, as compared to other consumption goods, it is optimal from the perspective of taxation efficiency to levy a relatively higher tax on these goods than those with more elastic demand (Ramsey, 1927). Even if taxes do not significantly change an individual's smoking behavior, they have the potential to generate substantial government revenues that can be used to improve social welfare more broadly.

Despite their potential to reduce the consumption and adverse effects of tobacco use, tobacco taxes are often underused and opposed by policymakers. One of the most common arguments against tobacco taxation is that it may be unfair by adversely affecting the poor, who may allocate a relatively higher proportion of their income towards the consumption of tobacco products. The findings from available studies, however, suggest the opposite: tobacco taxes can result in health and welfare gains without imposing an excessive burden on the poor (Sassi et al., 2018).

The distributional impacts of a tax are the differential impacts across individuals or households affected by it. Distributional impacts are often analyzed using tax incidence analysis, which compares an individual's income before and after the tax change, to approximate or get a sense of changes in their welfare. A commonly used method of tax incidence analysis is the accounting approach which compares only the tax burden and does not take into account any health or productivity impacts of the behavioral responses to a tax and price change. In the case of consumption of tobacco, which not only has negative effects on the health and productivity of its consumers (so-called internalities), but also generates distortions through negative externalities, ignoring the impacts of behavioral responses may lead to misleading results on the distributional impacts of a tax.

Therefore, this toolkit presents two methods of analyzing the distributional impacts of tobacco tax, including the accounting approach as well as a method known as the Extended Cost-Benefit Analysis (ECBA). ECBA is presented as a superior method to the commonly-used accounting approach for goods such as tobacco since it incorporates the impacts of behavioral changes on health and productivity in analyzing the distributional impact of tobacco tax.

When considering a tobacco tax increase as a policy intervention, ECBA intends to capture the effects of higher tobacco taxes and the shock to households' medium- and long-term economic welfare, beyond the effect on their short-term changes in income and expenditures. Welfare can be broadly understood as the well-being or living standards of people and societies. Nonetheless, ECBA adopts a more narrow definition of economic welfare, "the part of welfare that is associated with the economic aspects of life" (Pigou, 1951). This definition concentrates on the aspects of welfare that can be translated to a monetary value. On the other hand, ECBA excludes several components of human well-being and development, including freedoms, happiness, capabilities, and the intrinsic value of life expectancy and health conditions, among others (Deaton & Zaidi, 2002). Moreover, empirically, ECBA adopts measures of income or consumption available from household survey microdata to approximate the monetary value of household welfare. While the literature recognizes the many limitations of consumption and income measures of welfare, this toolkit attempts to follow, to the highest degree possible, international best practices available for the empirical measurement of welfare. The interested reader can find more details in Deaton and Zaidi (2002) and Deaton (2019). Other aspects of welfare that are unfortunately excluded from the analysis cannot be adequately captured by a simplified monetary measure, but they are nonetheless affected by income and consumption (Deaton & Zaidi, 2002).

1.1 Purpose of this toolkit

The primary purpose of this toolkit is to guide researchers in the analysis of the distributional impacts of tobacco taxation—especially in low- and middle-income countries, where evidence is limited. With this knowledge, policy responses can be developed and monitored to establish their effectiveness, appropriateness, and impact on other policy goals. For example, if the goals are to reduce smoking's harmful effects on smokers and those around them and to increase welfare through both reduced tobacco consumption and higher overall tax revenue, tax increases need to be designed with consideration for poor households to ensure equity.

This toolkit reviews two economic methods that can be used to analyze the distributional impacts of tobacco taxes (the accounting approach and ECBA) with a brief discussion of the theoretical background for each method of estimation and the use of the statistical software Stata® to implement both. By presenting both methods in this toolkit, users can gain a more accurate and objective understanding of the impacts of tobacco tax policies on equity. While the accounting approach is commonly used in tax incidence analysis, ECBA is a more novel and superior method as it accounts for not only the short-term, but also the mid- and long-term impacts of a tax increase. Well-documented, methodologically-sound estimates of the impacts of tobacco tax increases on tax burden and progressivity can inform policymakers about the costs and benefits of various policies.

This toolkit is one of several toolkits developed by the World Bank, the World Health Organization (WHO), and Tobacconomics aimed at providing guidance for conducting economic analysis of tobacco demand and the impact of tobacco consumption on employment, welfare and equity, illicit trade, and economic costs. This is also the third in a series of Tobacconomics toolkits designed to build capacity and core competencies in economic analysis of tobacco taxation to build a strong, local evidence base for effective tobacco taxation policy.

1.2 Who should use this toolkit

This toolkit is intended for researchers, analysts, policymakers, and tax administrators who seek to define and implement a tobacco tax policy that adequately takes into account concerns regarding its impact on lower-income socioeconomic groups. While the discussion of econometric methods and step-by-step guides to Stata directly benefit researchers working on the economics of tobacco control, the policy discussions and interpretations of results provided in this toolkit are also intended to benefit policymakers, analysts in government agencies, and those in civil society organizations to better understand the distributional impacts of tobacco taxes.

The toolkit is written and designed for readers with moderate knowledge of economics, statistics and econometrics, and tax administration. For readers who are less familiar with tobacco taxation, there are chapters providing background information, a brief review of other empirical studies on tobacco taxation, and references to helpful resources and additional information.

1.3 How to use this toolkit

The toolkit is organized as follows. Chapter 2 describes relevant concepts, reviews the literature on the distributional impacts of tobacco taxes, and discusses the theoretical framework for the analysis. Then, two methods for measuring the distributional impacts of tobacco taxes are presented. Chapter 3 presents the accounting approach, and Chapter 4 presents ECBA.

For each method, the required data for the analysis and data sources are first discussed. Then, each chapter provides step-by-step guidance to implement the analysis using Stata. Finally, a case study is presented to illustrate the step-by-step procedure, along with the interpretation of results.

2 Relevant concepts, literature review, and theoretical framework

A good understanding of an empirical method requires knowledge of its foundational concepts, the theoretical framework behind it, and existing empirical evidence on the topic of interest.

The economic rationale for the introduction or increase of a tax on tobacco products includes several arguments. First, a tobacco tax can be used to correct for negative externalities caused by the consumption of tobacco. Second, taxation of tobacco products may improve social welfare through improved health outcomes and increased productivity. Taxes incentivize smokers to stop smoking or reduce consumption, compensating for their lack of self-control, lack of attention, and false beliefs on the impact of tobacco use—factors which have been found in the literature to lead individuals to overconsume tobacco and alcohol. Finally, it is optimal to tax tobacco as the demand for tobacco products has a relatively low price elasticity.

Nonetheless, a common argument against tobacco taxes is that they impose a disproportionate burden on the poorest households, who tend to allocate a considerably higher share of their income to purchasing tobacco products. The empirical evidence, however, supports the opposite conclusion. As lower-income consumers are relatively more sensitive to price changes, increasing the price of tobacco products via taxes leads to a greater reduction of their consumption (relative to other smokers), resulting in a relatively larger reduction in their tax burden than their wealthier counterparts. Moreover, since higher prices disincentivize consumption, and lower-income households are relatively more likely to consume tobacco and spend a larger share of their budget on tobacco, they benefit from relatively greater savings in medical expenses and increases in future income.

Two main concepts in analyzing the distributional impact of tax policies are tax fairness and progressivity. Tax fairness stipulates that a tax should be equitably applied to all taxpayers. However, this principle needs to strike a balance between fairness for individuals and fairness for society, whenever these two differ. Furthermore, scholars and practitioners differ in their opinions on how tax fairness should be achieved.

Traditionally, empirical evidence on the distributional impacts of tobacco taxation has been based on tax incidence analyses concentrating on short-term or direct effects only. This method estimates the change in the household or individual welfare, by allocating the tax burden based on current consumption and the tax increase, while ignoring the second-order effects of the behavioral changes due to a tax increase. Since tobacco consumption is associated with various noncommunicable diseases (NCDs), it leads to high costs for medical treatment, in addition to losses in productivity due to morbidity and premature mortality. Hence, a more comprehensive method to evaluate the distributional impacts of tobacco taxation should incorporate behavioral changes triggered by the tax change. This chapter explains the difference in the theoretical framework of these two methods.

2.1 Concepts

A tax system that is generally perceived as equitable and fair is considered a good tax system. Since Adam Smith first established the need for equality in a tax system as one of the "four maxims with regard to taxes" (Smith, 1776), other scholars have expanded upon those maxims by citing tax equity and fairness most frequently as characteristics of an ideal tax system.

While some argue that formulating a simple definition of equity and fairness is difficult, there is general agreement that a tax system should be equitable. However, there is no such agreement about how a fair tax should be defined. One of the reasons why tax fairness is difficult to define is the multidimensionality of the concept (Gerbing, 1988; Christensen et al., 1994; Christensen & Weihrich, 1996; Thomas, 2012). The perception of fairness is also important as it affects the public's trust in authorities as well as tax compliance (Braithwaite, 2002; Maroney et al., 2002; Trivedi et al., 2003; Hartner-Tiefenthaler et al., 2012). This section discusses the concepts of tax fairness, regressivity, and progressivity.

2.1.1 Tax fairness

The concept of tax fairness is multidimensional and depends on the purpose of the imposed tax. While most taxes are levied to raise revenues to finance publicly provided goods and services, some are also imposed to adjust or regulate economic and social behavior—for example, a Pigouvian tax in the case of externalities (Pigou, 1951)—and/or to redistribute resources. Depending on the purpose of the tax, the principles of tax fairness will differ.

When the objective of a tax is revenue collection, two principles commonly used for assessing tax fairness are the "benefit" and "ability to pay" principles. The benefit principle states that an individual should only pay for those public goods and services that they receive in exchange and from which they benefit (Samuelson, 1954; Musgrave & Musgrave, 1973). Those who benefit the most from public goods and services (e.g., public education, health, etc.), however, are usually the least able to pay for them. Moreover, the benefits for an individual from consuming goods and services are very difficult to measure. To address these limitations, the ability-to-pay principle is a useful alternative. It assumes that the tax paid by an individual should depend on the burden that the tax creates relative to their wealth (Mill, 1970).

Unlike the benefit principle, the ability-to-pay principle is efficient, since public goods and services are provided at zero prices, and tax payments are not exclusively associated with the beneficiaries. The ability-to-pay principle can be defined differently depending on the interpretation of the optimal tax base and tax structure. The optimal tax base is considered a matter of "horizontal equity" (people with similar income and wealth should pay a similar amount of tax), while the tax rate structure is a question of "vertical equity" (the tax liability should vary in proportion to income). Some argue that annual spending is a fairer measure of one's ability to pay than income because the latter does not capture overall wealth when assessing one's taxable capacity (Kaldor, 2014). Similarly, there is no consensus in terms of the preferred structure of tax rates. While some argue that "equal sacrifice" in taxation (Mill, 1970) means that the tax should be levied at a proportionate rate, others call for progressive rates due to diminishing marginal utility to maintain the quality of the sacrifice. In other words, if a reduction in the marginal utility of a taxable good or service happens faster than the increase in the quantity consumed, a higher tax should be imposed at higher levels of income or wealth.

In the case of excise taxes, when the purpose of taxation is to encourage or discourage certain economic or social behavior, tax fairness depends on several factors: whether there is a rational relationship between the tax and its objective or goal, the justice of the goal, and the distributional impact of the tax (Duff, 2008). For example, environmental taxes are commonly justified as economically efficient, and they comply with the principle of corrective justice (Ross, 1956), according to which those who cause environmental damage should compensate society for it. A similar argument holds for the taxation of tobacco products, as consumption of tobacco has a negative health impact not only on the consumer, but also on people around them, causing health damage from second-hand smoke, environmental damage, increased public health expenditures, and fiscal pressures, among others.

2.1.2 Tax progressivity and regressivity

The tax burden is defined as the share of a person's income that they pay in tax during a given time period. This ratio is also called the average or effective tax rate, while the marginal tax rate is the tax rate on an additional unit of income. The distributional impacts of a tax can be assessed by comparing these ratios for different income groups. A common misconception is that tax progressivity is defined by increasing the marginal tax rate. For example, a tax system with a single constant marginal (or flat) tax rate can still be progressive or regressive depending on tax exemptions and deductions.

Before defining progressive versus regressive tax systems, it should be emphasized that there are two main definitions of tax progressivity: the income-based or the ability-to-pay definition, which some authors refer to as the accounting definition (Remler, 2004), and the welfare-based definition. Based on the ability-to-pay definition, a progressive tax system is one where the tax burden increases as a person's ability to pay increases. In such a system, a taxpayer's average or effective tax rate is lower than their marginal tax rate. The opposite is the case for regressive taxation, where the tax burden decreases as the ability to pay increases. Finally, if the ratio of tax payment and income is constant, then the system is called a proportional tax system. This concept can be applied to either annual income or lifetime income, and either one tax only or the whole tax. There are arguments that annual expenditure is a better indicator of one's well-being than annual income (Poterba, 1991). Regardless, the ability-to-pay definition does not observe a true measure of the tax burden, as it fails to capture any health or productivity impacts of the behavioral responses to taxation. The welfare-based definition of progressivity does incorporate these effects and observes how a tax change impacts one's overall welfare, not only their income. In other words, the welfare-based definition considers the impacts of the behavioral changes resulting from a tax increase. Under this framework, a reduction in tobacco consumption due to a tax and price increase would not only reduce the tax burden of the consumer but would likely positively impact their health outcomes and productivity and, consequently, reduce medical spending and increase future earnings.

2.1.3 Approaches to measuring distributional impacts

The impacts of taxation on a person's or household's welfare can be divided into direct effects and indirect effects. The direct effect is the effect of a price change due to a tax increase on the individual or household welfare. Indirect effects are driven by a combination of tax-induced changes in the demand or supply of a good or a service (which subsequently impact people's welfare beyond their short-term disposable incomes), tax efficiency, and revenue collection. As a result, the net distributional impact depends on the distribution of both direct and indirect effects across households and how additional revenues are used.

In analyzing the distributional impacts of taxation, three general methodological approaches can be employed including the partial equilibrium, limited general equilibrium, and general equilibrium approaches. In addition to data requirements and levels of complexity, the main difference between these approaches is the extent to which they incorporate indirect welfare effects: the partial equilibrium approach focuses only on the direct effects of taxation, the limited general equilibrium approach considers only direct effects and some indirect effects, and the general equilibrium approach incorporates both direct and indirect welfare effects.

In general, the partial equilibrium approach focuses on the first-order effect of taxation on household income and ignores any responses on the demand or supply side. Nevertheless, an analysis using this approach can provide useful information on the distributional impacts of a tax change on household income. Because it requires relatively little data, modeling, and time, partial equilibrium analysis can be conducted relatively easily. General equilibrium, on the other hand, incorporates indirect effects through responses in demand and supply, and it is used when one needs to evaluate a trade-off between efficiency and distributional impacts of tax reform. However, general equilibrium is a much more complex approach, and building such a model is a very resource- and data-intensive task. As an illustration of the difference between these two approaches, partial equilibrium analysis ignores information on how tax revenue proceeds are used, while general equilibrium does incorporate it and is, therefore, more complete. In other words, the main difference between these two approaches is that partial equilibrium asks, "assuming everything else remains unchanged, who pays the most tax?" while general equilibrium asks, "taking everything into account, who benefits and who loses the most from this tax?"

2.2 Literature review

One of the main arguments from policymakers and other stakeholders in opposition to tobacco taxes is that they, like other indirect taxes, are regressive. However, the evidence—mostly available for high-income countries but increasingly in low and middle-income countries as well—suggests that this concern may be overstated and that, on the contrary, tobacco tax increases can result in gains in health and welfare for the poor (Sassi et al., 2018).

In analyzing the distributional impacts of tobacco taxation, it is not sufficient to only consider the ratio of tax to income at the time the tax is introduced; one should also include the health benefits from reduced consumption in response to a tax. Additionally, different socioeconomic groups respond differently to price changes, and smoking prevalence is also different across socioeconomic groups. As a tax increase on tobacco products aims to reduce both smoking prevalence and the quantity of tobacco consumed, one needs to know the consumption patterns across socioeconomic groups and their responsiveness to price in evaluating whether a tax is regressive or progressive (Summers, 2018). Moreover, as lower socioeconomic groups bear a disproportionally larger morbidity and mortality burden from NCDs (Institute for Health Metrics and Evaluation, 2019), they are likely to bear relatively higher health costs than higher socioeconomic groups. Therefore, lower socioeconomic groups would benefit relatively more through a significant reduction of these indirect costs resulting from reduced consumption.

2.2.1 Estimates of price elasticity of demand for tobacco products by socioeconomic group

The evidence on the responsiveness of different socioeconomic groups to changes in prices of tobacco products mostly shows a relatively greater elasticity among lower-income groups. Evidence from high-income countries shows, in general, relatively greater responsiveness in lower compared to higher socioeconomic groups (such as Townsend et al., 1994, for the United Kingdom and Siahpush et al., 2009, for Australia). In the United States, most studies find relatively greater responsiveness to tobacco price changes in lower than in higher socioeconomic groups (Chaloupka, 1991; Farrelly et al., 2001; Colman & Remler, 2008), though a few analyses offer inconclusive evidence (Franks et al., 2007).

In the case of low- and middle-income countries, although some studies have offered mixed evidence (Önder, 2002; Karki et al., 2003; Sarntisart, 2003; Levy et al., 2004; Chaloupka et al., 2012), a much larger and growing body of evidence has shown a significantly greater response in the lower-income groups than among those with higher income (for example, in Albania (Gjika et al., 2020), Argentina (Cruces et al., 2020), Bangladesh (Fuchs, Gonzalez Icaza, & Paz, 2019; Nargis et al., 2014), Bosnia and Herzegovina (Fuchs, Orlic, & Cancho, 2019; Gligorić et al., 2022), Chile (Fuchs, Gonzalez Icaza, & Paz, 2019), China (Huang et al., 2015; Verguet et al., 2015), India (Selvaraj et al., 2015), Indonesia (Adioetomo et al., 2005; Fuchs, Gonzalez Icaza, & Paz, 2019), Lebanon, Jordan and Palestine (Chalak et al., 2021), Mexico (Macías Sánchez et al., 2020), Moldova (Fuchs & Meneses, 2018), Montenegro (Cizmovic et al., 2022), Pakistan (Nayab et al., 2020), Peru (de los Rios et al., 2020), Russian Federation (Fuchs, Gonzalez Icaza, & Paz, 2019), Serbia (Vladisavljević et al., 2021), South Africa (Fuchs, Gozalez Icaza, & Paz, 2019), Turkey (Önder & Yürekli, 2016), and Ukraine (Fuchs, Gonzalez Icaza, & Paz, 2019).

Furthermore, several studies have estimated responsiveness to price changes by age and by gender. While evidence by gender has been mixed (Awawda et al., 2022; Chaloupka & Pacula, 1998), studies according to age groups—although mostly from high-income countries—suggest that youth are relatively more responsive to a tobacco price increase than adults (Kjeld et al., 2021). These findings align with economic theory that suggests that limited income, peer effects, and lower addiction levels affect youth responsiveness to tobacco price increases.

Several studies have also analyzed substitution between tobacco products as a result of a price change, particularly among similar products (such as cigarettes compared to roll-your-own tobacco). While the results in high-income countries show evidence of substitution, the limited evidence from low- and middle-income countries is mixed. While Liu et al. (2015) and Laxminarayan and Deolalikar (2004) find evidence of substitution in China and Vietnam, respectively, evidence from India (John, 2008) shows no significant cross-price elasticity between tobacco products. Additionally, research from Lebanon, Jordan, and Palestine (Chalak et al., 2021) finds no evidence of substitution between cigarettes and waterpipe tobacco products. Other studies show that consumers tend to switch to more expensive products (such as from domestic to international brands) as their income increases.

2.2.2 Estimates of distributional impacts of tobacco tax

Economists' traditional view is that most indirect taxes, including tobacco taxes, are regressive (Lyon & Schwab, 1991). This has been one of the main arguments used by policymakers and others against tobacco taxation. Such concern is based largely on evidence that considers only the average tax burden and does not consider any impacts of behavioral responses to the tax or indirect benefits (including health benefits) from reduced consumption. The traditional view has also been challenged in the literature by authors who claim that not only annual, but also lifetime income should be observed, and that impacts of behavioral responses cannot be ignored. For example, Lyon and Schwab (1991) assert that costs of tobacco consumption include so-called "internalities:" costs that consumers impose on themselves but do not fully internalize (e.g., due to a lack of self-control caused by false beliefs or incomplete information, people only partially internalize the negative health impacts of current tobacco consumption on their future-self)[1] (Herrnstein et al., 1993; O'Donoghue & Rabin, 2006). For this reason, these authors argue that progressivity or regressivity of tobacco taxation depends not only on the distribution of tax burden but also on internality-reduction benefits from the tax. Allcott et al. (2019) find that, in the case of soda taxes, internality-reduction benefits are highly progressive.

Warner (2000), Chaloupka et al. (2011), and Chaloupka et al. (2012) argue that, because the poor are more responsive to changes in price than the rich, tobacco tax increases can be progressive. Bosch and Koch (2014) test Warner's (2000) hypothesis by comparing the effective tax rate by income group before and after

[1] For example, if increased health risks from tobacco use impose $x of cost on an individual, but the consumer limits the consumption by recognizing the cost of only 60% of $x, the cost that is overlooked (the internality cost) is 40% of $x.

a 2007 tobacco tax change in South Africa. They find that tobacco taxes are regressive but become less regressive after the tax increase. Alternatively, applying a partial equilibrium approach, Gospodinov and Irvine (2009) estimate price elasticities by socioeconomic group in Canada and find no evidence that lower socioeconomic groups have relatively higher price responsiveness, which leads them to conclude that the tax system is regressive.

Some studies analyzed tax incidence using a lifetime versus annual income. For example, Lyon and Schwab (1991) find no difference in tobacco tax incidence using these two measures, while for alcohol they find the tax system to be slightly less regressive when a lifetime income tax measure is observed. On the other hand, Poterba (1989) compares average percentages of spending on unhealthy and environmentally harmful goods (tobacco, alcohol, and gasoline) in annual income and total expenditure by quintile, average spending to income, and spending by age group to total expenditure ratios. The author finds evidence that the difference between annual and lifetime incidence may be substantial and calls for greater reliance on the general equilibrium approach in modeling tax incidence.

Several studies include the mid- and the long-term impacts of the tax and find mixed evidence. For example, Verguet et al. (2015) estimate the distributional impacts of a tobacco tax increase in China using the extended cost-effectiveness analysis (ECEA). They find that a 50-percent price increase via the excise tax would save a substantial number of lives (about one-third of those among the households in the poorest quintile). Additionally, they find a higher tax would increase overall household expenditure on tobacco, but it would reduce overall expenditure on tobacco in the poorest households. The ECEA approach is described in Box 4.1.

Similarly, Fuchs et al. (2017) use an ECBA approach to estimate the distributional impacts of a tobacco tax increase in Chile. They assume that household income would change through three channels due to the tobacco tax increase: tobacco expenditures would change due to higher taxes, medical expenses would change due to lower consumption of tobacco, and earnings would change due to lower premature mortality. Moreover, they assume variation in price responsiveness between income groups. They find welfare gains in lower-income groups from the tax increase. Similar evidence has been found in several other countries using the same approach (Fuchs et al., 2019; Fuchs Tarlovsky & Gonzalez Icaza, 2020; Fuchs, Orlic, & Cancho, 2019). Saxena et al. (2019) apply an ECEA to estimate the distributional impacts of a ten-percent soda tax implemented in South Africa in 2018. They find that the tax would reduce the number of obesity-related deaths and out-of-pocket (OOP) medical spending, but the impact would be felt relatively more in the third- and fourth-income quintiles, as they consume relatively more soda. They also find that this tax would reduce impoverishment caused by OOP medical expenses.

2.3 Theoretical framework

Generally, incidence analysis indicates that the introduction of a tax—analyzed in a partial equilibrium framework—increases the market price, reduces the number of consumers, generates state revenue, and introduces efficiency loss. The magnitude of these effects depends on the market supply and demand elasticities (Rosen & Gayer, 2014; Gruber, 2016). In the case of tobacco, the economic rationale for levying a tax can be justified through several different conceptual frameworks. First, as with other goods that generate negative externalities, the tax can be used to correct these distortions. Second, as the demand for tobacco products has a relatively low price elasticity compared to other goods, a tax that is justified within a logic of optimal taxation (proportional to the inverse of the price elasticity of the demand for the good or service in question) should also be relatively higher as compared to tax on other goods whose demand is more elastic (Ramsey, 1927). Finally, much of the behavioral literature provides a framework that justifies tobacco taxation as a result of self-control issues, lack of attention, and false beliefs that can lead individuals to overconsume tobacco. Given this, increasing tobacco taxes may produce improvements in social welfare (Bernheim & Rangel, 2004; Mullainathan et al., 2012; Chetty, 2015).

All three conceptual frameworks imply that setting very high taxes on tobacco products serves the common good. If high taxes can make smokers either quit or reduce their consumption, the effect on their finances and health is positive. In addition, such taxes can generate substantial government revenues. However, this reasoning assumes that—no matter the income level of tobacco consumers—they face the same change in utility when their available income changes. In other words, smokers do not differ in their marginal utility of income. With this logic, policymakers would consider a unit of tax revenue to be the same regardless of whether those taxed with the tobacco levy were the richest or poorest in the country.

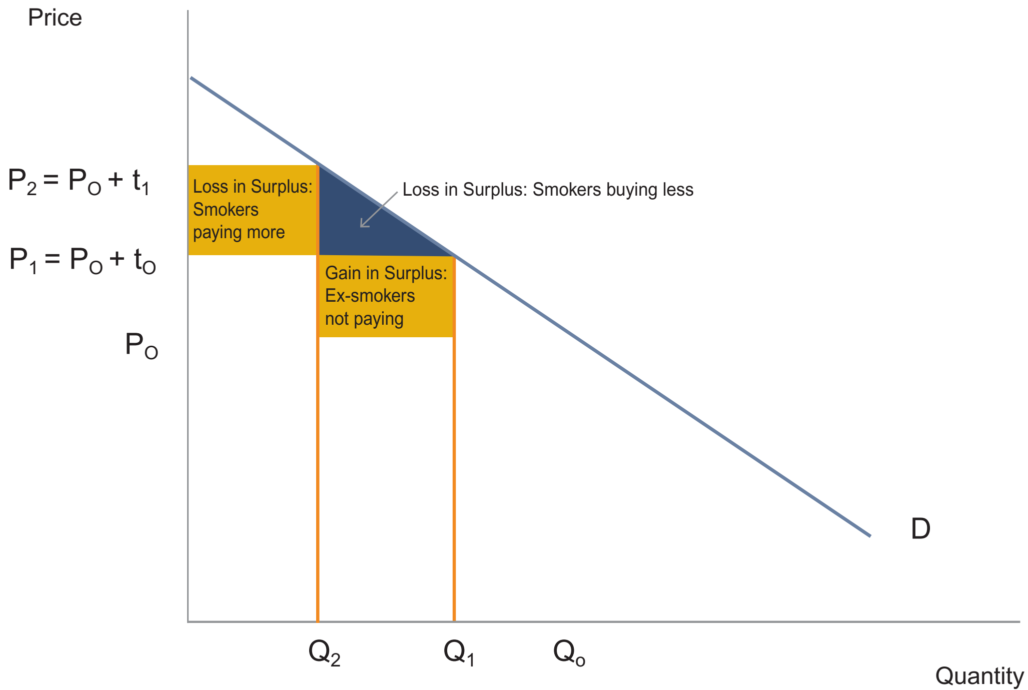
Based on this reasoning, a common objection to tobacco taxes is that they are regressive, meaning the tax burden tends to fall disproportionately on the poorest households who, based on evidence, allocate a considerably higher proportion of their income towards tobacco products. Notably, however, this conceptualization misses two key issues: 1) price elasticities of tobacco can be heterogenous across income groups; and 2) changes in the taxation of tobacco do not only affect household spending through expenditures on the consumer product.

Concerning the first point, if the poorest consumers were sufficiently sensitive to price changes, which is to say they have a relatively higher price elasticity of demand for tobacco, raising the price of tobacco products would have a larger impact on their tobacco consumption, relative to wealthier peers. Evidence in high-income countries shows that the poorest households have relatively higher, in absolute terms, price elasticity of demand for tobacco than their wealthier counterparts (Chaloupka, 1991; Townsend et al., 1994; Farrelly et al., 2001; Colman & Remler, 2008; Siahpush et al., 2009).

To the second point, tobacco taxes can indirectly affect households beyond the current expenditure on tobacco products. Given that the tax disincentivizes consumption of tobacco, the associated improvements in health outcomes can lead to savings on current and future medical expenses associated with tobacco-related diseases, and to increased life expectancy, improved quality of life, and longer and more productive time in the workplace. When the poorest households are those that more significantly reduce tobacco consumption, the savings in medical costs and the increase in future earnings may be relatively greater, reversing the regressive result indicated when those effects are not taken into account (Fuchs & Meneses, 2017).

According to the “ability to pay” definition of tax progressivity, a tax is defined as regressive if the tax share of income declines as income increases, and it is progressive if the tax share increases with income (Rosen & Gayer, 2014). Based on this definition, a change in excise tax has both positive and negative effects. The positive effect is in the reduced amount of tax liability due to reduced consumption, while the negative effect consists of higher tax payments because the consumed items are taxed at a higher rate. Colman and Remler (2008) describe these effects for a cigarette excise tax using a simple model (by assuming that the supply curve is completely elastic at a constant marginal cost of production and the market is perfectly competitive). The equilibrium under the initial tax system (before the tax increase) is presented with P_1 and Q_1, while P_2 and Q_2 represent the price and quantity after the tax increase, respectively. So, after the tax increase (where the tax amount is t_1) the consumer cuts back on consumption by an amount due to the higher price. Former smokers gain in surplus the complete rectangle $(Q_1-Q_2)*P_0$, plus a reduction in tax liability in the amount $(Q_1-Q_2)*t_0$ (the bottom green rectangle). For the remaining quantity of cigarettes that a smoker continues to consume, the tax liability increases in the amount $Q_2*(t_1-t_0)$ (top green rectangle) (Figure 2.1).

Figure 2.1 Effects of increasing tobacco taxes, unique consumer type



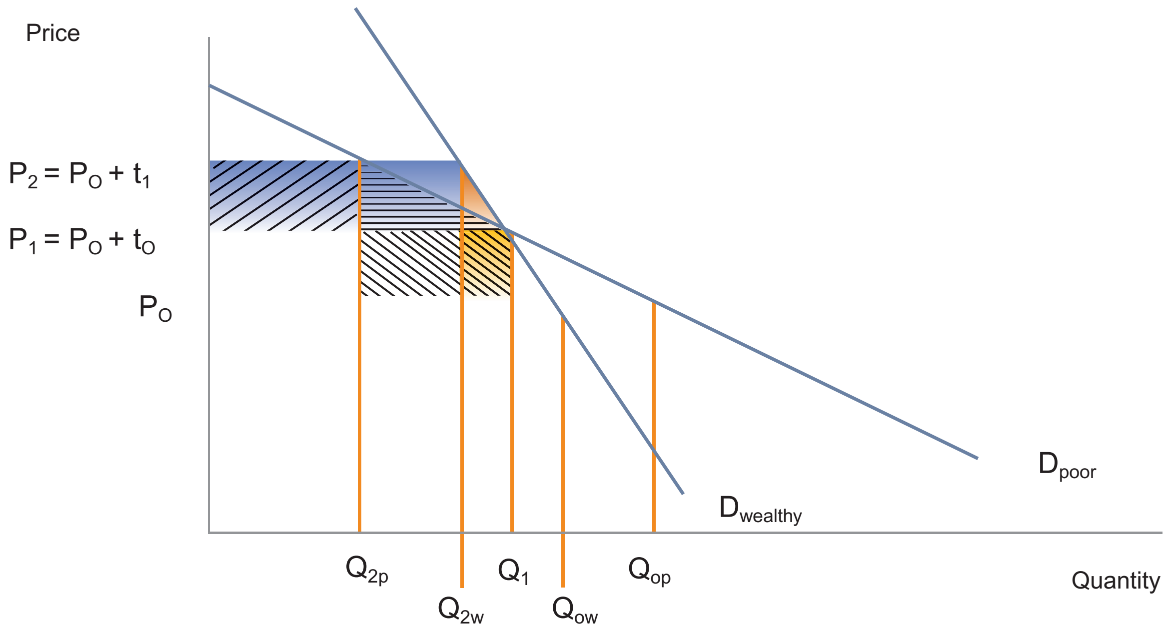
According to the welfare-based definition, tax progressivity is determined based on the consumer's willingness to pay for a good or service, which reflects its value to the consumer. With a tax increase, the consumer's welfare is reduced for two reasons. First, the consumer spends more per cigarette unit purchased after the tax increase, and second, the smoker consumes fewer cigarettes due to the higher price, considered "lost enjoyment" (blue triangle in Figure 2.1). So, the total loss in consumer surplus equals $Q_2*(t_1-t_0) + ½(Q_1-Q_2)*(t_1-t_0)=½(Q_1+Q_2)*(t_1-t_0)$ (Figure 2.1), which is an indicator of the consumer welfare loss (Colman & Remler, 2008).

Thus, the difference between the "ability to pay" approach (or the accounting approach) and the "willingness to pay" based approach (or welfare approach) is that the former ignores the loss in consumer surplus due to reduced consumption (blue triangle in Figure 2.1), while the latter ignores the value of income no longer spent on cigarettes due to reduced consumption (bottom green rectangle in Figure 2.1). For a historical discussion of the "ability to pay" based approach (or the accounting approach) and the "willingness to pay" based approach (or welfare approach), as well as additional discussion of the implications of using different definitions of tax burden, see Remler (2004).

When Warner (2000) states that increasing tobacco taxes can have a progressive impact because poor smokers are more responsive to price increases than richer smokers, he seems to be considering gains related to smokers paying less (as they reduce their consumption). The effect of higher tobacco taxes depends on the elasticities of demand for both the "ability to pay" based approach (or the accounting approach) and the "willingness to pay" based approach (or welfare approach). Based on the "ability to pay" approach, for a change in the cigarette tax to be progressive, $(Q_1-Q_2)*t_0$ must be large and $Q_2*(t_1-t_0)$ must be small for lower-income consumers, which in turn requires the low-income consumers' consumption to be relatively more elastic than that of higher-income consumers (Figure 2.2). For illustrative purposes, assume that before the tax increase all consumers, regardless of their income level, consumed the same quantity of cigarettes Q_1 at the same price P_1. Additionally, assume that the demand among lower-income consumers (D_{poor}) is more elastic than among higher-income consumers ($D_{wealthy}$).

After the tax increase by (t_1-t_0), the lower-income consumer will have a reduction in tax liability in the amount (Q_1-Q_{2p})*t_0 due to reduced consumption and an increase in tax liability in the amount Q_{2p}*t_1 for the cigarettes that they continue to consume. For the higher-income consumer, the corresponding reduction in tax liability equals (Q_1-Q_{2w})*t_0, and the increase in liability is Q_{2w}*(t_1-t_0). Since (Q_1-Q_{2w})*t_0 is significantly lower than (Q_1-Q_{2p})*t_0, and Q_{2w}*(t_1-t_0) is significantly larger than Q_{2p}*t_1, the increased tax on cigarettes shifts part of the burden from the lower-income to the higher-income consumer. Based on the welfare approach, since Q_{2w}>Q_{2p}, the higher-income consumer has a greater loss in consumer surplus ½ (Q_1+Q_{2w})*t_1 than the lower-income consumer ½ (Q_1+Q_{2p})*t_1.

Figure 2.2 Effects of increasing tobacco taxes, lower and higher-income consumers



However, to determine whether a tax change is progressive or not, it is necessary to consider the consumer's income, their sensitivity to the price change, and the percentage of income they spend on cigarettes. The share of tobacco spending tends to be higher among the poor compared to the rich, but that is an empirical question. The greater the share of total income spent on cigarettes, the greater the tax burden, but also the greater the welfare loss from increased expenses due to a tax increase. A consumer whose spending on cigarettes represents a small share of their income is relatively less impacted than the consumer who spends a larger share of their income. So, even the lower-income consumer may have a smaller net loss in consumer surplus than the higher-income consumer, whether the tax change is progressive or not.

2.4 Critiques of the welfare approach

As with any economic model, under a traditional welfare analysis, assessment of an intervention's economic benefits is mostly defined by the assumptions. While the traditional economic theory described above is reasonable when assessing the economic impact of regulations on many consumer goods, it can result in inaccurate estimates of a policy's effect when applied to the analysis of tobacco products. This is due to the market failures caused by addiction and imperfect and asymmetric information as well as the presence of externalities.

The most controversial issue in applying conventional economic theory and measurement tools to the economic analysis of addictive behaviors is how to measure the reduction in consumer surplus or the benefit that smokers receive when they smoke. Consumer surplus is measured by the gap between a consumer's willingness to pay for tobacco products and the price they pay when considering a specific public policy—in this case, a tax increase. Economists have been very critical of the "lost consumer surplus" approach in the case of tobacco products, See for example Chaloupka et al. (2015), where the authors list the problems with the way this theoretical approach treats tobacco like any other consumer product.

The consensus is that the traditional methodology is not appropriate for analyzing a public policy's impact on tobacco products. Most smokers do not find smoking "pleasurable" and derive little "consumer surplus" from smoking. Instead, most continuing smokers are avoiding the withdrawal symptoms they would experience if they were able to stop smoking and break the addiction that most regret having ever started. Indeed, Gruber and Mullainathan (2005) find that the self-reported happiness of potential smokers rises when cigarette taxes are increased. This is consistent with quitting causing an increase, rather than a reduction, in consumer surplus. Pechacek et al. (2018) find that most current smokers report high or very high discontent due to their inability to quit, perceived addiction, and regret having started to smoke in the first place.

It is commonly accepted that the decision to initiate smoking before the legal age of smoking is irrational. This is illustrated by laws regulating youth access to tobacco products. When considering how to treat lost consumer surplus in this type of economic impact analysis, the consensus is that benefits to those who started using tobacco products regularly before the legal age—and who quit in response to regulatory actions—should not have any offset for lost consumer surplus. The conventional use of consumer surplus as a measure of smokers' benefit may apply to a small subset of smokers, but that subset represents no more than 20 percent of smokers. That small subset of smokers includes those who started smoking as adults, are well-informed about the consequences of smoking, have no desire to quit, and were induced to quit by a tobacco control policy against their will (Chaloupka et al., 2015).

These limitations of the welfare approach result in a substantial underestimation of the net benefits of tobacco control regulation. This approach may be better considered as a lower bound for how tobacco control regulation impacts society.

Conclusion

This chapter explains the two most important concepts for the analysis of the distributional impact of tobacco taxes: fairness and progressivity. While there is an agreement that taxes should be applied equitably, not all scholars agree on what makes a tax fair. Whether a tobacco tax is progressive or regressive depends on responsiveness to price changes and the initial smoking prevalence of different socioeconomic groups. The empirical evidence has predominantly shown that lower-income households are relatively more sensitive to price increases via taxes than their wealthier counterparts. Poorer households also tend to spend a disproportionately larger share of their income on tobacco. Hence, lower income households reduce their consumption more significantly and experience a relatively smaller increase in tax burden after the price increase compared to wealthier smokers. Moreover, due to a relatively larger reduction in consumption, lower-income households experience significantly larger reductions in medical costs for treatment of tobacco-attributable diseases and larger reductions in lost earnings due to morbidity and premature mortality, among other benefits linked to improved health outcomes.

3 Evaluating distributional impacts using the accounting approach

The tax incidence analysis (or accounting approach) estimates the change in the allocation of the tobacco tax burden among households or individuals as a result of higher tobacco product prices (via higher taxes) while ignoring the impact of the behavioral response to the tax and price change. This chapter presents technical guidance on how this analysis can be done using household expenditure survey (HES) data. This method only compares the before- and after-tax payments for tobacco consumption. It does not account for any losses or benefits of reduced consumption due to higher taxes, such as lower health expenses or increased productivity.

By ignoring the behavioral responses to tax increases and health benefits from reduced consumption, economists have traditionally argued that tobacco taxes, like other indirect taxes, are regressive. However, some authors have challenged this view and show that—even when the impact of the behavioral response is ignored—the tax increase can be progressive or tobacco taxes can become less regressive (Verguet et al., 2021). This impact particularly depends on the price responsiveness of different income groups. As most studies find that lower-income groups are relatively more sensitive to price increases, an increase in tax and price would lead to a relatively larger reduction in consumption among poorer individuals and households, resulting in a relatively lower increase or even a reduction of their tax burden.

This chapter presents detailed technical guidance on analyzing the distributional impacts of tobacco tax using tax incidence analysis with HES data. The technical guidance is illustrated through a case study. An alternative method that includes behavioral responses to a tax increase and considers the impact of those losses and benefits is analyzed in Chapter 4.

3.1 Data requirements and sources

The three most important pieces of information required for evaluating the distributional impact of a tobacco tax increase using the tax incidence analysis are: price (and income) elasticity of quantity demanded, spending on tobacco and quantity consumed by an individual or household, and structure of the price of tobacco before and after the tax increase. Elasticity estimates by income group may either be adopted from the previous reliable studies for a specific country or can be estimated using available data. This section briefly discusses various sources of data that can be used to estimate elasticities and conduct a tax incidence analysis.

3.1.1 Household expenditure survey (HES) data

Household expenditure surveys (HES) are sample surveys of households which are asked to provide information on their estimated spending and quantity purchased of different goods and services during a certain time period, known as the recall or reference period. These surveys are also called household budget surveys or household consumption surveys. Household surveys provide socioeconomic data used to derive important indicators to inform various development policies. In addition to national HES, which are funded by national budgets and conducted regularly mostly by national statistics agencies, there are HES that are sponsored by different international organizations and mostly conducted on an ad hoc basis. An example of a household survey conducted by international organizations in low- and middle-income countries is the Living Standards Measurement Study (LSMS), conducted by national statistics agencies with technical assistance from the World Bank. The first LSMS was conducted in 1985 in Cote d'Ivoire and Peru, and LSMS has been carried out in more than 40 low- and middle-income countries since that time.

Commonly, microdata from national HES—which are needed for any advanced econometric analysis—are not publicly available, but can be obtained upon request from the national agencies in charge of conducting the survey, usually for a fee. The LSMS microdata, however, is publicly available on the World Bank website free of charge. The drawback of LSMS is that it is only available for a limited number of countries and for a very limited number of years. Another potential resource is the International Household Survey Network (IHSN), a catalog of more than 1,000 HES from more than 200 countries, from which certain publicly available metadata can be downloaded.

HES are commonly designed based on a census, where all households are randomly selected with an equal probability. Usually, the selection of households consists of two stages. In the first stage, clusters of households—referred to as the primary sampling units (PSU)—are randomly selected according to administrative regions, such as counties or municipalities. In the second stage, households—known as the second-stage units—are randomly selected from each PSU. While not very common in HES, if there is a third stage of selection, these are called the third-stage units, usually individuals. Whichever is the last stage of selection, the units selected in that stage are referred to as the ultimate sampling units.

In addition to the demographic and socioeconomic characteristics of households—such as the number of household members, their gender, age, education level, and employment status—HES data typically provides detailed information on the households' expenditures and purchased quantities during the reference period. This information includes details on the household expenses and assets and often, on the quantity consumed of either all or some goods and services. Some HES provide information on tobacco products separately, sometimes both on spending and quantity. In other cases, tobacco product information is combined into a larger group with other products, such as alcohol. In these cases, it is very difficult to conduct any econometric analysis on tobacco using HES data. On the other hand, HES in some countries include not only disaggregated data on tobacco but also information on various types of tobacco products, such as cigarettes, bidis, and smokeless tobacco in the Indian National Sample Survey (NSS) or on kretek and "white" cigarettes in the Indonesian National Socioeconomic Survey (SUSENAS).

Based on information about the households' socioeconomic status (SES), econometric analysis can be conducted by SES group. While the information on income is sometimes provided in HES, it can also be estimated by proxy via the sum of all reported spending during the reporting period. This information is necessary for analyzing the distributional impacts of tobacco taxes.

When using HES data in econometric analysis, various econometric issues need to be addressed due to the design of HES. These issues and ways to resolve them have been discussed in great detail by Deaton (1997) and summarized by John et al. (2022). In addition, John et al. (2022) present detailed technical guidance on estimating prevalence and conditional elasticities of demand by income group using HES data.

3.1.2 Other sources

Various surveys with individuals as respondents provide information on tobacco consumption. One such survey is the Global Adult Tobacco Survey (GATS), which has been conducted by the Centers for Disease Control and Prevention (CDC) and WHO in about 25 countries since 1999. GATS is a nationally representative cross-sectional survey of adults aged 15 and older, and has been conducted in several waves in some countries.

The objective of GATS is to collect comparable data on adult tobacco use and key tobacco control indicators. It provides information on current smoking participation (current smoker, former smoker, never smoker) and smoking frequency (daily, less than daily) as well as self-reported spending on tobacco products, the quantity of tobacco consumption, and prices per unit of tobacco product. It also includes data on self-reported income, although the question on income often has a high nonresponse rate. A problem with individual self-reported data is the potential underreporting of consumption. Studies have dealt with this issue by assuming that the underreporting is proportional to the respondents' actual level of consumption, which implies that the estimated effects are not systematically biased. WHO (2010) provides technical guidance on estimating the price elasticity of demand using GATS data.

Another survey that collects individual-level data on tobacco consumption and socioeconomic characteristics is the International Tobacco Control (ITC) Policy Evaluation Project. The ITC Project was created in 2002 at the University of Waterloo and has been conducted in 29 countries using telephone and/or web interviews in high-income countries and face-to-face interviews in low- and middle-income countries.

One limitation of using individual-level data in a distributional impact analysis is that it may provide only information on the income of the respondent but not on the total household income, which is generally a better measure of the financial well-being of a household and each of its members.

3.2 Microsimulation

To estimate the distributional impact of tobacco tax using tax incidence analysis, one needs the price and income elasticities of demand by income group. These can be either adopted from other studies or estimated using either HES or individual-level data. For guidance on estimating price and income elasticities of demand by income group, see John et al. (2022). For simplicity, this section will present steps of microsimulation in the case of cigarettes, but the same approach applies to any other type of tobacco product.

To compare the tax burden before and after the tax change, one needs to know the structure of tax on cigarettes in the country for which the analysis is done. Assuming the simplest case, where a uniform specific tax in the amount of τ_{esp} per unit of cigarettes and a value-added tax (VAT) of τ_{vat} percent of the retail price is levied, the structure of the retail price p_{cig} is

$$p_{cig} = p_{not} + \tau_{esp} + p_{cig} * \tau_{vat}$$

$$p_{cig} = \frac{p_{not} + \tau_{esp}}{1 - \tau_{vat}} \quad (3.1)$$

where p_{not} is the net-of-tax cigarette price. Note that VAT liability is calculated by multiplying the VAT rate with the value added. However, to express VAT as percent of retail price,

$$\tau_{vat} = \frac{VAT\ rate}{1 + VAT\ rate}.$$

In a slightly more complex case, where, in addition to the uniform specific tax and VAT, a uniform ad valorem tax of τ_{eav} percent of retail price is levied, the structure of the retail cigarette price p_{cig} is

$$p_{cig} = p_{not} + \tau_{esp} + p_{cig} * \tau_{eav} + p_{cig} * \tau_{vat}$$

$$p_{cig} = \frac{p_{not} + \tau_{esp}}{1 - \tau_{eav} - \tau_{vat}} \quad (3.2)$$

If the tax system is even more complex, with a multitier tax structure instead of uniform, the expression of price structure is not straightforward and depends on the details of the tax structure.

Assuming a simple case of a uniform specific and ad valorem tax, the following steps explain the microsimulation procedure for analyzing the distributional impacts of an excise tax change.

Step 1: Expressing the percentage change in price as a percentage change in tax

While price elasticity shows the percentage change in quantity demanded q_{cig} as a result of a percentage change in price p_{cig}, one first needs to know how much the price would change if the tax changes by a certain percentage. Assuming a case when only the specific tax is increased by *t* percent and assuming, for simplicity, that tax is fully shifted to the consumers (i.e., full pass-through) and there is no change in the cost of production (i.e., p_{not} is constant), based on equation (3.2) the difference between the new price p^*_{cig} and the old price p_{cig} is

$$p^*_{cig} - p_{cig} = \frac{t}{1 - \tau_{eav} - \tau_{vat}} * \tau_{esp} \quad (3.3)$$

In other words, *t* percent increase in specific excise tax translates to

$$\frac{p^*_{cig} - p_{cig}}{p_{cig}} = \frac{t}{1 - \tau_{eav} - \tau_{vat}} * \frac{\tau_{esp}}{p_{cig}} \quad (3.4)$$

which is the percent increase in the retail sale price of cigarettes, assuming full pass-through, no change in the cost of production, and ad valorem excise tax rate and VAT rate.

Thus, the new total excise tax per unit of cigarettes, as a percent of the post-tax retail price, is

$$\tau^*_{cig} = \frac{\tau_{eav} * p^*_{cig} + (1+t) * \tau_{esp}}{p^*_{cig}} \quad (3.5).$$

In the case of an increase in an ad valorem tax by *t* percentage points, assuming all else remains constant, the formula for the retail price increase is

$$\frac{p^*_{cig} - p_{cig}}{p_{cig}} = \frac{t}{1 - (\tau_{eav} + t) - \tau_{vat}} \quad (3.6)$$

and the new total excise tax per unit of cigarettes, as a percent of the post-tax retail price, is

$$\tau^*_{cig} = \frac{(\tau_{eav} + t) * p^*_{cig} + \tau_{esp}}{p^*_{cig}} \quad (3.7).$$

Ideally, one would calculate the price increase for each individual or household in the survey. However, information on self-reported price and brand of cigarettes would be necessary to properly apply the statutory rates from the tax schedule. In addition, one would need a list of market prices by cigarette brand. For each brand, the price increase would be calculated based on the assumed increase in tax. The estimated price increase by brand would, then, be merged with the individual data based on the reported brand. While certain surveys, such as GATS, may provide such information, HES does not include information on market price.

Where information on market price and brand is available for each individual in the survey, p_{not} should be calculated first as

$$p_{not} = p_{cig} * (1 - \tau_{eav} - \tau_{vat}) - \tau_{esp} \quad (3.8).$$

Then, based on information from the tax code, the assumption on the tax increase (either specific or ad valorem or both) by tier, the change in the VAT rate, and tax-shifting, the new price would be calculated for each individual.

Because this calculation is not possible with HES data, it is simplest to assume a uniform price increase for all households (for example, equal to the increase in price of the most-sold brand) calculated as in (3.4). This approach is not without limitations, since the price increase would be relatively larger for households who smoke cheaper brands and smaller for people who smoke more expensive brands. Alternatively, an increase in weighted average price can be used, where market share by the brand is used as a weight, should such data be available.

Step 2: Calculating tax paid by each household on cigarette purchases before tax increase

Based on equation (3.2), the total excise tax *e*, expressed as the percentage of retail price, is

$$\tau_{cig} = \frac{\tau_{eav} * p_{cig} + \tau_{esp}}{p_{cig}} \quad (3.9).$$

In other words, τ_e is the percent of the price per pack of cigarettes that is paid as an excise tax. This also means that τ_e is the percent of a household's spending on cigarettes that represents the tax payment.

Using τ_e from equation (3.9), cigarette excise tax liability τ_{hcig} before the tax increase for each household is calculated as

$$\tau_{hcig} = \tau_e * x_{hcig} \quad (3.10)$$

where x_{hcig} is spending on cigarettes by household *h* before the tax increase.

Step 3: Estimating the quantity demanded after the tax increase

To estimate the new demanded quantity of cigarettes after *t* percent increase in tax, the resulting percent increase in cigarette price, $\frac{t}{1-\tau_{eav} - \tau_{vat}} * \frac{\tau_{esp}}{p_{cig}}$ from equation (3.10), is assumed for each household.

By applying price elasticity $\mathcal{E}_p$ with pre-tax-increase cigarette quantity demanded q_{cig} and expected price increase, the post-tax-increase quantity of cigarettes q^*_{cig} is estimated for each household.

Step 4: Estimating the post-tax-increase tax liability

By multiplying the new quantity q^*_{cig} by the new price p^*_{cig}, new spending on cigarettes x^*_{hcig} is calculated.

Then, the new excise tax liability is calculated by multiplying the new effective excise tax rate τ^*_{cig} from Equation (3.5) by new spending on cigarettes x^*_{hcig}.

Step 5: Calculating pre- and post-tax-increase tax burden for each household

The pre-tax-increase tax burden for each household B_{hcig} is

$$B_{hcig} = \frac{\tau_{cig} * x_{hcig}}{x_h} \quad (3.11)$$

where τ_{cig} is the effective excise tax rate, x_{hcig} is spending on cigarettes by household h before the tax increase, and x_h is total household spending over an observed period (a proxy of household income).

After the tax increase, the corresponding tax burden equals

$$B^*_{hcig} = \frac{\tau^*_{cig} * x^*_{hcig}}{x_h} \quad (3.12).$$

In this case, for simplicity, it is assumed that household income does not change.

Step 6: Calculating average pre- and post-tax-increase burden by income group

Before-tax-increase and after-tax-increase average tax burden by income group is, respectively, calculated as

$$B_{cig_g} = \frac{1}{n_g} \sum_{h=1}^{n_g} B_{hcig} \quad (3.13)$$

and

$$B^*_{cig_g} = \frac{1}{n_g} \sum_{h=1}^{n_g} B^*_{hcig} \quad (3.14)$$

where g represents the income group.

Whether the analysis is done by terciles, quintiles, or deciles depends on its objective and the country context, but also on the size of the survey data sample used to estimate the elasticities. For example, since price elasticity estimated using the Deaton method depends on the number of clusters (i.e., the consistency property), the smaller the number of households per cluster, the higher the measurement error. As Deaton addresses potential endogeneity in price variables by using cluster-average price, the smaller the number of households per cluster, the less likely is the problem of endogeneity addressed. See John et al. (2022) for a detailed discussion. In addition, even in cases where the survey sample is large enough to have even ten income groups, the difference in the estimated elasticities may not be economically and/or statistically significant.

Step 7: Comparing the distribution of tax burden pre- and post-tax increase

In a progressive tax system, B_{cig_g} increases with income. So, if $B_{cig_1} < \cdots < B_{cig_g}$, one can conclude that before the tax change, the tax system was progressive.

If after the tax change, the system is still progressive (that is, $B^*_{cig_1} < \cdots < B^*_{cig_g}$, one can analyze whether there are any changes in the level of progressivity based on the change in the tax burden for each income group. For example, if the absolute difference between B_{cig_1} and $B^*_{cig_1}$ is smaller than the difference between B_{cig_2} and $B^*_{cig_2}$, and both are smaller than the difference between B_{cig_3} and $B^*_{cig_3}$, one can conclude that the system became more progressive.

3.3 Case study: Georgia

This section presents a case study of analyzing distributional impacts using tax incidence analysis in Georgia with Household Income and Expenditure Survey (HIES) data for 2017. The analysis uses price elasticities of demand by income group estimated for illustration purposes using 2002–2017 HIES data (Table 3.1). To isolate the distributional impact of a tax increase, it is assumed that income (total household spending) does not change. However, this assumption can be changed to also account for a change in income using income elasticities estimated with the same code as for price elasticities by income group.

Table 3.1 Total price elasticity of demand for tobacco by income group

	(1) Low-income	(2) Middle-income	(3) High-income
Prevalence elasticity	-0.271***	-0.211***	-0.199***
Intensity elasticity	-0.339*	-0.0120	0.00545
Total price elasticity	**-0.610**	**-0.211**	**-0.199**

Source: Authors' calculations based on the Georgia Household Income and Expenditure Survey (2017)

As price elasticity of smoking prevalence ε_{pp} and smoking intensity ε_{pc} are separately estimated, total price elasticity ε_p is calculated by adding them together. Since the price elasticities of smoking intensity for the middle- and high-income groups are not statistically significant, they are not taken into account in calculating the total price elasticity. As expected, the highest total elasticity is estimated for the low-income group and the lowest for the high-income group.

To demonstrate the microsimulation procedure of analyzing the impact of a tax increase on a change in tax burden by income group, the tax change is first translated to a change in price. It would be ideal to have information on the brands of cigarettes consumed by each individual or household and their tax and price structures. However, HES data do not provide such information. Therefore, for simplicity, the tax structure and price of the most-sold brand in Georgia are considered. In 2017, the price of the most-sold brand of cigarettes in Georgia was 3.70 Georgian Lari (GEL) (Table 3.2). Georgia levies both specific and ad valorem taxes on cigarettes. In 2017, the specific tax per pack of 20 cigarettes was 1.70 GEL, while the ad valorem tax was ten percent of the retail price. In addition, the VAT rate was 15.3 percent, which corresponds to 13.3 percent when expressed as a percent of the retail price. As a result, in 2017 the share of excise tax in retail price was 55.9 percent, while the share of total tax (excise and VAT) was 69.2 percent.

In **Step 1**, the tax change is translated to a change in price. Increases in specific and ad valorem taxes differently impact the price increase. If a specific tax is increased by ten percent (from 1.70 GEL to 1.87 GEL per pack) and nothing else is changed (Scenario 1), the retail price would increase by six percent (from 3.70 GEL to 3.92 GEL per pack). As the ad valorem tax is a percent of the retail price, the amount of ad valorem tax would also increase. In Scenario 2, the same increase in price is achieved by increasing the ad valorem tax rate from ten percent to 14.35 percent (that is, a 4.35 percentage point (pp) increase) and no change in the specific tax.

Table 3.2 Structure of retail price in 2017 and scenarios for tax increase

	Baseline	Simulation			
	2017	Scenario 1 (10% specific tax increase)		Scenario 2 (4.35 pp valorem tax increase)	
	GEL	GEL	% change	GEL	% change
Most-sold brand price	3.70	3.92	6.0%	3.92	6.0%
Specific tax	1.70	1.87	10.0%	1.70	0.0%
Ad valorem (10%)	0.37	0.39	6.0%	0.56	52.1%
VAT (15.3%)	0.49	0.52	6.0%	0.52	6.0%
Net-of-tax price	1.14	1.14	0.0%	1.14	0.0%
Excise tax as % of retail price	55.9%	57.7%		57.7%	
Total tax as % of retail price	69.2%	71.0%		71.0%	

Source: Authors' calculations based on World Bank (n.d.)

As shown in Table 3.4, a ten-percent increase in the specific excise tax would result in a six-percent increase in the price of the most-sold brand, assuming nothing else changes. In other words, the price increase equals

$$\frac{p^*_{cig} - p_{cig}}{p_{cig}} = \frac{0.1}{1 - 0.1 - 0.133} * \frac{1.7}{3.7} = 0.06\ .$$

The resulting share of post-tax-increase cigarette excise tax in retail price is 57.7 percent, from

$$\tau^*_{cig} = 0.1 + \frac{1.1 * 1.70}{3.92} = 0.577.$$

Next, the pre-tax-increase tax payment on cigarettes for each household τ_{hcig} is calculated (**Step 2**) by simply multiplying the pre-tax share of excise tax in retail price (55.9 percent) with spending on cigarettes reported by each household x_{hcig}.

In **Step 3**, the post-tax-increase quantity demanded q^*_{cig} is estimated by applying the respective total elasticity $\mathcal{E}_p$ to each household assuming a six-percent price increase.

Once the new quantity demanded is estimated, it is possible to estimate the post-tax increase in cigarette spending x^*_{hcig} and tax payment on cigarette purchases for each household τ^*_{hcig} (**Step 4**).

After the tax payment on cigarette purchases before and after the tax increase is calculated for each household, it is possible to calculate the pre- and post-tax-increase tax burden, B_{hcig} and B^*_{hcig}, respectively (**Step 5**). To isolate the distributional impact of a tax increase, it is assumed that income (total household spending) does not change, so the denominator would be equal in both equations (i.e., pre- and post-tax increase). However, this assumption can be changed to also account for a change in income using income elasticities.

From the household-level tax burden, the average tax burden by income group is easily calculated (**Step 6**). One can compare the distribution of tax burden by income group pre- and post-tax increase to analyze the impact of the tax. However, before proceeding with the comparison of the tax burden, it is useful to see some descriptive statistics by income group, since that may help with understanding the estimated tax burden before and after the tax increase. As Table 3.3 shows, in 2017 the percentage of households with smokers (smoking prevalence) and quantity of cigarettes consumed (smoking intensity) were lower among the low-income households than among their high-income counterparts. Despite that, the average share of spending on cigarettes in total household spending was almost 50 percent higher among low-income than high-income households with smokers. Table 3.3 also shows a decrease in smoking prevalence and an increase in smoking intensity across all income groups between 2002 and 2017. While the low and the middle-income group have seen almost no real growth in income over this period, there was an increase in the budget shares dedicated to purchasing cigarettes, the highest share for the low-income group.

Table 3.3 Selected descriptive statistic

	2002			2017		
	Low-income	**Middle-income**	**High-income**	**Low-income**	**Middle-income**	**High-income**
Total expenditure (GEL)	4,129	7,078	11,093	4,204	7,079	12,267
Expenditure per household member (GEL)	966	1,860	3,927	995	1,901	4,512
Expenditure on cigarettes (GEL)	357	496	606	635	873	1,127
Expenditure on cigarettes (% of total expenditure)	7.5%	6.5%	5.3%	13.8%	11.0%	9.3%
Households with smokers (%)	28.4%	37.9%	44.1%	20.4%	27.3%	32.1%
Quantity of cigarettes	224	282	301	230	293	341

Source: Authors' calculations based on the Georgia Household Income and Expenditure Survey (2017)

Table 3.4 shows that in 2017 before the tax increase (Column 1) the burden of the cigarette excise tax was just slightly progressive, as the difference in tax burden between the low- and high-income groups was less than 0.3 percentage points. After a ten-percent tax increase (Column 2), the tax burden for all income groups increased, although not significantly, due to a small tax/price increase. Column 3 shows the simulated impact of a 50-percent tax increase, which translates to a 30-percent increase in price. The increase in tax burden is highest for the high-income group (0.15 percentage points for the ten-percent tax increase and 0.64 percentage points for the 50-percent tax increase) and lowest for the low-income group (between 0.12 and 0.34 percentage points, depending on the tax increase).

Although very slightly, the tax increase strengthened the progressivity of the tobacco excise tax, since after the ten-percent tax increase the difference in tax burden between the low- and high-income groups is 0.26 percentage points (0.56 percentage points for the 50-percent tax increase). In other words, a ten-percent tax increase raised the tax burden by 7.6 percent, 5.9 percent, and 8.0 percent for the low-, middle-, and high-income groups, respectively. Keeping in mind the distribution of smoking prevalence and average smoking intensity by income group (Table 3.3), it is not surprising that the simulated impact of the tax/price increase is so small, as the low-income group, which is the most responsive to the price increase, has the lowest smoking prevalence and smoking intensity.

Table 3.4 Estimated tobacco tax burden by income group, before and after the tax increase

	Before tax increase	After tax increase	
		10% tax increase	50% tax increase
	(1)	(2)	(3)
Low-income	1.557%	1.675%	1.893%
Middle-income	1.589%	1.683%	2.135%
High-income	1.812%	1.958%	2.455%

Source: Authors' calculations based on the Georgia Household Income and Expenditure Survey (2017)

As explained above, these estimates of tax burden assume no change in income. Depending on the change in income for different households in different income groups and their respective expenditure elasticity of tobacco consumption, the estimated tax burden for each group may change, impacting the resulting distributional impacts of the tobacco excise tax.

3.4 Conclusion

This chapter provides detailed technical guidance for analyzing the distributional impacts of a tobacco tax, including guidance on how to conduct a microsimulation using price elasticities of demand to evaluate the impact of a tobacco tax increase on the tax burden. A case study presenting the impact of a hypothetical uniform tobacco tax increase in Georgia concludes the chapter. The results show that as the lower-income groups are relatively more responsive to a price increase, a tax increase can lead to the tax becoming more progressive since the lower-income group would have the lowest increase in tax burden.

4 Evaluating distributional impacts using ECBA

The extended cost-benefit analysis (ECBA) estimates the short-, medium-, and long-term impacts of a cigarette price change on net disposable income. ECBA presents a partial equilibrium incidence analysis that incorporates differential price responsiveness for different income groups to analyze the change in available income (short-term effect), reduction in health care costs (medium- to long-term effect), and the increase in income resulting from reduced tobacco-related disease (long-term effect). The purpose of this analysis is to determine whether an increase in the tobacco tax rate that translates into an increase in the price of cigarettes would be progressive or regressive considering the welfare effects of the reduction in tobacco consumption.

ECBA accounts for the effect of increased taxes on direct costs imposed on the immediate spending capacity of smokers, but also it includes the well-known health and economic effects that smoking entails, resulting in large benefits to current and potential smokers, governments, and society. Hence, ECBA aims to quantify the economic mechanisms that translate an increase in tobacco taxes to costs and benefits to households, including those that materialize in the medium- to long-term. Those mechanisms are summarized below. While data and empirical limitations do not allow for identification and quantification of all mechanisms in every country, researchers can adapt this theoretical framework to suit the specific circumstances and data availability of their case study.

The ECBA methodology is also related to other methodologies for the evaluation of policy interventions (BOX 4.1) (Pichon-Riviere et al., 2013; Pichon-Riviere, 2015; Verguet et al., 2015; Fuchs & Meneses, 2017).

Box 4.1 Extended cost-effectiveness analysis (ECEA) versus extended cost-benefit analysis (ECBA)

Cost–effectiveness analysis (CEA) and cost–benefit analysis (CBA) are related tools for policy evaluation. Similarly, extended cost-effectiveness analysis (ECEA) and extended cost-benefit analysis (ECBA) are related.

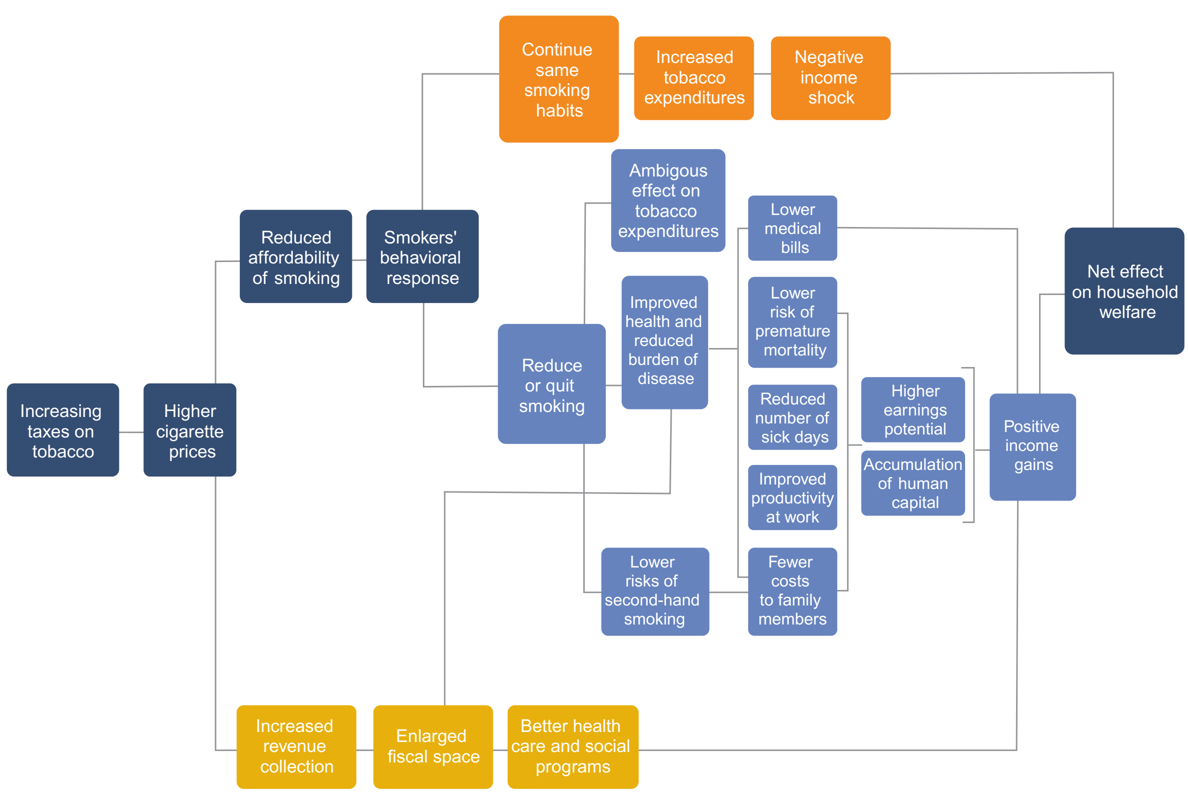
- CEA relates the costs of implementing a public policy to its key outcomes. In other words, CEA examines both the costs and health outcomes of one intervention and compares the results with the pre-intervention scenario (or an alternative intervention) by estimating how much it costs to gain a unit of a health outcome, like a life-year gained or a death prevented.
- CBA compares costs of implementing a public policy to the value of its key outcomes. In other words, cost-benefit analysis is a way to compare the costs and benefits of an intervention, where both are expressed in monetary units.

Both CEA and CBA compare the costs of implementing a public policy with the outcomes, including health outcomes, and both analyses have been reviewed and extended to incorporate additional factors.

- ECEA builds on CEA by including the effect of the intervention on financial risks (intervention may reduce financial risks), the effect on direct expenditures (intervention may crowd out expenditures), and distributional impacts (intervention may have different impacts across the wealth distribution).
- ECBA builds on CBA by including the effect of an intervention on financial risks (intervention may reduce financial risks) and the accumulated medium- and long-term expenditure effects of an intervention. ECBA approach considers the distributional impact across different income groups providing a sense of the potential income effects of implementing an intervention.

Unlike ECEA, it is not the intention of ECBA to provide a measure of the effectiveness of an intervention nor to compare alternative interventions. However, the income effects obtained using ECBA—and their contributions to potentially reduce poverty and the risks of impoverishment due to catastrophic health expenditures—can potentially be used in cost-effectiveness ratios and for comparison purposes under an ECEA framework. In addition, ECBA does not incorporate the public costs from tax implementation and administration.

Figure 4.1 Framework of ECBA: Costs and benefits for household welfare



Source: Adapted from Postolovska et al. (2018)

Under ECBA, the net effect of the tax increase can be either positive or negative for each income group. The magnitude of the effect reflects the impact of the higher tax on income or welfare.

The distribution of the effects across income groups matters as well. In line with distributional incidence analysis, the results of ECBA are expressed in relative terms, as a share of (average) household income. Hence, the analysis across groups shows whether the tobacco tax increase concentrates the costs and benefits more heavily on poorer households or wealthier segments of the population, relative to their income. If the effects of increasing taxes on available income show a negative slope across income groups, that means the tax increase has a progressive effect, as the larger gains accrue to lower-income groups, while a positive slope across income groups means that the upper-income households receive larger benefits relative to their incomes.

ECBA provides a more comprehensive and evidence-based evaluation of the consequences of tobacco tax policies on the future well-being of different groups of the population, with a special focus on the poor. On the other hand, ECBA represents a partial equilibrium approach, which does not incorporate other relevant effects of increasing tobacco taxes. ECBA does not incorporate distributional or second-round effects of the use of additional revenues by governments, nor does it consider how consumers spend their income after the introduction of the tax policy (that is what would be their income after paying tobacco taxes but also after receiving economic benefits from reduced smoking). ECBA also ignores other indirect effects, such as the health and economic effect from a reduction in exposure to second-hand smoke, potential household benefits from increased public expenditure resulting from the higher tax revenues, etc.

This chapter begins with a description of the data required and then presents the technical steps for conducting ECBA. It concludes with a case study.

4.1 Data requirements and sources

The empirical application of ECBA uses HES data as the main input and complements other sources of mainly administrative information to integrate different channels through which taxing tobacco products can affect welfare in the short-, medium-, and long-term. The data set needs a variable that maps each household to a specific income group, which can be done with the Stata command *xtile.* This distributes the population into equally sized income groups. For ECBA all households (including smokers and non-smokers) are considered for the definition of the income level.

4.1.1 Price elasticity by income level

Price elasticity is crucial in defining and calibrating the estimation because it determines the sensitivity of demand to a change in tobacco prices. Consumers respond to price increases by adjusting their consumption choices. When the price increases, individuals may consume a lower quantity of cigarettes. There are two key relationships: 1) between tobacco price elasticities and income; and 2) between tobacco price elasticities and age. People from low-income groups tend to have more elastic demand than those from middle- and higher-income groups. At the same time, younger population groups are also relatively more responsive to tax increases because they tend to be less affected by addiction and more affected by peer effects. At the same time, they have less disposable income. Individuals are more or less sensitive to price changes depending on the characteristics of the product as well as other characteristics, including available income, gender, and age. With either individual- or household-level data, one can estimate elasticities by income group and use the results as inputs for ECBA (see John et al., 2022). However, when the calculation of price elasticities of tobacco products is not possible, ECBA can be implemented using elasticities by income group already available in the literature.

After a tax and price increase, some smokers may quit, others may reduce consumption, and yet others may continue consuming the same number of cigarettes. ECBA considers the monetary impact in terms of available income of increasing tobacco taxes for a certain group of the population. For example, to evaluate the impact of the tax increase on low-income groups, one should consider the effect on smokers as well as non-smokers. That can be done by using total price elasticity, which is the sum of prevalence elasticity and conditional elasticity:

$$\varepsilon = \varepsilon_{pc} + \varepsilon_{pc} \ .$$

The elasticities can be saved in a separate .dta file and merged with the HES data, using the command:

```
merge m:m xtile using "${data}elasticities.dta", nogen
```

In the previous line the directory path is defined as a global path. Stata allows other alternatives, for example using a cd command to define the working directory. The user can also create a new variable and replace the price elasticity for each income group. For example, considering cigarette price elasticity:

```
gen elast1=.
replace elast1=-1.065 if inc==1
replace elast1=-0.235 if inc==2
replace elast1=-0.076 if inc==3
```

or using the elasticity from Table 3.1:

```
gen elast2=.
replace elast2=-0.610 if inc==1
replace elast2=-0.211 if inc==2
replace elast2=-0.199 if inc==3
```

Alternatively, elasticities can be taken from the literature. In that case, elasticities by income group can be introduced to the data set using the data editor or importing into the data set from other file formats (check Swagel, 1994).

4.1.2 Tax and price structure

The impact of a tax increase on price depends on a series of factors, including the tax structure under consideration and the price level. When considering a differential tax structure with heterogeneous impacts on different income groups, the calculations and analysis are more complex. Most surveys do not include information on taxes paid by households or individuals. However, based on their reported spending on tobacco products, the excise tax paid by each individual or household can be calculated according to information from legislation on the structure of the tax system. See Chapter 3 for details.

ECBA can be estimated using the average price and average shock by income group or simulating the impact of the price increase and the shock for each household. When a survey collects price data, the simulation can use reported prices to simulate the heterogeneous impact. Considering the assumptions described in Chapter 3, the same analysis can be extended to unit values. The simplest case is assuming a shock that increases cigarette prices for the entire population homogenously.

An example of a uniform price shock across the population:

```
gen  shock =.06
```

This results in a six-percent price increase for all brand price categories (uniform shock) ΔP.

Some studies (e.g. Fuchs, Gonzalez Icaza, & Paz, 2019) have incorporated differential price increases by income group by introducing multiple shocks, depending on the income group and the tax structure considered. Assuming that lower-income groups purchase lower-priced tobacco, increasing the specific excise would result in a higher tax burden (as a percentage tax increase) for poorer smokers but lower relative price increases for wealthier households. However, assuming different prices by income group introduces endogeneity into the model, given that income is one factor in determining a brand choice.

For example:

```
gen shock = .
        replace shock    = 1     if inc==1
        replace shock    = .5    if inc==2
        replace shock    = .36   if inc==3
    tab shock */tab shock
```

This would assume a 100-percent price increase for those smokers in income group one, a 50-percent price increase for those smokers in income group two, and a 36-percent price increase for those smokers in income group three.

4.1.3 Medical expenses

Quantifying the health costs of tobacco use can be a highly complex task. Various categories of health costs have been used in the literature, depending on the applied calculation methodology and the goals of the studies. While there are several categories of health costs resulting from tobacco use, the most common classification used in empirical studies distinguishes between direct and indirect costs. The direct costs of tobacco use refer to the monetary value of goods and services consumed as a result of tobacco use and related illness, and they consist of health care costs (such as physicians' and other service fees, medical supplies, and medicines) and non-health care costs (such as transportation and food supplements). ECBA captures the reduction in medical expenses as a result of a tax increase. ECBA also considers indirect costs, such as the cost of productivity loss related to morbidity and premature death linked to tobacco consumption.

Direct health care expenditures related to smoking are traditionally modeled as a function of the smoking-attributable fraction (SAF) of disease, utilization rates of health services, and average cost per unit of utilization. A detailed explanation exceeds the scope of this document, but users can refer to Vulovic (2019) for a summary discussion on the estimation of tobacco-related medical expenditures.

The preferred source of information for ECBA is a reliable estimate of country-specific medical costs from the national government agency, academia, WHO, or the World Bank's World Development Indicators (WDI). If the estimate of smoking-attributable medical costs is not available, it can be estimated by multiplying the total medical costs with SAF, which represents the proportion of a total outcome (for example, total health care costs) attributable to past and current tobacco use. SAF considers current and former smoking prevalence and the relative risk (RR) of mortality and morbidity due to tobacco-related disease incurred by current and former smokers in comparison to never smokers (see WHO, 2011) for more details). SAF can also be proxied based on the data from the Global Burden of Disease (GBD) database for most countries, as the ratio of tobacco-attributable deaths to total number of deaths.

One may find national estimations of direct medical expenses from household surveys, previous literature, or other administrative records. The best source of information for ECBA is a reliable estimate of country-specific medical costs. However, in many cases, such data is not easily accessible, in which case alternative sources may be used. Goodchild et al. (2018) estimate the total economic cost of smoking-attributable diseases worldwide. Using linear regression analysis, they estimated the SAF for countries with missing information. With this method they estimated the smoking-attributable health expenditure (SAHE) and total economic cost attributable to smoking for 125 countries (representing 97 percent of the world's smokers). Table 4.1 summarizes the information for selected countries with the highest prevalence of tobacco use. In the absence of country-level information, the SAHE estimations can be an alternative source to implement ECBA. One limitation from using figures from this study is that SAF is estimated using regression analysis and it may not be as accurate compared to country-specific calculations and inputs.

Understanding the country-specific context is essential to accurately approximate and determine which medical expenses to include. Those costs can be paid out of pocket (OOP) by patients and their families or financed through public or private insurance schemes. Depending on the country context, users may choose to include the entirety of medical expenses linked to tobacco consumption, regardless of the financing source, in ECBA. Alternatively, ECBA can be calculated using the fraction of out-of-pocket expenses only. In cases where data on tobacco-specific OOP expenses is not available, users can

Table 4.1 Tobacco-attributable economic costs in selected countries

	Country classification, exchange rate, and smoking-attributable death (SAD) rate				Smoking-attributable health expenditure (SAHE)			Total economic cost attributable to smoking	
	Income group	WHO region	PPP$ rate	SAD rate	PPP$ (millions)	NCU (millions)	THE (%)	PPP$ (millions)	NCU (millions)
Bangladesh	LIC	SEAR	24.7	255	884	21,819	6.7%	6,426	158,578
Brazil	UMIC	AMR	1.5	143	16,955	25,722	6.1%	48,140	73,031
China	UMIC	WPR	3.5	137	24,320	85,463	3.0%	111,721	392,591
India	LMIC	SEAR	15.9	112	8,369	133,198	3.5%	114,276	1,818,691
Indonesia	LMIC	SEAR	3,700.0	245	4,075	15,075,983	6.0%	172,752	639,173,131
Mexico	UMIC	AMR	7.7	65	5,345	40,982	4.3%	7,450	57,127
Pakistan	LMIC	EMR	25.3	128	694	17,539	3.2%	5,666	143,208
Philippines	LMIC	WPR	17.9	200	1,290	23,060	4.9%	15,062	269,326
Ukraine	LMIC	EUR	3.7	331	2,357	8,605	8.2%	12,509	45,668
Viet Nam	LMIC	WPR	7,314.4	228	1,333	9,749,871	5.0%	11,568	84,610,753

Note: PPP$ Rate = Purchasing power parity exchange rate, SAD rate = smoking-attributable death rate per 100,000 population, PPP$ = international dollars in millions, NCU = national currency units in millions, THE = total health expenditure, GDP = gross domestic product. HIC = high income country, UMIC = upper-middle income country, LMIC = lower-middle income country, LIC = low-income country. AFR = African Region, AMR = Region of the Americas, EMR = Eastern Mediterranean Region, EUR = European Region, SEAR = South-East Asia Region, WPR = Western Pacific Region.
Source: Authors' calculations based on Goodchild et al. (2018)

approximate it by the share of OOP expenses in all medical expenses, which is available for several countries from the WDI database. When assessing the costs of tobacco-related medical expenses distributed across income groups, ECBA does not consider the age group for which the medical expenses are computed nor how they are attributed to households with different adult/children distributions. However, ECBA methodology can be adapted, recognizing possible under- or over-estimation biases and interpreting the results accordingly.

The final step includes allocating the total tobacco-attributable costs to income groups. The costs of tobacco-related medical expenses can be distributed across income groups of the HES according to the share of households that report positive purchases of tobacco in each income group. The costs of tobacco-related medical expenses are distributed across income groups proportionately to the number of households that consume tobacco per income group.

4.1.4 Years of working life lost (YWLL)

Another source of indirect health costs incorporated in ECBA is the value of lost earning potential or productivity due to disability and mortality related to smoking. ECBA estimates the impact of a tax increase on a household's available income as a result of a longer and more productive life—that is, the income gains derived from the increased number of working years or reduction in years of working life lost (YWLL). ECBA considers annual household income obtained from survey data. In case household income is obtained from other indicators, for example, average wage or GDP per capita, other variables such as labor force participation or the proportion of children and adults should be also considered. If available, information on the disability-adjusted working years of life lost (DALYs) incorporates the negative effects of tobacco on household incomes via both mortality and disability.

The estimated lost earnings from reduced working life due to tobacco consumption are used to estimate the change in income. This calculation requires country-specific data on smoking-attributable deaths, which is used to calculate the years of life lost. This data can be obtained from national health authorities or sources such as the GBD database. While the simplified calculation of YWLL requires smoking-attributable mortality data by age groups only, additional productivity adjustments due to smoking-related morbidity of current workers can be incorporated (for example, gender-specific data) if data allows. The GBD publishes data on the number of death events by causes (diseases) that are related to the risk of smoking. Data are disaggregated by age group (in five-year cohorts) and gender.

One way to calculate YWLL is to assume a retirement age (for example, 65 years) as the end of the working life. Any premature death before that age implies a loss in labor income for the household. Hence, the YWLL estimates are obtained by multiplying the distance between the age at premature death and the 65-year cap by the number of smoking-attributable death events for that age and gender. The sum of all products for both genders represents the country's total years of working life lost due to smoking-attributable deaths.

For example, Fuchs Tarlovsky and Gonzalez Icaza (2020) use an ECBA to assess the welfare and distributional effects of raising taxes on cigarettes in Georgia. The authors use data from the GBD to calculate that close to 7,000 smoking-attributable premature deaths among Georgians in 2017 translate to forgone incomes from 28,822 YWLL (Table 4.2).

Ideally, one would use data on YWLL for different income groups in the population. Nonetheless, such disaggregation is unlikely to be available. Hence, to estimate the increase in working years by income group, the total tobacco-attributable years of life lost are distributed across income groups proportionately to the number of households that consume tobacco per income group.

Finally, when data on morbidity is available, it can also be incorporated into ECBA. DALYs are calculated as the sum of the years of life lost (YLL) due to premature death and the years lost due to disability (YLD) caused by a specific health condition or its consequences, in this case, tobacco consumption. Data on DALYs attributed to the risks of smoking can be found from the GBD database. By combining DALYs and retirement age, it is possible to obtain a measure of the reduction in productive years considering premature

Table 4.2 YWLL, by age group and gender, Georgia 2017

Age group	Retirement age (all)	Average years until retirement	Smoking-related deaths			YWLL		
			Males	Females	All	Males	Females	All
30 to 34	65	33	34	3	37	1,122	99	1,221
35 to 39		28	74	5	79	2,072	140	2,212
40 to 44		23	143	9	152	3,289	207	3,496
45 to 49		18	270	16	286	4,860	288	5,148
50 to 54		13	505	34	539	6,565	442	7,007
55 to 59		8	763	56	819	6,104	448	6,552
60 to 64		3	972	90	1,062	2,916	270	3,186
All before retirement			2,761	213	2,974	26,928	1,894	28,822
All after retirement			3,413	413	3,826	N/A	N/A	N/A
Total			6,174	626	6,800	26,928	1,894	28,822

Note: Retirement is assumed at age 65 for both males and females. Only death events related to the risk of smoking are considered, while the risks of second-hand smoke and chewing tobacco are not.
Source: Calculations based on data from the GBD 2019

death and time spent disabled by tobacco related disease (the medical condition and how it affects a person is weighted to indicate the level of disability, so one DALY is equal to one year of healthy life lost). For example, Cruces et al. (2020), Divino et al. (2020), del los Ríos et al. (2020) and Macías Sánchez et al. (2020) estimated ECBA for Argentina, Brazil, Peru, and Mexico, respectively, using data produced by Instituto de Efectividad Clínica y Sanitaria (IECS).

4.2 Estimating the distributional impact

This section describes the main steps involved in conducting an ECBA for a tobacco tax increase. Researchers planning to estimate price elasticity by income group are advised to first read John et al. (2023). ECBA mainly consists of four steps to estimate the change in available income as a result of a price increase.

Step 1: Setting up the analysis

First, data on tobacco consumption, total household consumption (which is also a proxy for total income), sociodemographic characteristics, and sampling design data are retrieved from the microdata. This information is complemented with other data on tobacco-attributable medical expenses and mortality. Policy scenarios such as the expected price increase are also defined at this stage.

Step 2: Identifying the change in tobacco consumption patterns

To estimate the variation in cigarette consumption after the price increase, this step considers the change in prices (ΔP_j) and the tobacco price elasticity (ε_j) for each income group. ECBA estimates the impact of a price change resulting from a tax change.

* Change in quantity of tobacco consumed

```
gen q_ch_1= shock*elast1
gen q_ch_2 =shock*elast2
```

Step 3: Estimating a change in tobacco expenditures (A)

To transform the variation in cigarette consumption into a variation of tobacco-related spending, this model includes the initial expenditure patterns for household *i* in each income group at time 0. The change in cigarette expenditure is presented as a share of income (or, alternately, total expenditure as a proxy for income). The change in tobacco expenditures for household *i* in income group *j* can be estimated using the price elasticity for each income group as in Equation (4.1),

$$\Delta \text{ Cigarette expenditure}_{i,j} = ((1+\Delta P)\left(1+\varepsilon_j * \Delta P\right) - 1) * \frac{\text{Cigarette expenditure}_{i,j,0}}{\text{Total expenditure}_{i,j,0}} \tag{4.1}$$

where *Cigarette expenditure*$_{i,j,0}$ is the cigarette expenditure in period 0 (before the tax increase) for household *i* in income group *j* and *Total expenditure*$_{i,j,0}$ is the total household expenditure on period 0 (before the tax increase) for household *i* in income group *j*.

Considering income-specific elasticities, Equation (4.1) allows for estimation of the change in cigarette expenditures for household *i* in income group *j*.

*(A). Change in cigarette expenditures

```
gen expend_d=(1-(1+$)*(1+q_ch_medium))*(cigexp_hh/aggr_hh)*100
gen expend_s=(1-(1+$)*(1+q_ch_lower))*(cigexp_hh/aggr_hh)*100
```

* Average effect by income group

```
mean expend_d expend_s [w=popweights], over(xtile)
```

To quantify the welfare impact for each income group, the average impact is quantified across all households within income groups. The command <mean expend_d expend_s [w=popweights], over(xtile)> stores the average variation on expenditure as result of the price shock. As this line includes popweights, this average is weighted to be representative of the population.

Step 4: Estimating a change in tobacco-related medical expenses (B)

Equation (4.2) estimates the income gains associated with reduced medical expenses after an increase in tobacco prices. As before, household *i* in income group *j* faces a price increase ΔP and the income-specific elasticity ε_j.

$$\Delta \text{ Medical expenses}_{i,j} = ((1 + \varepsilon_j * \Delta P)\text{-}1) * \frac{\text{Cost of treating tobacco}-\text{related diseases}_{i,j,0}}{\text{Total expenditure}_{i,j,0}} \qquad (4.2)$$

where *Cost of treating tobacco related diseases*$_{i,j,0}$ is the medical expenses for treating diseases related to tobacco in period 0 (before the tax increase) for household *i* in income group *j*. Equation (4.2) allocates the costs of tobacco-related medical expenses across income groups proportionately to tobacco consumed. Equation (4.2) is also presented as a share of total expenditure to show the percentage loss relative to original expenditure.

A negative result in Equation 4.2 conveys a reduction in medical expenses, hence a gain to disposable income for a household. In the case that medical expenses associated with tobacco consumption are not available by income group, the aggregate costs of tobacco-related medical expenses can be distributed across income groups by considering the weight of each income group among all tobacco-consuming households (i.e., the relative share of different household income groups among all tobacco-consuming households).

*(B) Change in medical expenses

* Identify total medical expenses related to smoking

```
gen med = <scalar> // here the user writes the medical expenses*
Allocate medical expenses across income groups
egen smoker_I =sum(smoker*hhweights) // smoker is a binary
variable, =1 for households with smokers, =0 otherwise
bys inc: egen smoker_i=sum(smoker*hhweights)
gen smoker_w =smoker_i/smoker_I
gen medicalexp_i=med_exp * smoker_w
```

* Effect on income from reducing tobacco-related medical expenses

```
gen med_d =-((q_ch_1 * medicalexp_i)/exp_i)*100
gen med_s=-((q_ch_2 * medicalexp_i)/exp_i)*100

table inc [w = int(popweights)], c(mean med_d mean med_s)
```

Step 5: Estimating a change in potential earnings linked to the YWLL (C)

Under ECBA, changes in consumption have a direct effect on reducing tobacco-related premature deaths. In this fifth step, the reduction in forgone income for household *i* in income group *j* as result of a price increase is translated into an increase in income.

$$\Delta \text{ Income lost}_{i,j} = ((1 + \varepsilon_j * \Delta P)\text{-}1) * \frac{\text{Years of working life lost}_i * \text{Income}_{i,j,0}}{\text{Total expenditure}_{i,j,0}} \qquad (4.3)$$

Where *Years of working life lost*$_i$ is the YWLL to tobacco-related diseases for household *i* and *Income*$_{i,j,0}$ is the yearly income for household *i* in income group *j* on period 0 (before the tax increase).

As explained above, in case YWLL data is not available by income group, the country-aggregate data may be distributed across income groups proportionately to the number of households that smoke tobacco in each income group.

* Identify total YWLL related to smoking

```
gen YWLL = <scalar>// here the user writes the number of YWLL
```

* Allocate YWLL across income groups, relative to share of smoker households

```
bys inc: egen i_pop=sum(popweights)
gen YWLL_i= YWLL*(smoker_w/i_pop)
```

* Effect on income from reducing the YWLL

```
gen YWLL_d =-((q_ch_1* YWLL_i)* exp_i / exp_i)*100
gen YWLL_s=-((q_ch_2 * YWLL_i)* exp_i / exp_i)*100

table inc [w = int(popweights)], c(mean YWLL_d mean YWLL_s)
```

Step 6: Calculating the net income effects (A) + (B) + (C)

In this step, ECBA calculates the net income effect for each income group. This involves adding up the components of Equation (4.1), (4.2), and (4.3) by income group.

* Net effect = Change in tobacco expenditures + Reduced medical expenses + Reduced YWLL

```
gen net_d=expend_d+med_d+YWLL_d // Using elasticities1
gen net_s=expend_s+med_s+YWLL_s // Using elasticities2

table inc [w = int(popweights)], c(mean net_d mean net_s)
```

This step involves important consideration around present and future incomes. A reduction in tobacco consumption is strongly related to a decline in the incidence of tobacco-related diseases in the medium and long run. However, in equation 4.2, the *Cost of treating tobacco related diseases*$_{i,j,0}$ is the total value of medical expenses associated with tobacco consumption in the current year of analysis. Hence, ECBA assumes that the health effects of tobacco-related diseases will immediately diminish with the reduction in tobacco consumption. Although this assumption is implausible in the short term because changes in the effects of tobacco-related diseases take time to materialize, this simplified approach provides an estimate of the effects of tax increases in the medium to long term.

In case of Equation 4.3, the numerator *Years of Working Life Lost*$_i$**Income*$_{i,j,0}$ is the net present value of future household income that would be lost if tobacco consumption remains unchanged. As the tax induces a reduction in tobacco consumption, households would increase their expected incomes by preventing premature deaths related to smoking. Similar to the case of reduced medical expenses, the reduction in YWLL represents a medium- to long-term effect, due to potential lags in translating tobacco cessation or consumption to mortality incidence.

There are two relevant considerations in estimating the value of YWLL. First, ideally, the empirical estimation would use the labor-specific incomes for each household. In practice, HES only provide proxies of labor incomes, such as total income or expenditures. As all components of ECBA are expressed relative to the household income (or consumption) aggregate, this would imply the same variable would be in the numerator and denominator. Hence, the division simplifies to 1 and seems redundant. As the code is presented for the general case, the code leaves the explicit terms, in case some application/researcher can come up with a 'better' variable of household labor incomes.

Second, the valuation of forgone household incomes that are prevented by reducing smoking should be a present value. The choice of an appropriate discount rate is not trivial. Hence, users may choose to simulate different scenarios and discount rates to discount future flows in present values. Alternatively, a simplified version of ECBA where household incomes are not discounted would assume that households' valuation of money is uniform across time.

Step 7: Presenting ECBA results – plot incidence curves

ECBA results are commonly presented by incidence curves, which plot the average effect of increasing the price of cigarettes by income group. Incidence curves present the effect of the cigarette price increase on net income (as a proxy for welfare) for different population groups. Hence, the distributional effects of a tax change can be observed from the incidence curves by observing which income group will benefit most (in relative terms) from the tax increase. The population is divided and ranked by income groups, according to a measurement of household per capita income. The tax incidence curves express the two main ECBA results: the magnitude and the distribution of the effect of increasing taxes across income groups.

4.3 Case study: Georgia

This section provides step-by-step guidance to implement an ECBA using microdata from Georgia. As described in Chapter 3, data are gathered from the Household Income and Expenditure Survey (2017). The presented Stata code for the estimation of ECBA is applied to the case of a cigarette tax increase.

The code provided in the Appendix is used to obtain the results presented in this section. The underlying model and suggested code presented here correspond to the most basic version of an ECBA and can be adjusted based on data availability.

The data set needs a variable that maps each household to an income group. The population can be distributed into equally-sized income groups (for example, ten deciles, five quintiles, or three terciles), according to the measurement of a variable that captures income. All the households (including smokers and non-smokers) are considered. This is easily done with the Stata command *xtile* and the survey population weights.

This example uses two sets of previously estimated price elasticities by income, one of which is presented in Table 4.3. The elasticities can be saved in a .dta file and merged with the Georgian microdata using the following command:

```
use "${data}hbs_microdata_2017.dta", clear
merge m:m xtile using "${data}elasticities.dta", nogen
```

Alternatively, one can create a new variable and replace the price elasticity for each income group, as in:

```
gen elast1=.
replace elast1=-1.065 if inc==1
replace elast1=-0.235 if inc==2
replace elast1=-0.076 if inc==3
```

or using elasticities from Table 3.1:

```
gen elast2=.
replace elast2=-0.610 if inc==1
replace elast2=-0.211 if inc==2
replace elast2=-0.199 if inc==3
```

Alternatively, elasticities can be taken from the literature. In that case, elasticities by income group can be introduced in the data set using the data editor or importing into the data set from other file formats (check Swagel, 1994).

As an example, the analysis is set up (**Step 1**) as a uniform percentage price increase for all the income groups, considering differential cigarette price elasticities for different income groups.

In **Step 2**, the change in tax and price is translated to a change in tobacco consumption. To show the effect of the elasticities on prices, Table 4.5 presents the absolute effect on cigarette consumption (**Step 3**).

Consumption changes that arise from an increase in cigarette prices would reduce the absolute consumption relatively more for the lower-income group. For instance, in the case of the first set of cigarette price elasticity estimates, the low-income group would reduce cigarette consumption by 6.4 percent, the middle-income group by 1.4 percent, and the high-income group by 0.5 percent. In the same fashion, with the second set of cigarette price elasticities, the low-income group reduce cigarette consumption by 3.7 percent, the middle-income group by 1.3 percent, and the high-income group by 1.2 percent.

Table 4.3 Variation in cigarette consumption after a six-percent increase in cigarette prices, Georgia 2017

	Using elasticity 1 (1)	Using elasticity 2 (2)
Low-income	-0.064	-0.037
Middle-income	-0.014	-0.013
High-income	-0.005	-0.012

Source: Authors' calculations based on the Georgia Household Income and Expenditure Survey (2017)

Across the three income groups, increasing tobacco taxes reduces consumption, as expected by the estimated negative price elasticities of demand. For the income groups that reduced consumption less than proportionally, that results in an increase in cigarette expenditures and represents a decrease in available income. This direct effect can be seen as a welfare loss because consumers would devote a higher share of their incomes to purchase cigarettes, thereby reducing the consumption of other goods. The only exception

Table 4.4 Change in tobacco expenditures after a six-percent increase in cigarette prices, Georgia 2017

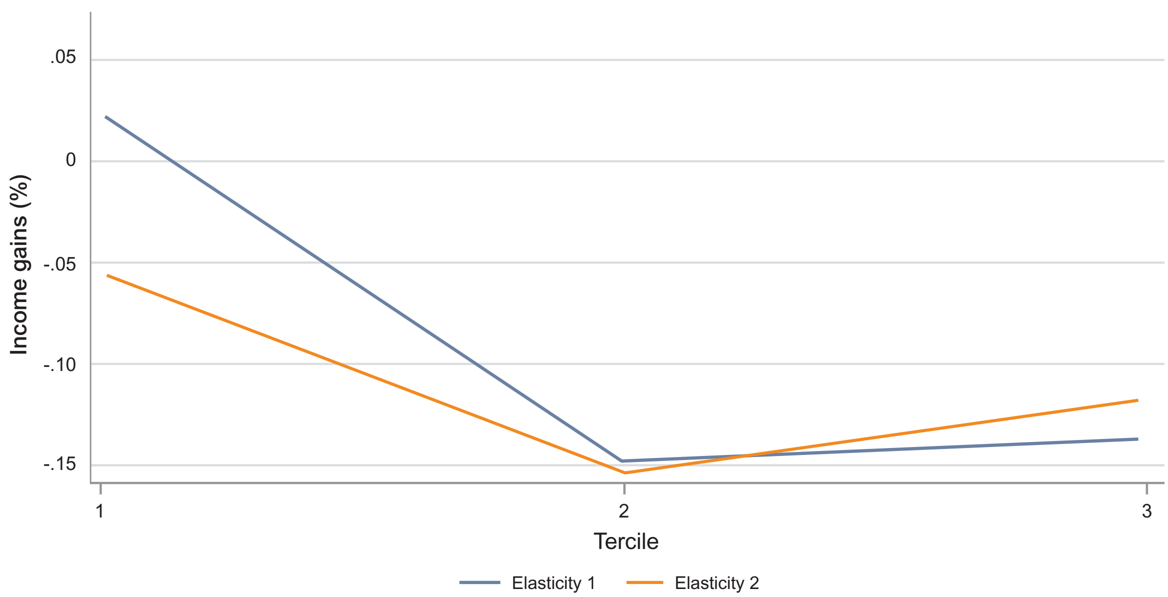
	Using elasticity 1			Using elasticity 2		
	Low-income	Middle-income	High-income	Low-income	Middle-income	High-income
Mean	0.021	-0.147	-0.135	-0.057	-0.152	-0.116
Std. Err.	0.000	0.000	0.000	0.000	0.000	0.000
[95% CI]	0.021 0.021	-0.147 -0.146	-0.136 -0.135	-0.057 -0.057	-0.152 -0.151	-0.117 -0.116

Source: Authors' calculations based on the Georgia Household Income and Expenditure Survey (2017)

is the lower-income group when price elasticity 1 is used. In that case, the lower-income group shows a positive 0.02-percent income gain (Figure 4.2). The estimation of the change in tobacco expenditures (Step 4) shows a clear progressive effect for Georgians, because the lower-income groups lose proportionally less of their income: the lower-income group loses 0.05 or gains 0.02 percent, while the higher-income group's available income decreases between 0.12 and 0.14 percent.

Despite the U-shaped distribution, the impact for middle-income (tercile two) and high-income (tercile three) groups in the case of using elasticity 1 shows a that terciles two and three have a very similar impact (relatively flat loss) in available income (Figure 4.1).

Figure 4.2 Welfare and distributional effects: Direct expenditure effect of tobacco taxes (increase in expenditure because of tobacco taxes)



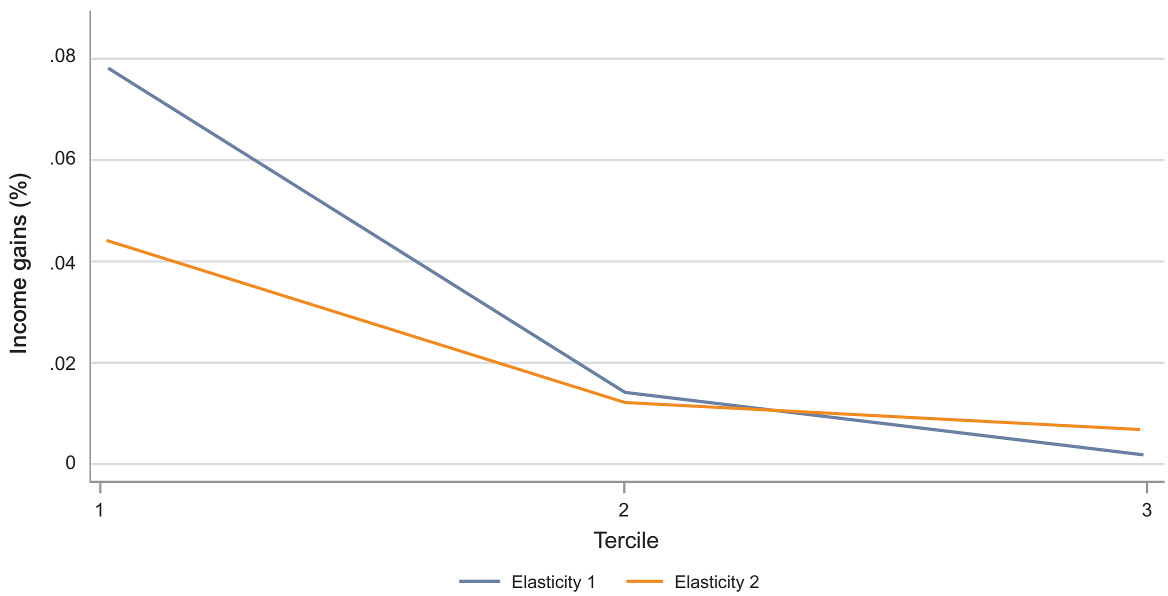
Source: Authors' own estimation using a price shock of six percent

2 Based on estimates from 2012 by Goodchild et al. (2018), adjusted for annual inflation.

Step 4 requires estimating the change in tobacco expenditures. The total smoking-attributable health expenditures in Georgia were estimated at 80.8 million GEL in 2017.[2]

Figure 4.3 reports the income gains derived from the reduction in medical expenses for each income group. The reduction in tobacco consumption would have a positive effect on income through the reduction in medical costs. The income gains would vary between 0.04 and 0.02 percent in the case of using elasticity 1 and between 0.05 and 0.01 percent with elasticity 2 (Figure 4.3). No matter the elasticity assumptions, variations across income groups are consistent.

Figure 4.3 Welfare and distributional effects from reduced consumption

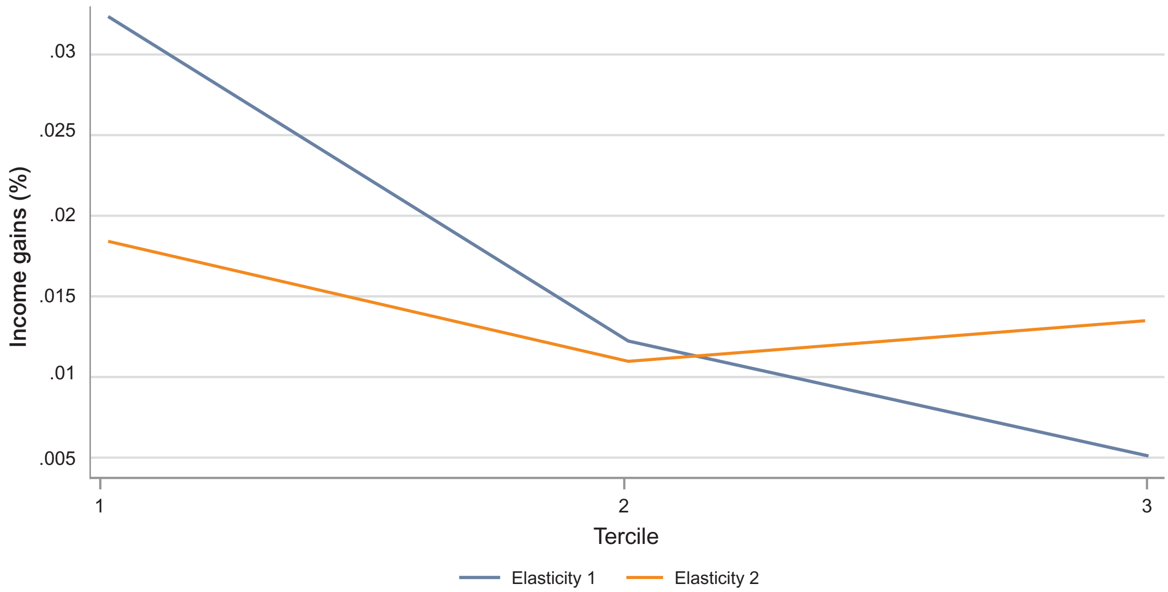


Source: Authors' own estimation using a price shock of six percent

The cost of years of working life lost because of tobacco consumption for each income group (**Step 5**) is calculated using the age pattern of mortality and estimating the years of life lost. Using GBD data, 7,000 smoking-related premature deaths among Georgians in 2017 can be translated to forgone income during 28,794 years of working life lost (YWLL).

The welfare effect is then estimated using elasticities by tercile group. In the case of Georgia, for each death the number of potential years of work are calculated, and the lost working years are divided across the income groups according to the share of all smokers placed in each income group. Using equation 4.3 and Table 4.2, the lower-income group would increase their available income by 0.03 or 0.02 percent, while the higher-income group's available income would increase between 0.005 and 0.01 percent, depending on the price elasticity assumption. Despite the elasticity assumptions, income gains as result of a longer productive life show a progressive pattern. (Figure 4.4).

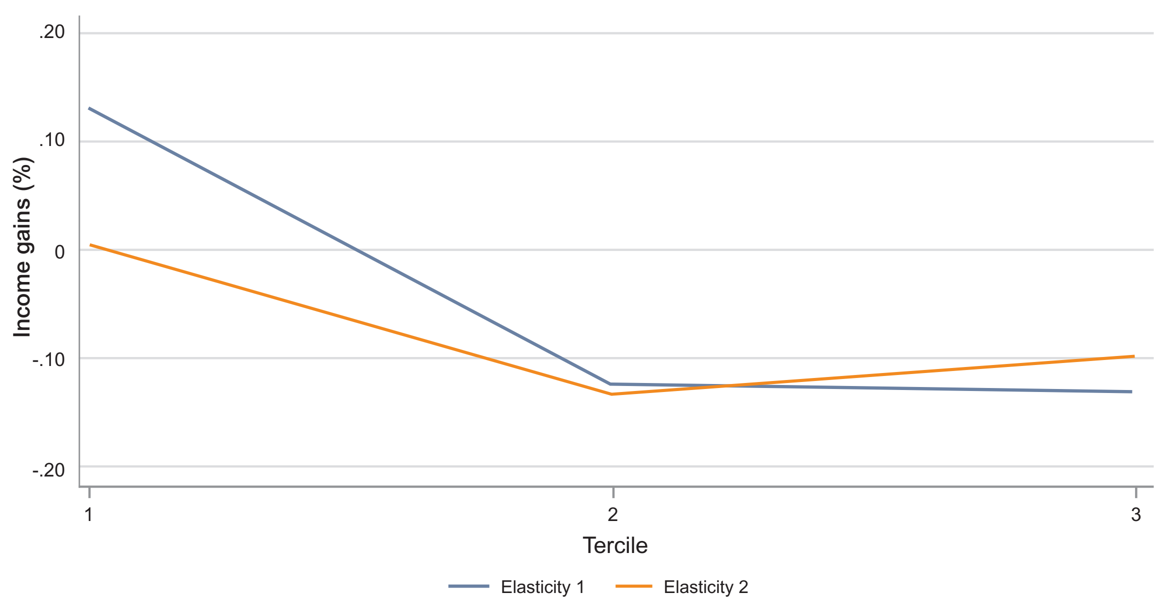
Figure 4.4 Welfare and distributional effects: Reduced years of working life lost (YWLL)



Source: Authors' own estimation using a price shock of six percent

Step 6 implies calculating the net effect of the tax increase in terms of household income. In ECBA, that implies adding the direct price effect, the reduced medical expenses, and the reduced YWLL. The simulated tax-induced price change in Georgia has a progressive impact on income, resulting in net positive income gains for the lower-income group (between 0.13 and 0.006 percent) and a net negative income change for the higher-income groups (terciles two and three, between 0.13 and 0.10 percent). Figure 4.5 demonstrates the net income effect of higher cigarette prices, showing the incidence curves for Georgia by adding components (A) + (B) + (C).

Figure 4.5 Net income effects (A) + (B) + (C)



Source: Authors' own estimation using a price shock of six percent

The net effects in Georgia are small in magnitude, but they provide evidence that raising taxes on cigarettes can contribute to increasing household incomes and reducing inequality in the medium to long term. When using price elasticity 1, the lower-income group increases its expenditure on tobacco products. However, when using price elasticity 2, the expenditure on tobacco products decreases. Also, income gains as a result of lower medical costs and reduced YWLL are lower due to smaller expected reductions in consumption. Despite these differences, the overall impact is consistent: increasing tobacco taxes in Georgia has progressive effects. For all the income groups, an increase in cigarette prices reduces tobacco consumption, reduces tobacco-related medical costs, and increases income (as a result of additional years of working life). Lower-income households reduce their consumption even more and capture larger benefits relative to their income level.

4.4 Caveats and limitations

Despite providing a more comprehensive approach based on economic theory and available empirical evidence, ECBA has limitations. ECBA is limited in its ability to incorporate important and possibly dynamic effects of taxing tobacco. First, several benefits for individuals and societies of reducing smoking are difficult to quantify in some contexts, including the effects of second-hand smoking, productivity losses among current workers, and even the intrinsic value of lives lost due to the harms caused by smoking. Second, the empirical application of ECBA captures a partial equilibrium model that incorporates only first-round effects. Increasing taxes on tobacco, however, can unleash second-round and dynamic effects that are difficult to predict. For example, consumer behavior changes can create economy-wide reactions, while behavior changes (elasticities) would likely change over time and for different magnitudes of the price shock.

4.5 Conclusion

This chapter presents a step-by-step process to apply the ECBA methodology for analyzing the impact of tobacco tax increases. ECBA methodology can assist researchers and policymakers to empirically estimate the distributional effects of increasing tobacco taxes. In the ECBA framework, the net income and distributional effects depend on the magnitude and distribution of price elasticities across income groups, as well as the initial consumption patterns (share of cigarette expenses) across the population. Additionally, the magnitude and distribution of the price shock are other key determinants of the net effect. Although the design and administration of tax structures are largely outside the scope of this toolkit, they have relevant implications for the welfare and equity effects. For example, higher prices as a result of specific tax increases would yield higher price shocks on cheaper brands, discouraging consumption of brands that may be mostly consumed by lower-income groups.

The Georgia case study presents a simplified example of a uniform price increase for all income groups. In line with many country studies applying the ECBA methodology, Georgia showcases that the medium- and long-term benefits of reducing smoking can outweigh the short-term costs of taxes, resulting in net income gains, particularly among lower-income groups (Fuchs & Meneses, 2017; Fuchs & Del Carmen, 2018; Fuchs, Del Carmen, & Mukon, 2018; Fuchs, Matytsin, & Obukhova, 2018; Fuchs & Meneses, 2018; Fuchs, Gonzalez Icaza, & Paz, 2019; Fuchs, Orlic, & Cancho, 2019; Fuchs, Marquez, et al., 2019; Mugoša et al., 2022; Zubović et al., 2022).

ECBA allows for a more comprehensive welfare and distributional analysis that often contradicts less sophisticated analyses which neglect behavioral changes or indirect health benefits of reduced smoking. For example, when only the direct effect is considered and a uniform elasticity is assumed, an analysis from Argentina shows that an increase in the price of cigarettes would be regressive, by disproportionally increasing the expenditure of the poorest households. However, as shown by another analysis from

Argentina, when considering the indirect effects and accounting for heterogeneity in sensitivities to price changes, an increase in the price of cigarettes actually improves income distribution (Cruces et al., 2020).

In practice, when lower-income households reduce smoking relatively more than wealthier smoking households as a result of tobacco price increases, they also experience the largest share of gains. When considering the sensitivity of each income group to price changes, the lowest-income groups reduce their spending on cigarettes the most. A price increase would benefit most the groups with the least resources, in terms of reductions in health care expenditures for treating tobacco-related diseases and creating additional earnings from more years of productive life.

Reduction in medical costs tends to be a significant component of net benefits under ECBA. In Chile, Peru, the Russian Federation and Ukraine, reducing medical expenses constitutes the largest long-term benefit of a tobacco price increase under ECBA model (Fuchs & Meneses, 2017; Fuchs, Matytsin, & Obukhova, 2018; de los Ríos et al., 2020). All income groups benefit from the reduction in medical expenses as taxes discourage smoking. However, reducing medical expenses often disproportionally benefits lower-income households, which tend to be more responsive to price changes in tobacco products. Similarly, examples in Bangladesh and Brazil also illustrate that increasing tobacco prices has large positive welfare gains associated with reductions in years of working life lost (Carmen et al., 2018; Divino et al., 2020). Increasing tobacco taxes has a progressive impact even when prevalence is higher among higher-income groups, such as in Kyrgyzstan (Postolovska et al., 2018) and Mexico (Macías Sánchez et al., 2020). In this case, price increases would result in positive welfare gains for all income groups, but the poorest experience the most benefits in the short, medium, and long term.

As in the Georgian example, a large number of case studies support the conclusion that increasing taxes on cigarettes is unlikely to generate regressive effects. Despite variation in the exact distribution of benefits, tobacco taxes tend to generate positive and progressive welfare gains, improving incomes of the poorest, and creating long-term benefits across societies.

References

Adioetomo, S. M., Djutaharta, T., & Hendratno. (2005). *Cigarette consumption, taxation, and household income: Indonesia case study* (Health, Nutrition and Population (HNP) discussion paper). World Bank. http://hdl.handle.net/10986/13737

Allcott, H., Lockwood, B. B., & Taubinsky, D. (2019). Regressive sin taxes, with an application to the optimal soda tax. *The Quarterly Journal of Economics, 134*(3), 1557–1626.

Awawda, S., Chalak, A., Khader, Y., Mostafa, A., Abla, R., Nakkash, R., Jawad, M., Salloum, R. G., & Abu-Rmeileh, N. M. (2022). Gender differences in the price elasticity of demand for waterpipe and cigarette smoking in Lebanon, Jordan and Palestine: A volumetric choice experiment. *BMJ Open, 12*(7), Article 7. https://doi.org/10.1136/bmjopen-2021-058495

Bernheim, B. D. & Rangel, A. (2004). Addiction and cue-triggered decision processes. *American Economic Review, 94*(5), 1558–1590. https://www.aeaweb.org/articles?id=10.1257/0002828043052222

Bosch, A. & Koch, S. F. (2014). *Using a natural experiment to examine tobacco tax regressivity* (Department of Economics Working Paper No. 2014-24). University of Pretoria Department of Economics. https://www.up.ac.za/media/shared/61/WP/wp_2014_24.zp39511.pdf

Braithwaite, V. (2002). A new approach to tax compliance. In V. Braithwaite (Ed.), *Taxing democracy* (pp. 1–11). Ashgate Publishing Ltd.

Carmen, G. D., Fuchs, A., & Genoni, M.E. (2018). *The distributional impacts of cigarette taxation in Bangladesh* (Policy Research Working Paper No. 8580). World Bank. http://hdl.handle.net/10986/30424

Chalak, A., Nakkash, R., Abu-Rmeileh, N. M. E., Khader, Y. S., Jawad, M., Mostafa, A., Abla, R., Louviere, J., & Salloum, R. G. (2021). Own-price and cross-price elasticities of demand for cigarettes and waterpipe tobacco in three Eastern Mediterranean countries: A volumetric choice experiment. *Tobacco Control*, Published online. https://doi.org/10.1136/tobaccocontrol-2021-056616

Chaloupka, F. J. (1991). Rational addictive behavior and cigarette smoking. *Journal of Political Economy, 99*(4), 722–742. https://doi.org/10.1086/261776

Chaloupka, F. J. & Pacula, R. L. (1998). *An examination of gender and race differences in youth smoking responsiveness to price and tobacco control policies* (Working Paper 6541). National Bureau of Economic Research. https://doi.org/10.3386/w6541

Chaloupka, F. J. & Powell, L. M. (2019). Using fiscal policy to promote health: *Taxing tobacco, alcohol, and sugary beverages.* Tobacconomics. https://www.tobacconomics.org/files/research/509/Using-Fiscal-Policy-to-Promote-Health-Taxing-Tobacco-Alcohol-and-Sugary-Beverages.pdf

Chaloupka, F. J., Straif, K., & Leon, M. E. (2011). Effectiveness of tax and price policies in tobacco control. *Tobacco Control, 20*(3), 235–238. http://dx.doi.org/10.1136/tc.2010.039982

Chaloupka, F. J., Warner, K. E., Acemo lu, D., Gruber, J., Laux, F., Max, W., Newhouse, J., Schelling, T., & Sindelar, J. (2015). An evaluation of the FDA's analysis of the costs and benefits of the graphic warning label regulation. *Tobacco Control, 24*(2), 112–119. https://doi.org/10.1136/tobaccocontrol-2014-052022

Chaloupka, F. J., Yurekli, A., & Fong, G. T. (2012). Tobacco taxes as a tobacco control strategy. *Tobacco Control, 21*(2), 172–180. https://doi.org/10.1136/tobaccocontrol-2011-050417

Chetty, R. (2015). Behavioral economics and public policy: A pragmatic perspective. *American Economic Review, 105*(5), 1–33. https://www.aeaweb.org/articles?id=10.1257/aer.p20151108

Christensen, A. L. & Weihrich, S. G. (1996). Tax fairness: different roles, different perspectives. *Advances in Taxation, 8*, 27–62.

Christensen, A. L., Weihrich, S. G., & Newman, M. G. (1994). The impact of education on perceptions of tax fairness. *Advances in Taxation, 6*, 63–94.

Cizmovic, M., Mugosa, A., Kovacevic, M., & Lakovic, T. (2022). Effectiveness of tax policy changes in Montenegro: Smoking behaviour by socio-economic status. *Tobacco Control,* tobaccocontrol-2021-056876. https://doi.org/10.1136/tobaccocontrol-2021-056876

Colman, G. J. & Remler, D. K. (2008). Vertical equity consequences of very high cigarette tax increases: If the poor are the ones smoking, how could cigarette tax increases be progressive? *Journal of Policy Analysis and Management, 27*(2), 376–400.

Cragg, J. G. (1971). Some statistical models for limited dependent variables with application to the demand for durable goods. *Econometrica, 39*(5), 829–844. https://www.jstor.org/stable/pdf/1909582.pdf

Cruces, G., Falcone, G., & Puig, J. (2020). *Tobacco taxes in Argentina: Toward a comprehensive cost-benefit analysis*. CEDLAS. https://tobacconomics.org/research/tobacco-taxes-in-argentina-toward-a-comprehensive-cost-benefit-analysis/

Deaton, A. (1988). Quality, quantity, and spatial variation of price. *The American Economic Review, 78*(3), 418-430. http://www.jstor.org/stable/1809142

Deaton, A. (1997). *The analysis of household surveys: A microeconometric approach to development policy.* World Bank. http://hdl.handle.net/10986/30394

Deaton, A. (2019). *The analysis of household surveys: A microeconometric approach to development policy.* World Bank. http://hdl.handle.net/10986/30394

Deaton, A. & Zaidi, S. (2002). *Guidelines for constructing consumption aggregates for welfare analysis* (LSMS Working Paper No. 135). World Bank. http://hdl.handle.net/10986/14101

de los Ríos, C., Medina, D., & Aguilar, D. (2020). *Cost-benefit analysis of tobacco consumption in Peru.* IEP. https://www.tobacconomics.org/files/research/614/iep-2019-policy-report-en-edv5-1.pdf

Divino, J. A., Ehrl, P., Candido, O., & Valadão, M. (2020). *An extended cost-benefit analysis of tobacco taxation in Brazil.* UCB. https://www.tobacconomics.org/files/research/9/policy-report-ucb-en-1.pdf

Duff, D. G. (2008). *Tax fairness and the tax mix.* The Foundation for Law, Justice and Society. https://commons.allard.ubc.ca/cgi/viewcontent.cgi?article=1103&context=fac_pubs

Farrelly, M. C., Bray, J. W., Pechacek, T., & Woollery, T. (2001). Response by adults to increases in cigarette prices by sociodemographic characteristics. *Southern Economic Journal 68*(1), 156–165.

Forsyth, D. R. (2018). *Group dynamics.* Cengage Learning, Inc.

Franks, P., Jerant, A. F., Leigh, J. P., Lee, D., Chiem, A., Lewis, I., & Lee, S. (2007). Cigarette prices, smoking, and the poor: implications of recent trends. *American Journal of Public Health, 97*(10), 1873–1877. https://doi.org/10.2105/AJPH.2006.090134

Fuchs, A. & Del Carmen, G. (2018). *The distributional effects of tobacco taxation: the evidence of white and clove cigarettes in Indonesia* (Working Paper No. 127593). World Bank. https://documents1.worldbank.org/curated/en/849901529997406429/pdf/127593-REVISED-PUBLIC-WBGIndoWhiteFINALweb.pdf

Fuchs, A., Del Carmen, G., & Mukon, A. K. (2018). *Long-run impacts of increasing tobacco taxes: evidence from South Africa* (Policy Research Working Paper No. 8369). World Bank. http://hdl.handle.net/10986/29497

Fuchs Tarlovsky, A. & Gonzalez Icaza, M. F. (2020). *Taxing tobacco in Georgia: Welfare and distributional gains of smoking cessation* (Policy Research Working Paper No. 9130). World Bank. http://hdl.handle.net/10986/33266

Fuchs, A., Gonzalez Icaza, F., & Paz, D. (2019). *Distributional effects of tobacco taxation: A comparative analysis* (Policy Research Working Paper No. 8805). http://hdl.handle.net/10986/31534

Fuchs, A., Marquez, P. V., Dutta, S., & Gonzalez Icaza, F. (2019). *Is tobacco taxation regressive? Evidence on public health, domestic resource mobilization, and equity improvements.* World Bank. http://hdl.handle.net/10986/31575

Fuchs, A., Matytsin, M., & Obukhova, O. (2018). *Tobacco taxation incidence: Evidence from Russia.* World Bank. http://hdl.handle.net/10986/30619

Fuchs, A. & Meneses, F. (2017). *Regressive or progressive?: The effect of tobacco taxes in Ukraine.* World Bank. http://hdl.handle.net/10986/28575

Fuchs, A. & Meneses, F. (2018). *Tobacco price elasticity and tax progressivity in Moldova.* World Bank. http://hdl.handle.net/10986/29329

Fuchs, A., Meneses, F., & Albert, J. (2017). *Are tobacco taxes really regressive?: Evidence from Chile* (Policy Research Working Paper No. 7988). World Bank. http://hdl.handle.net/10986/26238

Fuchs, A., Orlic, E., & Cancho, C. (2019). *Time to quit: The tobacco tax increase and household welfare in Bosnia and Herzegovina.* World Bank. http://hdl.handle.net/10986/31249

Gerbing, M. D. (1988). *An empirical study of taxpayer perceptions of fairness* (Order No. 8901321) [Doctoral dissertation University of Texas at Austin]. Dissertations & Theses Global.

Gligori, D., Preradovi Kulovac, D., Mi i, L., & Pepi, A. (2022). Price and income elasticity of cigarette demand in Bosnia and Herzegovina by different socioeconomic groups. *Tobacco Control, 31*(Supp. 2) s101–s109. https://doi.org/10.1136/tobaccocontrol-2021-056881

Goodchild, M., Nargis, N., & Tursan d'Espaignet, E. (2018). Global economic cost of smoking-attributable diseases. *Tobacco Control 27*(1), 58–64. http://dx.doi.org/10.1136/tobaccocontrol-2016-053305

Gospodinov, N. & Irvine, I. (2009). Tobacco taxes and regressivity. *Journal of Health Economics, 28*(2), 375–384.

Greene, W. H. (2018). *Econometric analysis* (8th Edition). Prentice Hall.

Gruber, J. (2016). *Public finance and public policy* (5th ed). Worth Publishers.

Gruber, J. & Mullainathan, S. (2005). Do cigarette taxes make smokers happier? *The B.E. Journal of Economic Analysis & Policy, 5*(1), 1–45. https://doi.org/10.1515/1538-0637.1412

Hartner-Tiefenthaler, M., Kubicek, B., Kirchler, E., Rechberger, S., & Wenzel, M. (2012). Perceived distributive fairness of European transfer payments and EU taxes in Austria, the Czech Republic, and the United Kingdom. *Applied Psychology, 61*(3), 454–478. https://doi.org/10.1111/j.1464-0597.2011.00478.x

Herrnstein, R. J., Loewenstein, G. F., Prelec, D., & Vaughn Jr., W. (1993). Utility maximization and melioration: Internalities in individual choice. *Journal of Behavioral Decision Making, 6*(3), 149–185. https://doi.org/10.1002/bdm.3960060302

Household incomes and expenditures survey 2017 [Data set]. National Statistics Office of of Georgia. https://www.geostat.ge/en/modules/categories/128/databases-of-2009-2016-integrated-household-survey-and-2017-households-income-and-expenditure-survey

Huang, J., Zheng, R., Chaloupka, F.J., Fong, G. T., & Jiang, Y. (2015). Differential responsiveness to cigarette price by education and income among adult urban Chinese smokers: Findings from the ITC China survey. *Tobacco Control, 24*(Suppl 3): 76–82. http://dx.doi.org/10.1136/tobaccocontrol-2014-052091

Institute for Health Metrics and Evaluation. (2019). Global Health Data Exchange (GHDx) [Data Set]. Retrieved from https://ghdx.healthdata.org/

John, R. M. (2008). Crowding out effect of tobacco expenditure and its implications on household resource allocation in India. *Social Science & Medicine, 66*(6), Article 6. https://doi.org/10.1016/j.socscimed.2007.11.020

John, R. M., Chelwa, G., Vulovic, V., & Chaloupka, F. J. (2019). *A toolkit on using household expenditure surveys for research in the economics of tobacco control.* Tobacconomics. https://www.tobacconomics.org/files/research/503/UIC_HES-Tool-Kit_Eng_final.pdf

John, R., Vulovic, V., Chelwa, G., & Chaloupka, F. (forthcoming 2023). *Using household expenditure surveys for research in the economics of tobacco control. A Tobacconomics toolkit* (2nd ed.). Tobacconomics. www.tobacconomics.org

Kaldor, N. (2014). *Expenditure tax.* Routledge.

Karki, Y. B., Pant, K. D., & Pande, B. R. (2003). *A study on the economics of tobacco in Nepal* (Health, Nutrition and Population (HNP) Discussion Paper). World Bank. http://hdl.handle.net/10986/13750

Kjeld, S. G., Jørgensen, M. B., Aundal, M., & Bast, L. S. (2021). Price elasticity of demand for cigarettes among youths in high-income countries: A systematic review. *Scandinavian Journal of Public Health*, Advance online publication. https://doi.org/10.1177/14034948211047778

Laxminarayan, R. & Deolalikar, A. (2004). Tobacco initiation, cessation, and change: Evidence from Vietnam. *Health Economics, 13*(12), Article 12. https://doi.org/10.1002/hec.932

Levy, D. T., Chaloupka, F., & Gitchell, J. (2004). The effects of tobacco control policies on smoking rates: a tobacco control scorecard. *Journal of Public Health Management and Practice, 10*(4), 338–353. https://doi.org/10.1097/00124784-200407000-00011

Liu, H., Rizzo, J. A., Sun, Q., & Wu, F. (2015). How Do Smokers Respond to Cigarette Taxes? Evidence from China's Cigarette Industry. *Health Economics, 24*(10), Article 10. https://doi.org/10.1002/hec.3084

Lyon, A. B. & Schwab, R. M. (1991). *Consumption taxes in a life-cycle framework: Are sin taxes regressive?* (Working Paper No. 3932). National Bureau of Economic Research. DOI: 10.3386/w3932

Macías Sánchez, A., Villarreal Páez, H. J., Méndez Méndez J. S., & García Gómez, A. (2020). *Extended cost-benefit analysis of tobacco consumption in México.* Centro de Investigación Económica y Presupuestaria, A.C. (CIEP). https://tobacconomics.org/uploads/research/Extended-Cost-Benefit-analysis_Tobacco_CIEP_EN_act-2-1.pdf

Maroney, J. J., Rupert, T. J., & Wartick, M.L. (2002). The perceived fairness of taxing social security benefits: The effect of explanations based on different dimensions of tax equity. *Journal of the American Taxation Association, 24*(2), 79–92.

Mill, J. S. (1970). *Principles of political economy.*

Mugoša, A., Čizmović, M., & Kovačević, M. (2022). *Distributional impacts of tobacco tax in Montenegro*. Institute of Socioeconomic Analysis (ISEA). https://tobacconomics.org/files/research/758/report-ecba-mne-final.pdf

Mullainathan, S., Schwartzstein, J., & Congdon, W. J. (2012). A reduced-form approach to behavioral public finance. *Annual Review of Economics, 4*(1), 511–540. https://www.annualreviews.org/doi/abs/10.1146/annurev-economics-111809-125033

Musgrave, R. A. & Musgrave, P. B. (1973). *Public finance in theory and practice.* McGraw-Hill.

Nargis, N., Ruthbah, U. H., Hussain, A. K., Fong, G. T., Huq, I., & Ashiquzzaman, S. M. (2014). The price sensitivity of cigarette consumption in Bangladesh: Evidence from the International Tobacco Control (ITC) Bangladesh Wave 1 (2009) and Wave 2 (2010) surveys. *Tobacco Control, 23 Suppl 1*(0 1): i39–i47. https://doi.org/10.1136/tobaccocontrol-2012-050835

Nayab, D., Nasir, M., Memon, J. A., Khalid, M., & Hussain, A. (2020). Estimating the price elasticity for cigarette and chewed tobacco in Pakistan: evidence from microlevel data. *Tobacco Control, 29*(Suppl 5), s319–s325. https://doi.org/10.1136/tobaccocontrol-2019-055232

O'Donoghue, T. & Rabin, M. (2006). Optimal sin taxes. *Journal of Public Economics, 90*(10–11), 1825–1849. https://doi.org/10.1016/j.jpubeco.2006.03.001

Önder, Z. (2002). The economics of tobacco in Turkey: New evidence and demand estimates (Health, Nutrition and Population (HNP) Discussion Paper). World Bank. http://hdl.handle.net/10986/13733

Önder, Z. & Yürekli, A. A. (2016). Who pays the most cigarette tax in Turkey. *Tobacco Control, 25*(1), 39–45. http://www.jstor.org/stable/24842094

Pechacek, T. F., Nayak, P., Slovic, P., Weaver, S. R., Huang, J., & Eriksen, M. P. (2018). Reassessing the importance of 'lost pleasure' associated with smoking cessation: Implications for social welfare and policy. *Tobacco Control, 27*(e2), e143–e151. https://doi.org/10.1136/tobaccocontrol-2017-053734

Pichon-Riviere, A. (2015). *Impact of tobacco tax increases on the social, economic and health burden from tobacco use in Latin America: A cost- effectiveness analysis in Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Honduras, Mexico, Panamá, Peru and Uruguay* [Conference presentation]. Regional Workshop Economics of Noncommunicable Diseases, Washington D.C., United States. https://www.paho.org/hq/dmdocuments/2015/presentacion-modelo-resultados.pdf

Pichon-Riviere, A., Alcaraz, A., Bardach, A., Augustovski, F., Caporale, J., & Francisco, C. (2013). Carga de enfermedad atribuible al tabaquismo en Argentina. Carga de enfermedad atribuible al tabaquismo en Argentina. Buenos Aires: Instituto de Efectividad Clínica y Sanitaria.

Pigou, A.C. (1951). Some aspects of welfare economics. *The American Economic Review, 41*(3), 287–302. http://www.jstor.org/stable/1802103

Postolovska, I., Nguyen, H. T. H., Sargaldakova, A., & Lavado, R. (2018). *An extended cost-effectiveness analysis of tobacco price increases in the Kyrgyz Republic (English)* (Report No. 125988). World Bank. http://documents.worldbank.org/curated/en/301241525698879477/An-extended-cost-effectiveness-analysis-of-tobacco-price-increases-in-the-Kyrgyz-Republic

Poterba, J. M. (1989). Lifetime incidence and the distributional burden of excise taxes. *The American Economic Review, 79*(2), 325–330. http://www.jstor.org/stable/1827779

Poterba, J. M. (1991). Is the gasoline tax regressive? *Tax Policy and the Economy, 5*, 145–164. https://www.journals.uchicago.edu/doi/abs/10.1086/tpe.5.20061803

Ramsey, F. P. (1927). A contribution to the theory of taxation. *The Economic Journal, 37*(145), 47–61. https://www.jstor.org/stable/pdf/2222721.pdf

Remler, D. K. (2004). Poor smokers, poor quitters, and cigarette tax regressivity. *American Journal of Public Health, 94*(2): 225–229. https://doi.org/10.2105/ajph.94.2.225

Rosen, L. (2013). An intuitive approach to understanding the attributable fraction of disease due to a risk factor: the case of smoking. *International Journal of Environmental Research and Public Health, 10*(7), 2932–2943. https://doi.org/10.3390/ijerph10072932

Rosen, H. & Gayer, T. (2014). *Public Finance* (10th edition). McGraw-Hill.

Ross, D. (1956). Aristotle: The Nicomachean ethics. *Philosophy, 31*(116), 77–77.

Samuelson, P. A. (1954). The Pure Theory of Public Expenditure. *The Review of Economics and Statistics, 36*(4), 387–389. https://doi.org/10.2307/1925895

Sarntisart, I. (2003). *An economic analysis of tobacco control in Thailand* (Health, Nutrition and Population (HNP) Discussion Paper). World Bank. http://hdl.handle.net/10986/13727

Sassi, F., Belloni, A., Mirelman, A. J., Suhrcke, M., Thomas, A., Salti, N., Vellakkal, S., Visaruthvong, C., Popkin, B. M., & Nugent, R. (2018). Equity impacts of price policies to promote healthy behaviours. *Lancet, 391*(10134), 2059–2070. https://doi.org/10.1016/S0140-6736(18)30531-2

Saxena, A., Stacey, N., Puech, P. D. R., Mudara, C., Hofman, K., & Verguet, S. (2019). The distributional impact of taxing sugar-sweetened beverages: Findings from an extended cost-effectiveness analysis in South Africa. *BMJ Global Health, 4*:e001317. http://dx.doi.org/10.1136/bmjgh-2018-001317

Selvaraj, S., Srivastava, S., & Karan, A. (2015). Price elasticity of tobacco products among economic classes in India, 2011–2012. *BMJ Open, 5*(12), Article 12. https://doi.org/10.1136/bmjopen-2015-008180

Siahpush, M., Wakefield, M. A., Spittal, M. J., Durkin, S. J., & Scollo, M. M. (2009). Taxation reduces social disparities in adult smoking prevalence. *American Journal of Preventative Medicine, 36*(4), 285–291. https://doi.org/10.1016/j.amepre.2008.11.013

Smith, A. (1776). *An inquiry into the nature and causes of the wealth of nations* (Volume One).

Summers, L. H. (2018). Taxes for health: evidence clears the air. *Lancet, 391*(10134), 1974–1976. https://doi.org/10.1016/S0140-6736(18)30629-9

Swagel, P. L. (1994). os14: A program to format raw data files. Stata Technical Bulletin 20:10–12. Reprinted in Stata Technical Bulletin Reprints, vol. 4, pp. 80–82. https://www.stata.com/manuals13/u21.pdf

Thomas, C. (2012). Assessing tax fairness dimensions in a small developing economy. *Business and Economics Journal.*

Townsend, J., Roderick, P., & Cooper, J. (1994). Cigarette smoking by socioeconomic group, sex, and age: effects of price, income, and health publicity. BMJ (*Clinical research ed.*), 309(6959), 923–927. https://doi.org/10.1136/bmj.309.6959.923

Trivedi, V. U., Shehata, M., & Lynn, B. (2003). Impact of personal and situational factors on taxpayer compliance: An experimental analysis. *Journal of Business Ethics, 47*(3): 175–197. https://doi.org/10.1023/A:1026294332606

US National Cancer Institute & World Health Organization. (2016). *The economics of tobacco and tobacco control* (NIH Publication No. 16-CA-8029A). National Cancer Institute Tobacco Control Monograph 21. https://cancercontrol.cancer.gov/brp/tcrb/monographs/monograph-21

Verguet, S., Gauvreau, C. L., Mishra, S., MacLennan, M., Murphy, S. M., Brouwer, E. D., Nugent, R. A., Zhao, K., Jha, P., & Jamison, D. T. (2015). The consequences of tobacco tax on household health and finances in rich and poor smokers in China: An extended cost-effectiveness analysis. *The Lancet. Global health, 3*(4), e206–e216. https://doi.org/10.1016/S2214-109X(15)70095-1

Verguet, S., Kearns, P. K. A., & Rees, V. W. (2021). Questioning the regressivity of tobacco taxes: A distributional accounting impact model of increased tobacco taxation. *Tobacco Control, 30*(3), Article 3. https://doi.org/10.1136/tobaccocontrol-2019-055315

Vladisavljevi, M., Zubovi, J., Uki, M., & Jovanovi, O. (2021). Inequality-Reducing Effects of Tobacco Tax Increase: Accounting for Behavioral Response of Low-, Middle-, and High-Income Households in Serbia. *International Journal of Environmental Research and Public Health, 18*(18), Article 18. https://doi.org/10.3390/ijerph18189494

Vulovic, V. (2019). Estimating the Economic Costs of Tobacco Use [Technical Note]. Tobacconomics. https://www.tobacconomics.org/files/research/522/UIC_Economic-Costs-of-Tobacco-Use-Note_v1.2.1.pdf

Warner, K. E. (2000). The economics of tobacco: myths and realities. *Tobacco control, 9*(1), 78–89. https://doi.org/10.1136/tc.9.1.78

WHO & WHO Tobacco Free Initiative. (2010). *Economics of tobacco toolkit: economic analysis of demand using data from the Global Adult Tobacco Survey (GATS).* World Health Organization. https://apps.who.int/iris/handle/10665/44409

World Bank. (n.d.) *A global review of country experiences: Georgia: Confronting illicit cigarette trade.* https://thedocs.worldbank.org/en/doc/482091549635012834-0090022019/original/WBGTobaccoIllicitTradeGeorgiav2.pdf

Zubović, J., Jovanovi, O., & Nedeljkovi, B. (2022). *Distributional impacts of tobacco excise taxes in Serbia*. Institute of Economic Sciences (IES). https://tobacconomics.org/files/research/810/ecba-study-final-nov-18.pdf

Appendix

A1. Stata code for microsimulation of standard tax incidence analysis

```
clear
set mem 1000m
set more off
use Georgia_2017_HES.dta, replace

***************************
**** PREPARING DATA ****
***************************

*Renaming variables and generating unit values
ren exp_cig_f_hh expcig
ren consaggr_hh exptotal
ren quant_cig_f qcig
ren hhsize hsize
gen uvcig=expcig/qcig

*Dropping observations that have insufficient information on either cigarette quantity or spending
gen d=0
replace d=1 if [qcig==.&expcig!=.]|[qcig!=.&expcig==0]
drop if d==1

*Creating income groups
gen exppc=exptotal/hsize
xtile inc = exppc [w=popweights], nq(3)
tab inc

*Step 1: Expressing the change in price as a change in tax (see Table 3.1)

****************************

**** MICROSIMULATION ****

****************************
```

*Step 2: Calculating pre-tax-increase tax payment for each household

```
gen taxcig=0.559*expcig
replace taxcig=0 if taxcig==. //*Replacing missing values with zeros
```

*Step 3: Estimating post-tax-increase quantity demanded

```
*Generating elasticity variable
gen elast=.
replace elast=-0.610 if inc==1
replace elast=-0.211 if inc==2
replace elast=-0.199 if inc==3

*Estimating post-tax quantity demanded, resulting from tax (price) increase
gen qcig1=qcig*(1+elast*0.06)
replace qcig1=0 if qcig1==.|qcig1<0 //*Replacing missing and negative values with zeros
```

*Step 4: Estimating post-tax-increase tax payment for each household

```
gen taxcig1=qcig1*uvcig*(1+0.06)*0.577
replace taxcig1=0 if taxcig1==.
```

*Step 5: Calculating pre- and post-tax-increase cigarette tax burden

```
gen taxbrdn=taxcig/exptotal //*Pre-tax-increase cigarette tax burden
gen taxbrdn1=taxcig1/exptotal //*Post-tax-increase cigarette tax burden
```

*Step 6: Calculating average pre- and post-tax-increase tax burden by income group

```
sort inc
by inc: egen avtaxbrdn=mean(taxbrdn)
tab avtaxbrdn

sort inc
by inc: egen avtaxbrdn1=mean(taxbrdn1)
tab avtaxbrdn1
```

A2. Stata code for implementing ECBA

```
set more off
set graph on
clear all
macro drop _all
        glo countrycode "geo"
        glo date : di %td date("$S_DATE", "DMY")
        glo path// <== Change
        glo maindir       "${path}/ecba_toolkit"
        glo data          "${maindir}/data/"
        glo output        "${maindir}/output/"
        glo logdir        "${maindir}/dofile_log/"

cap log close
```

```
*log using "${logdir}Toolkit_ECBA_incidence_${countrycode}_${date}.log", replace
di in red "*** RUNNING ELASTICITIES FOR ECBA TOOLKIT ${countrycode}.do ***"
di "log file printed on $S_DATE at $S_TIME"

glo countrycode "geo"
```

***Step 1: Setting up the analysis**

```
* Define the parameters for medical expenses and working years of life lost.
*glo med_exp "44948584" // This example includes only out-of-pocket share
glo med_exp "80847922" // This example includes direct costs
glo YWLL "28794"

* Merge household microdata and elasticities
        use "${data}hbs_microdata_2017", clear
        *merge m:m xtile using "${data}elasticities.dta", nogen

*renaming variables
rename exp_cig_hh expcig
rename quant_exp_cig_f_hh qcig
rename consaggr_hh exptotal
rename hhsize hsize

*Generating unit values and budget shares
gen uvcig=expcig/qcig
gen bscig=expcig/exptotal

*Dropping observations that have insufficient information on either cigarette quantity or spending
gen d=0
replace d=1 if [qcig==.&expcig!=.]|[qcig!=.&expcig==0]
drop if d==1

*Creating income groups
gen exppc=exptotal/hsize
label variable exppc "Per capita household aggregate consumption"
xtile inc = exppc, nq(3)
tab inc

*Generating elasticity variable
***Set 1 of elasticity estimates
gen elast1=.
replace elast1=-1.065 if inc==1
replace elast1=-0.235 if inc==2
replace elast1=-0.076 if inc==3

*** Set 2 of elasticity estimates
gen elast2=.
replace elast2=-0.610 if inc==1
replace elast2=-0.211 if inc==2
replace elast2=-0.199 if inc==3
```

```
* Define price shock parameter(s) for simulation
* Example of uniform price shock across the population
glo shock ".06"

/* Example of different price changes across income groups
	gen shock = .
		replace shock	= 1	if inc==1
		replace shock	= .5	if inc==2
		replace shock	= .36	if inc==3
	tab shock */

* ECBA distributional effects are non-conditional: they include all households (smokers and non-smokers).
*replace exp_cig_hh=0 if exp_cig_hh==.
replace expcig=0 if expcig==.
* Total household consumption by income group, inc i
bys inc: egen exp_i	=sum(exptotal*(popweights/hsize))
* Total expenditures in tobacco by income group, inc i
bys inc: egen tobac_i	=sum(expcig*(popweights/hsize))

* Produce Descriptive Statistics to understand the data
#delimit;
	tabstat hsize
		hhh_fem
		hhh_age
		smoker
		bscig
		[w=popweights], by(inc) stat(mean) long format;
#delimit cr
```

***Step 2: Identify the change in tobacco consumption patterns**

```
* Change Quantity of Tobacco Consumed
	gen q_ch_1 =	${shock}*elast1
	gen q_ch_2 =	${shock}*elast2

	mean q_ch_1 q_ch_2 [w=int(popweights)], over(inc)
```

***Step 3: Change in tobacco expenditures (A)**

```
g expend_d= (1-(1+${shock})*(1+q_ch_1))*(expcig/exptotal)*100
g expend_s= (1-(1+${shock})*(1+q_ch_2))*(expcig/exptotal)*100
mean expend_d expend_s[w=int(popweights)], over(inc)
```

*Step 4: Change in tobacco-related medical expenses (B)

```
* Allocate medical expenses across income groups
        egen smoker_I               =sum(smoker*hhweights)
        bys inc: egen smoker_i      =sum(smoker*hhweights)
        gen smoker_w                =smoker_i/smoker_I
        gen medicalexp_i            =${med_exp} * smoker_w
* Effect on income from reducing tobacco-related medical expenses
        gen med_d       =       -((q_ch_1 * medicalexp_i)/exp_i  )*100
        gen med_s       =       -((q_ch_2 * medicalexp_i)/exp_i  )*100

        table inc [w = int(popweights)], c(mean med_d mean med_s)
```

*Step 5: Change in years of working life lost (C)

```
* Distribute YWLL across income groups, relative to share of smoker households.
        bys inc:        egen i_pop              =sum(popweights)
gen YWLL_i              = ${YWLL}*(smoker_w/i_pop)
* Effect on income from reducing the YWLL
        gen YWLL_d      =-((q_ch_1      * YWLL_i)* exp_i / exp_i)*100
        gen YWLL_s      =-((q_ch_2      * YWLL_i)* exp_i / exp_i)*100

        table inc [w = int(popweights)], c(mean YWLL_d mean YWLL_s)
```

*Step 6: Net income effects

```
* Net Effect = Change in Tobacco Expenditures + Reduced Medical Expenses + Reduced YWLL

        gen  net_d      =       expend_d        + med_d         + YWLL_d
        gen  net_s      =       expend_s        + med_s         + YWLL_s

table inc [w = int(popweights)], c(mean net_d mean net_s)
```

*Step 7: Plot incidence line graphs

```
*Trick to plot graphs
        loc effects expend_d expend_s med_d med_s net_d      net_s YWLL_d YWLL_s
        collapse (mean) `effects' [w=popweights] , by(inc)
        glo shock100 = ${shock}*100
        glo pshock "${shock100}%"

*Only line graphs are plotted here. For smooth curves, use lpolyci command
```

```
****** GRAPH 1. Change in tobacco expenditures
twoway          (line expend_d  inc, xscale(range(1 3)) graphregion(color(white)))  ///
                (line expend_s  inc, xscale(range(1 3)) graphregion(color(white))
///title("Change in Tobacco Expenditures") xlabel(1(1)3)   ///
                xtitle("Tercile") ytitle("Income gains (%)") note("Source: Authors' own
estimation using a price shock of ${pshock} percent.")  ///
                legend(col(1)lab(1 "Elasticity 1") lab(2 "Elasticity 2")))

graph export "${output}/A_ChangeTobaccoExpenditures.png", replace

****** GRAPH 2. Change in tobacco-related medical expenses
twoway          (line med_d inc, xscale(range(1 3)) graphregion(color(white)))  ///
                (line med_s inc, xscale(range(1 3)) graphregion(color(white))  ///title("Change
in Tobacco-Related Medical Expenses") xlabel(1(1)3)      ///
                xtitle("Tercile") ytitle("Income gains (%)") note("Source: Authors' own
estimation using a price shock of ${pshock} percent.")  ///
                legend(col(1)lab(1 "Elasticity 1") lab(2 "Elasticity 2")))

        graph export "${output}/B_MedicalExpenses.png", replace

****** GRAPH 3. Change in the Years of Working Life Lost (YLL)
twoway          (line YWLL_d inc, xscale(range(1 3)) graphregion(color(white)))  ///
                (line YWLL_s inc, xscale(range(1 3)) graphregion(color(white))
///title("Change in the Years of Working Life Lost") xlabel(1(1)3)   ///
                xtitle("Tercile") ytitle("Income gains (%)") note("Source: Authors' own
estimation using a price shock of ${pshock} percent.")  ///
                legend(col(1)lab(1 "Elasticity 1") lab(2 "Elasticity 2")))

        graph export "${output}/C_YearsWorkingLifeLost.png", replace

****** GRAPH 4. Net Income Effect
twoway          (line net_d inc, xscale(range(1 3)) graphregion(color(white)))  ///
                (line net_s inc, xscale(range(1 3)) graphregion(color(white))  ///title("Net Effect:
Costs and Benefits of Increasing Taxes on Tobacco", size(medium))        ///
subtitle("(Change in Tobacco Expenditures + Medical Expenses + YWLL)")          ///
                xlabel(1(1)3)      ///
                xtitle("Tercile") ytitle("Income gains (%)") note("Source: Authors' own
estimation using a price shock of ${pshock} percent.")  ///
                legend(col(1)lab(1 "Elasticity 1") lab(2 "Elasticity 2")))

                graph export "${output}/NetEffect.png", replace

* END OF DOFILE.
```

www.tobacconomics.org
@tobacconomics