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Tool 6: Poverty

Equity Issues, Tobacco, and the Poor

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DRAFT

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Purpose of this Tool

Currently there are approximately 4 million tobacco related deaths annually. If present trends continue, by the year 2030 the number of deaths will soar to about 10 million annual deaths, with 7 million in low-income countries. However, government action to establish various tobacco control initiatives can prevent this from happening and save a significant number of lives. Tobacco control measures include:

- raising tobacco prices by imposing higher excise taxes
- advertising and marketing bans and restrictions
- clean indoor air provisions.

A 10% tobacco tax could lower tobacco consumption by 8% and save 10 million lives.

Perhaps the most effective tobacco control measure involves increasing tobacco excise taxes. For instance, if tobacco taxes are raised worldwide to increase the price of tobacco products by 10 percent, consumption will decline by approximately 8 percent and about 10 million lives can be saved. It is estimated that most of the reduction in death (about 90 percent) will occur in low- and middle-income countries (World Bank Report, 1999).

A popular and valid concern holds that raising tobacco excise taxes for the purposes of tobacco control imposes an untenable and unfair burden on the poor. In short, it is argued that higher tobacco excise taxes increase inequality in the post-tax distribution of income and reduces the real incomes of a particularly vulnerable group—the poor. This Tool discusses a number of approaches in which to examine the validity of this argument. Techniques to analyze the impact of tobacco consumption and tobacco taxes on the poor are explained. And analytical methods using country-specific data are examined so that policy analysts can effectively address concerns about the poor, tobacco consumption, and tobacco control policies.

According to a variety of measures, there are significant differences in the health of the wealthy and the poor. The poor experience higher rates of morbidity and shorter life expectancy, higher rates of infant mortality, and low birth weights. The relationships between superior health outcomes and higher income are noted in both cross-country studies and in studies examining health outcomes within a country across income levels. In general, this robust relationship between health and income is due to a number of factors. The poor suffer from inadequate nutrition, have inadequate access to medical services, are less informed about health care, and are subject to poor sanitation and crowding. In developed countries, however, much of the differences in health outcomes are due to differences in smoking behavior: the poor smoke more than the wealthy. For example, a recent study of income and birth weights attributes most of the difference in birth weights to the fact that poor mothers are more likely to smoke than wealthy mothers (Meara, 1999). If present trends continue, then throughout the world income differences in health outcomes will be increasingly driven by the propensity of lower income individuals to smoke more than the wealthy.

One argument against raising tobacco taxes is that it will adversely affect the poor. Consider that smoking is more prevalent among the poor. For a variety of reasons (e.g., lifestyle, limited access to health care, poor nutrition and sanitation, less education, inadequate shelter) the poor generally live shorter and less healthy lives than the wealthy. Increases in tobacco taxes further reduce the incomes and well being of the poor. Taxing tobacco products, then, is akin to "kicking people who are already down" (Sullivan, 2000). Framing this argument somewhat differently: A 10 percent price increase reduces consumption by 8 percent; assume that prevalence drops by 8 percent; the remaining 92 percent of the poor who continue to smoke suffer doubly by enduring the burden of tobacco related illnesses *and* the burden of higher taxes.

The relationship between income and tobacco consumption and expenditures is, in general, complicated. Consider these observations.

- In developed economies, prevalence and intensity of tobacco use is higher among poorer individuals than wealthier individuals.
- Overall prevalence of smoking is higher in low- and middle-income countries than it is in high-income countries. The exception to this is sub-Saharan Africa, which, for the most part, is a low-income region where the prevalence and use of tobacco is also low.
- Frequently within a low- or middle-income country, tobacco consumption increases with personal income.

To properly assess the impact of domestic tobacco policy of a particular country, the relationship between income, tobacco consumption, and expenditures within that country is of key

importance and must be estimated. In this section we outline how to go about doing this.

A tax can reduce standards of living by affecting either the uses of income (i.e., the way income is spent), or the sources of income (i.e., the way incomes are generated). Thus there are two ways in which the welfare of the poor and tobacco are linked. First, the purchase and consumption of tobacco products constitutes one of the ways the poor utilize their income. Second, poor individuals can also be involved in the production, sale, and distribution of tobacco products. That is, tobacco can be an important source of income for some poor households.

There are other methods of tobacco control besides tax increases. Tobacco warnings and counter-advertising, advertising restrictions and bans, and clean indoor air statutes are all non-tax tobacco control policies that reduce tobacco consumption. Further, these methods of control have fewer measurable effects on the distribution of income, as conventionally determined.[1] For this reason, such non-tax policies are very attractive. The downside to these methods is that their effectiveness is typically maximized only when used in conjunction with tobacco tax increases. So while tobacco tax increases are, by and large, the most potent tobacco control mechanism available, the use of other tools is important, particularly restricting smoking in public places and banning all advertising and promotion.

Who Should Use this Tool

This Tool is intended primarily for tax administration staff who seek to define and implement a tobacco tax that adequately encompasses the concerns over the poor. This is a practical tool offering concise, step-by-step instructions on properly measuring the tax base and designing a fair and equitable tax. Several mathematical equations are presented that require some knowledge of statistical surveying and sampling. This tool, therefore, is written and designed for the reader who has moderate to extensive knowledge of economics, statistics, and tax administration.

How to Use this Tool

This Tool focuses on the impact tobacco taxes have on the welfare of the poor and their consumption patterns. This analysis has two parts. The first part examines the effect of tobacco taxes on non-tobacco expenditures of the poor (i.e., the impact of higher tobacco taxes on

[1] These policies raise the full price of tobacco consumption. Thus it can be argued that, as price increases, such measures reduce the real standard of living. Alternatively, there is evidence that individuals are not completely informed about the health consequences of tobacco consumption, so that such measures correct a market imperfection. Adequately incorporating all these considerations requires esoteric modeling, and the effects on the distribution of income are difficult to measure.

expenditures on shelter, food, and clothing). The second part examines the impact of tobacco taxation on the distribution of income (i.e., whether tobacco taxes make the distribution of income less equitable). This Tool also briefly discusses the impact of tobacco taxation on the source of income for the poor. Finally, there is a discussion on the incidence of tobacco related illnesses among the poor.

All readers should refer to the **Key Information** chapter, as it provides basic information on the fundamentals and assumptions presented in this Tool.

The **Tobacco Consumption and Expenditures** chapter provides an introduction to properly identifying and measuring household incomes and expenditures, and how they can be impacted by tobacco taxes.

In the **Tobacco Tax Fairness** chapter, readers can get a better understanding of how to develop an overall tax system that is not overly burdensome on the poor.

Methods of measuring the impact of a tobacco tax are presented in the **Standard of Living** chapter.

The **Poverty and Tobacco-Related Illness** chapter focuses on the impact of a tobacco tax on the well being of smokers, consumers, and the poor.

Recommendations on viable tax mechanisms are presented and discussed in the **Tax Incidence** chapter.

II. Key Information

Definitions

Poverty

Poverty can be defined as that of a household suffering from economic deprivation.

The standard definition of poverty is that of a household suffering from economic deprivation. However, determining who fits this definition is often problematic, since the term "economic deprivation" is ambiguous and to some extent socially determined. For example, in some societies the absence of a telephone is regarded as a sign of deprivation; in other societies this is not the case. Sen (1982) provides a useful discussion of some of the conceptual issues involved in defining poverty. Additional discussion can be found at the World Bank web site (www.worldbank.org/poverty/). The U.S. Census web site also has many useful links (www.census.gov/hhes/poverty/povdef.html).

Some countries actually compute a poverty line—that is, an income level, adjusted for family size—that determines whether a given household is poor or not. Typically this poverty line is determined by computing the cost at market prices of a low-cost nutritious diet and then multiplying by some factor (three in the U.S.) to determine an amount needed for other necessities such as shelter, clothing, transportation, and utilities. If such a criteria is available for a country, it can be used to determine which households are poor. The World Bank Development Indicators give the percentage of the population living in poverty for a number of countries (www.worldbank.org/poverty/data/wdi2000/pdfs/table2_7.pdf).

In the absence of such a criterion, the best recourse is to consider the group of households making up the lower quintile of the income distribution to be defined as poor. This is a reasonable approach for high- and middle-income countries. For low-income countries this approach is arguably more problematic, and it may be reasonable to consider expanding the number of quintiles that are considered poor. For example, one might take the bottom two quintiles as constituting the poor.

Income

The common definition of income is cash-flow (i.e., the money flowing into the household as result of market activity). Thus if a family has a single wage earner who brings home a paycheck, the value of the paycheck is thought of as the income of the family.

Economists define income as consumption plus savings.

How do economists define income? When possible, economists use a broader definition of income than non-economists. Their approach begins by noting that income supports two important household activities: savings and consumption. Indeed, it is a basic identity that savings plus consumption must add up to total income. Thus income is defined as the amount of savings undertaken by the household plus the amount of consumption undertaken by the household. Net household savings is over a given period of time—in turn, the net change in household wealth. Hence income is defined as:

$$I = C + \Delta W$$

where: I = Income, C = Consumption, and ΔW = the net change in household wealth.

This is the Hague-Simon definition of income (for a discussion see Rosen, 1999).

This definition has several important practical implications. First, this approach means that in-kind income is included as a part of income. For instance, if a family receives a bushel of potatoes in exchange for work performed, and the potatoes are eaten by the family, family consumption rises. This increase in consumption is, according to the formula above, added to income. The standard way to account for this bushel of potatoes is to value the bushel of potatoes at current market prices. Thus if a bushel of potatoes sells for $20, the addition to income would be counted as $20. Secondly, if a family owns the house in which it resides, then the family is consuming housing services and this, too, is included as a part of income. Third, transfer payments and in-kind transfers from the government or private sources also contribute to consumption and accordingly are part of income. Additionally, capital gains, both realized and unrealized, are regarded as part of income.

As a practical matter, the Hague-Simon definition of income is larger than measures of income that are based on cash flow. Often it is not possible to include all consumption items in determining income, so measured income is frequently lower than true economic income.

Income Quintiles

When examining distributional issues, it is standard practice to partition the population by income quintiles or deciles. That is, the population (or a representative sample) is ranked by income. For income quintiles, the ranking is split into five equal-size groups. The bottom 20 percent of the population in terms of income forms the low-income quintile; this group is usually taken as the poor. The top

20 percent is the high-income quintile. The remaining 60 percent form the three middle-income quintiles, though in a low income country the second lowest quintile might also be regarded as poor. Whether to include the second lowest quintile as part of the poor can be determined by constructing a poverty line using the technique discussed in the poverty definition, above.

Good Data Sets

Determining income quintiles requires a household data set that represents a random sample of the country's population. If a survey is a true, unweighted random sample of the country's population, then income quintiles of its survey data set are an unbiased estimate of the income quintiles of the population. It is sometimes useful, however, to oversample lower income groups; this increases the accuracy of statistics about the poor and compensates for the likelihood that the poor are under counted.

Further, data set must have annual household income from both market and non-market sources. Market income refers to cash income generated by the sale of labor or other commodities for money. For instance, cash wages and revenue from the sale of home-produced agricultural goods are both counted as part of income. In computing incomes of the poor, however, it is particularly important that non-market sources of income also be included. For example, rent from owner-occupied housing and the value of agricultural products produced and consumed in the home should be included as part of total income. Thus it is important that the survey has information about the tenure status of housing and home agricultural production.

A possible, necessary adjustment is to control for differences in family size. If income data are collected by household, and households differ systematically in size, then in order to make meaningful comparisons across income groups, family size must be taken into account. For example, suppose poor households have an average family size of eight people, while wealthy households average three people in size. If the average poor household income is $2,400 and the average wealthy household income is $9,000, the per capita income for the poor is $400 and the per capita income for the wealthy is $3,000. Thus household incomes differ by a factor of 3.75 but standard of living differs by a factor of 7.5. In this case, household income alone understates the differences in living standards. In general, family size may vary across income groups, so adjust for income and consumption comparisons across income levels. The typical method for this is to standardize the size of households at four persons. (Compute this by taking per capita income for the average household and multiplying by four.) For the example above, the standardized poor household has an income of $1,600 and the standardized wealthy household has an income of $12,000.

Another consideration to keep in mind is the distinction between permanent and transitory income. Permanent income is a measure of lifetime average income; transitory income is a household's current measured income. At any given point of time, a household can have an economically unusual year (i.e., earnings may be unusually low or high). In examining the income distribution for a single year, a low-income household may be experiencing a particularly bad year so that its observed income—its transitory income—is significantly less than its permanent income. By the same token, a high-income household may be experiencing temporary good luck so that its transitory income is significantly higher than its permanent income.

There are a couple of implications in examining income distribution for only a single year.

- Such measures tend to overstate the dispersion of income. In other words, measures of income dispersion based on permanent income tend to suggest that there is less inequality than measures based on transitory income.
- An incorrect conclusion can be drawn to the extent that households base their consumption decisions on permanent income. For instance, if a household experiences economic misfortune for a single year, consumption may not be significantly reduced. This means that tobacco expenditures as a fraction of income will, for that year, rise. On the other hand, a household experiencing a particularly lucky year may choose to save most of the additional income and not significantly raise consumption. For this household, tobacco expenditures as a fraction of income will fall. Taken together, this effect makes the share of tobacco expenditures as a function of income appear to fall with income more sharply than is really the case. Put differently, if permanent income is available, tobacco expenditures as a function of income will not vary as much as when transitory, current income is utilized. A standard way of estimating permanent income is to compute a five-year average of inflation-adjusted earnings for each household. Unfortunately data to do this is often hard to come by and so this adjustment is often left undone. Obviously there is an important caveat in interpreting average income and expenditure data. Some of the implications of viewing expenditures and income from lifetime expenditures can be found in Poterba (1989).

Survey data needs to be partitioned by income quintiles. If the survey is not an unweighted random sample of the underlying population, the population weights associated with different income levels must be taken into account in partitioning the data set into representative quintiles. After partitioning the data into income quintiles, sum the total tobacco expenditures for each quintile and then divide by total income for the corresponding quintile. This provides average household tobacco expenditures for each quintile. There are two features to consider.

- If the absolute share of household tobacco expenditures for the lowest quintile is relatively small in absolute value (e.g., less than five percent), then one can make the argument that increasing tobacco taxes will not have a dramatic effect on the welfare of poor households.
- If the fraction of household expenditures on tobacco with respect to income changes is relatively constant, then the burden of tobacco taxes is more uniformly spread out over the entire population. On the other hand, if the share of tobacco expenditures declines sharply with income, then the burden of tobacco taxation falls disproportionately on the poor. If the poor's income share of tobacco expenditures is high or if the income-tobacco share gradient is steep, then consider decreasing some other tax that falls disproportionately on the poor and/or earmarking tobacco tax receipts for expenditure programs targeted to low-income groups. This offsets the burden generated by higher tobacco taxes.

Poor Data Sets

If good income data is not available, another approach is to examine tobacco consumption by level of education, if available. Education is typically well correlated with income, so that it serves as a reasonable proxy for unobserved income. Survey data can be partitioned by years of education; a reasonable breakdown might be:

- none
- elementary education
- middle school
- high school
- college or more

The most appropriate partition, of course, varies from one country to another.

The next step is to examine for each education category various characteristics of tobacco consumption. Depending on the type of tobacco consumption data available, compute the percentage of households with one or more smokers (i.e., the prevalence of smoking), average household tobacco consumption, and average tobacco expenditures. Examine the correlation between educational attainment and these variables to determine the approximate relationship between income and tobacco consumption. If the data suggests that less-educated individuals spend much more on tobacco consumption than well-educated individuals, then concern about the effect of tobacco taxes on the poor may be warranted and, likewise, call for policies to offset the distributional impact of tobacco taxes.

Assumptions and Requirements

This Tool assumes the poor are a particularly vulnerable group, thus requiring very close and careful examination of the impact of tobacco tax increases on the poor. Further, this Tool requires access to data about income distribution and consumption patterns in order to examine the impact of tobacco taxes and tobacco tax increases on the welfare of the poor. In the absence of detailed survey data, however, analysis can proceed by using very stylized assumptions and facts, such as the price of a package of cigarettes, wage rates for unskilled workers, and so forth.

The reader will gain the most from this Tool if he/she is acquainted with economic and statistical analysis. For maximum benefit, the reader should also feel comfortable with mathematics at the college level (i.e., algebra and some calculus), and should be very comfortable with the basics of supply and demand and the notion of elasticity. Knowledge and understanding of more advanced economic topics like tax incidence and income inequality measures is advisable. While an elementary background in statistics is required, the reader should also be acquainted with the notion of quintile, means, and income share. To undertake some of the analysis suggested by this Tool, the ability to work with large data sets is necessary—requiring familiarity with software packages such as SAS or SPSS. Access to a spreadsheet program like Microsoft Excel or Lotus 123 is highly recommended.

III. Tobacco Consumption and Expenditures

Consider Income and Expenditures

Income Share

To properly and effectively determine income share, a good data set must have annual expenditures on tobacco products. If expenditure data is collected on a per month basis, convert data to an annual basis to make it commensurate with income data. Then calculate the income share of tobacco expenditures as the total amount spent on tobacco products divided by total income:

Income Share = Tobacco Expenditure ÷ Total Income

One factor complicating the interpretation of income share of tobacco expenditure is the significant variation in the type and quality of tobacco products. Cigarettes differ in quality and price; international brand names such as Marlboro are more expensive than locally produced brands. If cigarettes are hand rolled, tobacco expenditures can constitute loose tobacco and cigarette papers. The availability of hand rolled cigarettes, *bidis*, and other cheap substitutes for machine manufactured cigarettes can mean that the consumption of tobacco products, as measured by tar and nicotine intake, is roughly the same across income groups, whereas tobacco expenditures absolutely and as a fraction of income vary. Thus, tobacco consumption by the poor can be similar to that of wealthier individuals, as measured by cigarettes smoked, but tobacco expenditures by the poor can be much lower because the poor smoke cheaper brands of cigarettes. There is no systematic way to adjust for this affect, but it is important to consider when interpreting data on income shares. It may also be more important to examine expenditure elasticities with respect to income than to examine the usual income elasticity of tobacco consumption.

Tobacco Expenditures

Differences in quality and expenditures also mean that the incidence of tobacco taxes differs depending on whether taxes are unit excise taxes or *ad valorem* taxes. If the tobacco taxes are *ad valorem* (i.e., specified as a percentage of the stated price), then in absolute terms the price of higher quality brands increases more than the price of lower quality brands. As a result, more of the tax burden can rest on middle- and upper-income smokers who smoke more expensive brands. If tobacco taxes are unit excise taxes (i.e., a set monetary value per cigarette), then more of the tax burden can rest on the poor, all else being equal.

Why is the income share of tobacco expenditures important? If the income share is large, tax increases can have a much bigger impact on household budgets. If the income share is relatively small, however, then tax increases, with all else being equal, do not have large budgetary implications for households. Thus average income share of tobacco expenditures is an important measure of the impact tobacco tax increases have on household welfare.

Average expenditures on tobacco are determined for different average income levels. The expenditure elasticity summarizes how expenditures change as income varies, and is defined as:

$$Є_{expenditure} = \%\Delta E \div \%\Delta I$$

where: the expenditure elasticity is the percentage change in expenditures E (that is, $\%\Delta E$) divided by the percentage change in income I (given by $\%\Delta I$).

An example can help clarify how this formula is utilized. Suppose the lowest quintile spends an average of $300 on tobacco products and has an average income of $2,000, while the next quintile spends an average $700 on tobacco and has an average income of $3,000. The percentage change in tobacco expenditures is:[2]

$(700 — 300) \div 300 \times 100 = 133$ percent.

The percentage change in income is:

$(3{,}000 – 2{,}000) \div 2{,}000 \times 100 = 50$ percent.

Hence the expenditure elasticity is $133 \div 50 = 2.67$.

Consider Elasticity and Product Quality

Income Elasticity

If income rises, what happens to the quantity of tobacco products purchased? Consumer purchases of tobacco products can respond in any number of ways to increases in income. Economists measure this

[2] For this calculation to be valid, all other relevant factors are held constant.

response using income elasticity, defined as the percentage change in quantity purchased divided by the percentage change in income. As an equation, this appears:

$Є_I = \%\Delta Q \div \%\Delta I = I\Delta Q \div Q\Delta I$

where: Δ = change.

I = income.

Q = quantity of tobacco purchased.

$Є_I$ can assume positive or negative values or be equal to zero.

If $Є_I$ is positive, then the product or good is a "normal good"—meaning, as income rises, tobacco consumption also rises. For example, if income increases by 10 percent and tobacco consumption increases by 20 percent, then the income elasticity of tobacco is 2. In this scenario, where tobacco consumption increases as income rises, the poor consume less tobacco products than their wealthier counterparts.

If $Є_I$ is negative, then the product or good is an "inferior good"—meaning, as income rises, tobacco consumption falls. For example, if income rises by 100 percent, but tobacco consumption falls 50 percent, then the income elasticity of tobacco is –0.5. In this scenario, where tobacco consumption falls as income rises, the wealthy consume less tobacco than the poor. This is actually the case in some high-income countries such as the United States.

Luxury Goods

If $Є_I$ exceeds one, then the product or good is not only a normal good but is also a luxury good. In this scenario, not only do tobacco purchases increase with income, but the income share of tobacco expenditures also rises as income increases. Thus, the wealthier purchase more tobacco products than the poor and spend a higher percentage of their income on tobacco products. For example, suppose weekly income is initially £100 and weekly tobacco consumption is 5 packs. Now suppose that income rises to £120 pounds and tobacco consumption increases to 10 packs. The percentage change in income is only 20 percent, while the percentage change in tobacco consumption is 100 percent. Hence:

$Є_I = 100\% \div 20\% = 5$

Here, cigarettes are a luxury good because the income elasticity exceeds one. If the price of a pack of cigarettes is £1, then the income share of cigarettes has risen from 5 percent to about 8 percent.

However, when income elasticity exceeds one, the type and quality of tobacco products that consumers use can change, in addition to the amount. Very poor individuals who originally purchase loose tobacco and cigarette papers may switch to machine manufactured

cigarettes as income rises. When income rises even further, consumers may switch to higher priced cigarette brands. Thus if tobacco products are narrowly defined, they can eventually prove inferior. A standard method to deal with the quality issue is to consider tobacco expenditures instead of quantity of tobacco products purchased. Hence, income elasticity is defined as:

ϵ_I = %ΔTobacco Expenditures ÷ %ΔIncome

Calculate Income Elasticity

Income elasticity can be crudely obtained as follows.

1. For each income quintile, determine average income and average household expenditures on tobacco.
2. Compute the percentage change in income and tobacco expenditures for the lowest to the second lowest income quintile, from the second lowest to the middle-income quintile, and so forth.
3. Compute the ratio of the percentage change in expenditure to the percentage change in income. Examine the ratio of these percentage changes to estimate the income elasticity.

Another approach is to examine the average income share of tobacco for different income groups. If income shares decline as the average income of the quintile increases, then this suggests an income elasticity of less than one. If the income share is rising, then this suggests an income elasticity exceeding one. If the absolute level of expenditures declines as income rises, then income elasticity is less than one.

If more data is available, such as a household or individual survey, use more sophisticated techniques to determine income elasticity. For instance, a standard of measuring the income elasticity of tobacco demand is to use multiple regression techniques. The dependent variable is quantity of tobacco consumed and the independent variables are price, income, and other control variables. The details of estimating a demand equation are outlined in **Tool 3. Demand Analysis**.

IV. Tobacco Tax Fairness

Define a Regressive Tax

The equity characteristics of a tax are important. Indeed, much of the discussion and dispute over tax policy centers on whether a given tax or tax increase is fair. The standard method to assess the fairness of a tax is to determine whether the tax, on net, makes the distribution of income more or less equal. A tax falling only on the wealthy reduces income inequality, as their post-tax income declines and moves closer to that of the poor. On the other hand, a tax falling primarily on the poor reduces their post-tax income while leaving the income of the wealthy unaffected. This increases the spread of post-tax income between rich and poor and raises the level of inequality.

Regressive taxes fall hardest on the poor and increase income inequality.

A tax that disproportionately falls on the poor and raises income inequality is regressive. If a tax takes a larger portion of the income of the rich than it does of the poor and reduces inequality, then it is progressive. If the taxes paid are an equal share of income for all income groups, the tax is proportional or neutral. In other words, the degree of inequality is not altered by the imposition of the tax.

Another related approach to tax equity is the notion of vertical equity—sometimes referred to as "equal sacrifice." The basic idea is simple: the disutility of taxation should be the same for all taxpayers. In other words, a tax should reduce the welfare of different people by the same amount. Equal sacrifice occurs when:

$$\Delta U_R(I_R) = U_R(I_R) - U_R(I_R - T_R) = U_P(I_P) - U_P(I_P - T_P) = \Delta U_P(I_P)$$

where: $U_R(I)$ = the utility of income for wealthy individuals.

$U_P(I)$ = the utility of income for poor people.

$\Delta U_R(I_R)$ = the reduction in the utility of the wealthy.

$\Delta U_P(I_P)$ = the reduction in the utility of the poor.

While this provides a nice conceptual framework in which to think about the issue of tax fairness, it does not provide too much in the way of concrete policy recommendations. There is one important lesson to be drawn from this approach. If there is diminishing

marginal utility (i.e., an extra dollar raises the utility of a wealthy person less than an extra dollar raises the utility of a poor person), then equal sacrifice requires that taxes paid by the wealthy person exceed the taxes paid by the poor person—that is, $T_R > T_P$. Considerable evidence suggests diminishing marginal utility of income. For example, aversion to risk is consistent with diminishing marginal utility of income. To make more precise recommendations beyond the suggestion that the wealthy pay more in taxes than the poor, more detailed knowledge of the utility function is required. Unfortunately, this type of information is difficult to obtain and controversial. For example, if the utility function is given by

$$U = \ln(I)$$

where: $\ln(I)$ = the natural log of income

then equal sacrifice requires that taxes be a constant fraction of income.

Determine if a Tax is Regressive

The study of who actually pays a tax is called the determination of tax incidence. Whether an excise tax is progressive, regressive, or proportional is determined by the pattern of consumption as income varies. Consider a simple example, if only the wealthy smoke cigarettes, then cigarettes taxes are progressive; if only the poor smoke, then cigarette taxes are regressive. In general, the income elasticity of tobacco consumption determines the incidence of the tax.

If a tobacco tax is a unit excise tax, then the amount of tax an individual pays as a fraction of income is determined as:

$$tQ \div I$$

where: t = the unit excise tax.

Q = the quantity of tobacco purchased.

I = the individual's income.

If this ratio does not change, then tobacco taxes are proportional or neutral. For this ratio to remain constant, the income elasticity of tobacco consumption must equal one. If this ratio declines as income rises, then tobacco taxes are regressive, meaning that as income rises, tobacco taxes constitute a declining share of income. In this case, the income elasticity of tobacco consumption is less than one. Alternatively, if this ratio rises with income, then wealthier individuals pay on average a greater percentage of their income out in the form of tobacco taxes. In this case, tobacco taxes are progressive and the income elasticity exceeds one.

Income Elasticity Less Than Zero

If the income elasticity is less than zero, then on average tobacco taxes are regressive. The imposition of tobacco taxes raises standard measures of inequality, such as the Gini coefficient. Tobacco taxes also violate notions of equal sacrifice, since poorer individuals pay more than wealthier individuals. Consider two basic notions.

It makes little sense to assess the impact of a single tax without reference to the entire tax system. In virtually any country there are a myriad of taxes imposed: excise, property, wage, and income taxes. To properly and completely assess the burden of taxation and its impact on the income distribution, the entire array of taxes needs to be considered. While a particular tax can fall disproportionately on the poor, the impact of that tax can be offset by other taxes that fall disproportionately on the wealthy. In its entirety, the tax system may impose a greater burden on wealthier groups. This also suggests that the tax system can be adjusted in order to ameliorate the burden of tobacco taxes. For example, offset the impact of higher tobacco excise taxes by lowering a tax on kerosene, so long as the pattern of kerosene use is similar to patterns of tobacco use.

Further broaden this system-wide perspective to include account expenditures when assessing the net effect of the fiscal system on the distribution of burden. If expenditures are targeted towards the poor, offset the burden of tobacco excise taxes on the poor. For example, if tobacco excise taxes are earmarked for health service for the indigent, this offsets tax payments and reduces the net burden of tobacco excise taxes. Thus in the final analysis, take into account the entire fiscal system—all taxes and expenditures—to assess the net impact of tobacco excise taxes on the poor.

Income Elasticity Between Zero and One

If the income elasticity is between zero and one, then total tobacco taxes paid *as a percentage of income* is declining. However, the total amount of tobacco taxes *paid* is increasing with income: wealthier individuals pay more tobacco taxes than the poor. For example, consider a household with an annual income of $1,000 that pays $50 in tobacco taxes. With an income elasticity of 0.5, a wealthier household pays more in tobacco taxes. Thus, assuming the same consumption behavior, a household with an annual income of $10,000 pays $225 in tobacco taxes. This is determined as follows:

$$Є_I = \%\Delta Q \div \%\Delta I = I\Delta Q \div Q\Delta I$$

or

$$0.5 = \%\Delta Q \div [(10{,}000 - 1{,}000) \div 1{,}000] \times 100$$

$$0.5 = \%\Delta Q \div 900$$

$$450\% = \%\Delta Q$$

Tax expenditure increases by 450 percent or, equivalently, by a factor of 4.5. Hence, the taxes paid by the wealthier household are $50 × 4.5 = $225. However, as a percentage of income the poorer household's tobacco taxes are 5 percent, whereas the wealthier household's tobacco taxes are 2.25 percent.

Standard measures of income equality examine income after taxes; usually by considering the share of income for each income group. This means that if a tax is a greater share of income for the poor than for the wealthy, income inequality increases. This is true even if the absolute amount of taxes paid rises with income. However, the notion of equal sacrifice does not necessarily require that taxes as a fraction of income rise with income. With diminishing marginal utility, the equal sacrifice principle requires that the total amount of taxes paid rises with income. If the income elasticity exceeds zero, the total amount of tobacco taxes paid rise with income. Whether or not taxes as a percentage of income rise with income depends on the shape of the utility function for money. While standard measures of inequality such as the Gini coefficient (discussed in the *Measure Inequality* section of the **Tax Incidence** chapter, below) rise if the income elasticity is between zero and one, other approaches to tax fairness cannot be violated. When the income elasticity of tobacco lies between zero and one, the wealthy pay more tobacco taxes than the poor, so the degree of unfairness is indeterminate.

Determine a Tax's Marginal Value

Up to this point, the discussion on the measure of progressivity has focused on *average* progressivity and regressivity. In other words, the examination has been on the fairness and equity of tobacco taxes in their entirety. For policy purposes, however, it is appropriate to examine the *incremental* or *marginal* impact of a change in tobacco taxes. In other words, what is the impact of an *increase* in tobacco taxes on the welfare of the poor, measures of inequality, and vertical equity?

A change in a regressive tax may not, in and of itself, be regressive, and therefore beneficial to the poor.

It is important to observe that even if, on average, tobacco taxes are regressive, changes in tobacco taxes may not be regressive. A simple example illuminates the logic behind this assertion. Consider two households, one wealthy and one poor. The poor household has an income of $1,000 and the wealthy household has an income of $10,000. The poor household pays $50 in tobacco taxes while the wealthy household pays $100 in tobacco taxes. In this scenario, tobacco taxes are, on average, regressive, as the poor household pays tobacco taxes totaling five percent of its income while the wealthy household pays only one percent of its income in tobacco taxes.

Suppose, however, that a 10 percent increase in tobacco taxes causes the poor household to reduce its tobacco purchases to such an extent that total taxes paid remains as before, but that the wealthy household does not reduce its tobacco expenditures at all. The

wealthy household then pays $110 in tobacco taxes, while the poor household still pays $50 in tobacco taxes. As a fraction of income, this is calculated as:

$\Delta R \div I$

where: ΔR = the change in taxes paid, that is, tax revenue.

I = income.

In the example, this quantity increases as income rises. For the poor household, the change in tobacco taxes is zero; for the wealthy household, the change in tobacco taxes is $10. Thus, on the margin, the tax increase is progressive—the tax increase lowers the degree of regressivity exhibited by the tobacco tax. That is, while the tobacco tax is on average regressive, after taxes have been raised, the tax is *less regressive* than it was before the tax was imposed. For policy purposes, the appropriate measure fairness is marginal progressivity. As the example indicates, marginal progressivity (or regressivity) can be quite different than average progressivity.

Price Elasticity

An important determinant of marginal progressivity is price elasticity, so it is particularly important to understand how it varies with income. Price elasticity measures the responsiveness of demand for a product to changes in its price, and is used to analyze and classify consumer demand for goods and services.

The impact of higher tobacco taxes on the poor depends on their response to the tax-induced increases in the price of tobacco products. A fundamental tenet of economics asserts that when the price of a good rises, the quantity consumed declines. Price elasticity is the measure used to gauge the sensitivity of quantity demanded to changes in price. The price elasticity of demand is a pure number (i.e., it has no units and is the ratio of percentage change in quantity demanded to percentage change in price). Formally the price elasticity is given by:

$\varepsilon = \%\Delta Q \div \%\Delta P = (\Delta Q \div \Delta P)(P \div Q)$

This number is non-positive—that is, it is zero or negative. In order to calculate it correctly, all other factors that might influence quantity demanded are held fixed. Thus, household income, advertising, tastes, and so on are assumed constant when the price elasticity is determined. An elasticity of zero is a special case and indicates that quantity demand is unresponsive to price—changes in price do not cause the quantity demanded to change. Otherwise, the price elasticity is negative indicating that as price increases, quantity demanded declines. If the price elasticity lies between 0 and negative one, then demand is inelastic. If the price elasticity is less than negative one, then demand is price elastic. A demand elasticity of exactly minus one is the special case of unit elastic demand.

The total amount spent on a good (i.e., expenditure) is the price times the quantity purchased. If the total price of tobacco increases while the quantity purchased declines, it is generally not possible to say whether total tobacco expenditures are rising, declining, or unchanged. Whether expenditures rise or fall depends on the magnitude of the quantity response. In particular, the change in expenditures depends on the price elasticity of demand. If quantity changes only a small amount in response to a price increase, then total tobacco expenditures are higher. Put differently, if demand is price inelastic, a price increase leads to greater expenditures. On the other hand, if quantity declines significantly in response to a price increase, then total tobacco expenditure is lower. Thus if quantity demanded is price elastic, then total expenditures decline if price increases. If the elasticity is exactly –1, then total tobacco expenditures are unchanged. In this case, the percentage increase in price causes an equal and offsetting percentage decline in quantity, so the amount spent on tobacco does not change.

Economists distinguish between long-term and short-term effects. In the short-term there is insufficient time to make all adjustments to a change in price. Accordingly, in the long-term there is sufficient time to make all adjustments to price changes. If tobacco prices rise, consumers may not initially quit. But as the price increase persists, tobacco users may eventually decide to quit. Higher prices can also deter the initiation of smoking, though it usually takes a while before this change has a significant affect on the number of smokers and the quantity of cigarettes consumed.

The economic theory of addiction (see Becker and Murphy, 1988) also stresses that individuals react differently to long-term, persistent price changes differently than they do to transitory, short-term price changes. Becker and Murphy demonstrate that the long-term price elasticity is smaller (more negative) than the short-term price elasticity. This is understandable. If a price change is initially viewed as temporary, smokers may continue to smoke at previous rates, but if the price increase persists, it can be viewed as permanent. When they view it as a permanent increase, smokers may then modify their smoking behavior, either quitting or cutting back on the number of cigarettes smoked. This means that in the long-term, the response of demand to price changes is greater than in the short-term.

Consider the long-term impact of the price-elasticity of tobacco demand.

In order to best examine the impact of tax-induced price increases for cigarettes, the long-term price elasticity of tobacco demand for the poor must be determined.[3] If an estimate of price elasticity for the entire population is obtained, the presumption is that Є, the price elasticity for the poor, is higher. For some specific cases, Є is estimated. In the United States a figure of about –0.8 is obtained In China, where the population estimate of price elasticity is –1.0, the price elasticity for the lowest income quintile probably exceeds –1.0. For low- and middle-income countries, the World Bank suggests a

[3] General methods for estimating price elasticity are discussed in **Tool 3. Demand Analysis**.

value of –0.8 (World Bank Report, 1999). Other studies use higher estimates: Peck *et al* (2000) use an estimate of –1.2; Townsend *et al* (1994) find a value of Є equal to –1.0 for the poor in the United Kingdom.

Marginal Progressivity

Marginal progressivity can differ from average progressivity. A key factor in determining marginal progressivity is the manner in which price elasticity of demand for tobacco changes with income level. A further consideration is whether the demand for tobacco increases, decreases, or remains the same as income varies. If tobacco is a normal good, and price elasticity rises (i.e., becomes more inelastic) as income increases, then on the margin an increase in tobacco taxes is most likely progressive.[4]

The argument is developed as follows. The change in taxes paid, ΔR, as a result of a change in the unit excise tax rate, Δt, is given by

$$((t \div p + t)Є + 1)Q\Delta t = \Delta R \qquad [6.1]$$

where: t = the unit excise tax so that Δt is the change in the unit excise tax.

$Є$ = the price elasticity which is non-positive.

Q = quantity.

p = pre-tax price.

How is this formula derived? The change in taxes that accompanies a rise in tax of Δt is

$$Q\Delta t + t\Delta Q = \Delta R$$

which indicates two effects: the first is the effect of increasing the tax on the amount originally purchased; the second comes from the original tax multiplied by the impact of the tax change on the quantity purchased. Factor out the quantity $q\Delta t$ and this expression becomes

$$(1 + (t \div Q)\Delta Q \div \Delta t)\ Q\Delta t = \Delta R \qquad [6.2]$$

Since the change in tax Δt is the same as the change in price Δp,

$$\Delta Q \div \Delta t = \Delta Q \div \Delta p = (Q \div p + t)Є$$

Substitute this expression into Equation 6.2 for ΔR to produce Equation 6.1. Then differentiate Equation 6.1 with respect to income:

$$d\Delta R \div dI = \Delta t[(t \div p + t)Є'(I) + ((t \div p + t)Є + 1)dQ \div dI] \qquad [6.3]$$

where: $Є'(I) = dЄ(I) \div dI$ (i.e., the rate of change in the income elasticity as income changes).

[4] While it is still theoretically possible for a tobacco tax increase to be progressive when tobacco is an inferior good, the price elasticity of tobacco demand must fall sharply with income.

This formula has some important implications. First, if $dQ \div dI$ (the rate of change in consumption as income changes) is positive and $\epsilon'(I)$ is positive, then Equation 6.3 is positive. In other words, if the price elasticity rises (falling in absolute value) as income rises and tobacco is a normal good, then incremental taxes paid when taxes increase rise with income. Second, even if tobacco is an inferior good and $dQ \div dI$ is negative, it is possible for incremental taxes to rise with income. This occurs if $\epsilon'(I)$ is sufficiently positive (i.e., price elasticity rises with income to such a degree that it offsets the negative income effect of $dQ \div dI$). If $dQ \div dI$ is zero (i.e., tobacco consumption does not vary by income), then ΔR rises with income when $\epsilon'(I)$ is positive.

On the margin, a tax increase is progressive if the ratio of $\Delta R \div I$ rises with income. This occurs if the following expression, in which income elasticity of additional taxes exceeds one, is true:

$$(I \div \Delta R)(d\Delta R \div dI) > 1 \qquad [6.4]$$

Estimate the left hand side of Equation 6.4 in the following way. Equation 6.1 permits estimation of ΔR if the quintile estimates of price elasticity, the average quantity of tobacco purchased by quintile, and the pre-tax price and tax t are known. Use estimates of ΔR, along with quintile average I, to compute differences in these variable from quintile to quintile. The ratio of these differences provide the estimate of $d\Delta R \div dI$:

$$\Delta(\Delta R) \div \Delta I \approx d\Delta R \div dI \qquad [6.6]$$

For each quintile, compute $I \div \Delta R$ and then combine with Equation 6.6 to obtain an estimate of Equation 6.4.

$$(I \div \Delta R)\Delta(\Delta R) \div \Delta I \approx (I \div \Delta R)(d\Delta R \div dI) > 1 \qquad [6.7]$$

If the resulting expression is greater than 1, then on the margin the tax increase is progressive.

It is possible for Equation 6.4 to exceed one, even if, on average, the tax is regressive (i.e., $T \div I$ declines with income). For example, consider the special case where $dQ \div dI = 0$, so that $T \div I$ automatically declines with income (provided that Q exceeds zero). In this case, the right hand side of Equation 6.4 becomes

$$(I \div \Delta R)(d\Delta R \div dI) = tI\epsilon'(I) \div Q(t\epsilon + (p + t)) \qquad [6.5]$$

If I is large relative to $Q(t\epsilon + (p + t))$, that is, the denominator of this expression and $\epsilon'(I)$ is positive, then Equation 6.4 holds.

As previously mentioned, empirical research consistently determines that ϵ rises with income—that is, $\epsilon'(I)$ appears to be positive (recall that ϵ is less than zero, so that a rising ϵ means that demand is becoming more inelastic). For plausible values of I, p, t, and ϵ, it is possible that Equation 6.4 exceeds one, because I is quite large compared to p, t, and ϵ. When $dQ \div dI$ exceeds zero, then the left hand side of Equation 6.5 is larger than the right hand side, suggesting that marginal tobacco taxes can be progressive—though this is an empirical matter.

Examples

Example A

Suppose that for the poor, $Є_{poor} = –0.8$ while for the wealthy, $Є_{wealthy} = –0.4$. Also suppose that for the poor Q = 100, the current price of cigarettes prior to taxation is $1.00, and the initial tax level is $0.50 per package. The proposed tax increase is $0.10. Using Equation 6.1, the increase in tobacco taxes paid by the poor is

$$\Delta R_{poor} = ((t \div p + t)Є_{poor} + 1)Q\Delta t = [(1 \div 3)(–0.8) + 1]100(0.10) = 7.33$$

Now suppose the income elasticity of demand is zero, so that for the wealthy Q = 100 and the price elasticity of demand is higher. Thus, also using Equation 6.1, the increase in tobacco taxes paid by the wealthy is

$$\Delta R_{wealthy} = ((t \div p + t)Є_{wealthy} + 1)Q\Delta t = [(1 \div 3)(–0.4) + 1]100(0.10) = 8.67$$

Thus the wealthy pay about 18 percent more in additional taxes, solely because of the rise in price elasticity that results with higher income. Whether or not this tax increase is progressive depends upon the difference in income between the low- and high-income groups. If the gap is less than 18 percent, then the tax increase is progressive.

Example B

A more extensive example uses data provided in Tables 6.1 and 6.2. Assume that for the poor Q = 50 and that $\Delta t = \$0.10$. The price elasticity of the wealthy ($Є_{wealthy}$) is held constant at –0.4. In Tables 6.1 and 6.2, $Є_{poor}$ varies between –1.2 and –0.4 while $Є_I$ varies between –0.5 and 1.0. Finally, p = 1.00, $\Delta t = 0.10$, and t = 0.50. Use Equation 6.1 to compute $\Delta R_{wealthy}$ and ΔR_{poor} with the following modification: the quantity purchased by the wealthy is given by

Table 6.1. Incremental Tax Ratio: $\Delta R_{wealthy}/\Delta R_{poor}$

	$Є_{poor}$		
$Є_I$	–0.40	–0.80	–1.20
–0.50	0.50	0.59	0.72
0.00	1.00	1.18	1.44
0.50	1.50	1.77	2.16
0.80	1.80	2.13	2.60
1.00	2.00	2.36	2.89

$Q_{wealthy} = (1 + Є_I)Q_{poor}$

This formula indicates that if $Є_I = –0.5$, then tobacco purchases of the wealthy are half that of the poor; if $Є_I = 1.0$, then the wealthy spend twice as much on tobacco as do the poor.[5] In general, the relationship between purchases of the poor and the wealthy is given by

$Q_{wealthy} = (1 + Є_I[\%\Delta I \div 100])Q_{poor}$

Thus if the income elasticity of tobacco consumption is 0.5 and the income of the wealthy 10 times that of the poor, then $Q_{wealthy}$ is 10 times that of Q_{poor}. Since $[\%\Delta I \div 100]$ is assumed equal to 1, then $Q_{wealthy} = (1 + Є_I)Q_{poor}$ is relevant.

Considering this modification, ΔR_{poor} in Table 6.1 is derived from the following version of Equation 6.1:

$\Delta R_{poor} = ((t \div p + t)Є_{poor} + 1)Q_{poor}\Delta t$

$\Delta R_{wealthy}$ is derived from the following modification of Equation 6.1:

$\Delta R_{wealthy} = ((t \div p + t)Є_{wealthy} + 1)Q_{wealthy}\Delta t = ((t \div p + t)Є_{wealthy} + 1)(1 + Є_I)Q_{poor}\Delta t$

Here, t, p, and Δt are the same as for the poor, while $Є_{wealthy} = –0.4$, and $Є_I$ ranges between –0.5 and 1.0.

Table 6.1 shows the ratio of the change in tobacco taxes paid by the wealthy over the change in tobacco taxes paid by the poor. When the income elasticity is negative, the poor pay more additional taxes then do the wealthy; however, this ratio increases as the price elasticity of the poor declines. As the income elasticity of income rises and the price elasticity of the poor drops, the ratio of taxes paid by the wealthy to taxes paid by the poor rises.

Table 6.2. Ratio of Incremental Tax Income Shares: $\Delta T_{wealthy}/I_{wealthy}/\Delta T_{poor}/I_{poor}$

	$Є_{poor}$		
$Є_I$	–0.40	–0.80	–1.20
–0.50	0.25	0.30	0.36
0.00	0.50	0.59	0.72
0.50	0.75	0.89	1.08
0.80	0.90	1.06	1.30
1.00	1.00	1.18	1.44

[5] This assumes the income of the wealthy is twice that of the poor, so the percentage change in income is 100 percent.

Table 6.2 shows the same parameter values for computing $\Delta R_{wealthy}$ and ΔR_{poor}, but I_{poor} = 1,000 and $I_{wealthy}$ = 2,000. This table compares additional taxes paid as a fraction income; entries are the ratio of incremental taxes paid as a fraction of income for the wealthy to the incremental taxes paid as a fraction of income for the poor. A value less than one indicates the incremental change in taxes paid as a fraction of income is greater for the poor, while a value greater than one indicates the incremental change in taxes paid as a fraction of income is greater for the rich than for the poor. A value exceeding one indicates the degree of inequality has declined as a consequence of raising taxes.

Table 6.2 also shows that as the price elasticity of the poor drops, additional taxes paid as a fraction of income rises. In the lower left hand corner of the table, the incremental tax changes are progressive (i.e., for these parameter values, increases in the tobacco tax reduce inequality on the margin). For example, the entry corresponding to an income elasticity of 0.8 and a price elasticity for the poor of –0.8 is slightly greater than one. On average, given these parameter values, the tobacco tax is regressive since the income elasticity is less than one; total taxes paid as a fraction of income is declining as income rises. Nonetheless, the fact that the value of this entry exceeds one indicates that on the margin, an increase in the tobacco tax is progressive (i.e., the degree of inequality is reduced when taxes are increased). Of course, the relevancy of this example to real world situations should be viewed with caution. In any particular case, actual parameter values must be determined in order to assess the impact of a tobacco tax increase on income inequality.

Knowledge Required to Conduct an Analysis

The calculations used in Table 6.1 and 6.2 require knowledge of several parameters. At a minimum, the price elasticity of the poor and the wealthy (i.e., the price elasticity for the lowest and highest quintiles) need to be determined. In addition, tobacco consumption levels of the poor and wealthy must be known, along with the proposed tax increases. If only the consumption of the lowest income quintile is known, the consumption of the highest income quintile can be estimated if the income elasticity of consumption is known. Average income for each quintile is also required. With these parameters, the calculations used in Tables 6.1 and 6.2 can be replicated to determine the marginal progressivity of tobacco tax increases.

V. Standard of Living

It is argued that higher tobacco taxes reduce the amount the poor spend on shelter, food, clothing, childcare, and other necessities. If true, the imposition of tobacco taxes reduces the standard of living for the poor, hurting an already vulnerable group. From this perspective, a household's share of expenses on non-tobacco items is the relevant focus in assessing the impact of higher tobacco taxes. If tobacco taxes increase and the expenditures on non-tobacco items in poorer households decline, then such households are worse off. However, if expenditures on non-tobacco items decline or stay the same, then such households are no worse off, and perhaps even better off, due to increased tobacco taxes. This chapter examines the effect of tax increases on the change in the share of non-tobacco expenditures.

Define the Parameters

Percentage Change in Tobacco Price

ΔT is the percentage change in tobacco price as a result of a tax increase. This is a policy parameter and is determined by the initial price of tobacco (i.e., the price of tobacco before a tax increase is put into place) and by the size of the tax increase, though varying quality and price can complicate this calculation. Assuming the poor purchase lower quality cigarettes, use the price of the cheaper brands of tobacco as an initial price. (Use a more sophisticated approach to generate a tobacco price index by weighing the different quality cigarette brands by expenditure shares for the poor.) It may be appropriate to determine the price and tax increases on hand-rolled cigarettes and *bidis*.

It is possible that tobacco consumption by the poor can largely escape higher taxes depending on the nature of taxation and the way in which the poor consume tobacco products. For instance, this can happen if higher tobacco taxes are limited to solely manufactured cigarettes while the poor consume primarily hand rolled cigarettes or *bidis*. If the tobacco tax is *ad valorem* (i.e., expressed as a rate rather

than an amount per unit), then do not take into account differences in tobacco quality. In this case the price change ΔT is given by

$$\Delta T = \Delta t \div (1 + t)$$

where: t = the initial tax rate.

Δt = the change in the tax rate.[6]

The role of substitution can play an important role in minimizing equity concerns for the poor. If there are lower-priced and/or non-taxed options available (e.g., hand-rolled cigarettes, *bidis*) then the impact of higher taxes on manufactured cigarettes on the welfare of the poor may be small. That is, as taxes on manufactured cigarettes increase, the poor may switch to the lower-priced, low-quality options (e.g., hand-rolled cigarettes, *bidis*). Because these options are not taxed or taxed at lower rates, the amount of tax revenue paid by the poor is reduced.

The equity effects of higher taxes are also smaller if taxes are *ad valorem*, as long as there are lower-priced options available. The absolute size of an *ad valorem* tax depends on the tax rate and the pre-tax price of the product. If the product's price is low, then the absolute amount of the tax, all else being equal, is lower than the absolute amount of the tax collected on higher-priced brands. Using *ad valorem* taxes mitigates to some degree the equity impact of higher cigarette taxes.

Prevalence Rate

ρ is the prevalence rate for low-income adults. To determine this rate accurately, it must be calculated from survey data. In the absence of good survey data, set ρ = 50 percent (i.e., 0.5). If there are good estimates of the average household's income share of tobacco expenditures, it is not necessary to obtain a value for this parameter, as made apparent below.

Number of Adults per Household

γ is the average number of adults per household. To determine this rate accurately, it must be calculated from survey data. In the absence of good survey data, it is sufficient to set $\gamma = 2$.

Household Tobacco Expenditures

α is the average household share of tobacco expenditures, calculated as total annual tobacco expenditures divided by total household income. Essentially, given a representative sample of poor households, tobacco expenditures are summed across households; for the same sample, household income is added up across households.

[6] Note: the initial price is absent from this equation (price cancels out), so the quality/price issue is not a concern.

Then divide total tobacco expenditures by total household income to get α, the average share of household income spent on tobacco products. Assuming a representative random sample of poor households, this procedure automatically takes into account prevalence rates and households with more than one smoker.

A rough estimate of α can be calculated.

1. Estimate the amount of tobacco consumed daily by a typical low-income smoker.
2. Using current market prices, determine the daily cost of such a habit.
3. Multiply by 365 to determine the annual tobacco expenditure.
4. Divide the annual tobacco expenditure by an estimate of annual income of a poor household. If there is one smoker in the household, this gives the share of tobacco expenditures.

If there is not exactly one adult per household or one adult smoker per household, the estimate can be refined.

1. Obtain an estimate of the average number of adults in a poor household (γ), as above.
2. Multiply the average number of adults in a household by the adult prevalence rate (ρ).
3. Multiply this product average tobacco expenditures per adult smoker (A).
4. Divide this product income (I).

Formally, this equation appears as

$$\alpha = \gamma \times \rho \times A \div I$$

Thus, if $\gamma = 2$ and $\rho = 0.4$ and $A \div I = 0.24$, then $\alpha = 0.192$. Of course, if α is the average of household tobacco expenditures for *all* low-income households, then this formula is not relevant. Instead, use the earlier formula directly, without modification.

Assess the Impact of Higher Tobacco Taxes on Household Expenditures

The decline in non-tobacco expenditures as a fraction of total expenditures (Δß) is given by the formula:[7]

$$\Delta ß = \alpha \times (1 + Є) \times \Delta T \qquad [6.8]$$

[7] This formula is derived by noting that $\Delta E \div \Delta P = Q(1 - Є)$, where E = total tobacco expenditures (i.e., PQ). From this formula, one can derive $\Delta E \div I = (P \div P)(\Delta P)Q(1 - \alpha) \div I$, where I = income. The left hand side of the equation is the change in the fraction spent on tobacco. To acquire the equation stated in the text, collect and rearrange the terms on the right hand side of the equation.

where: α = the fraction of total income spent on tobacco: $PQ \div I$, where P is the price of tobacco prior to the increase in taxes (and thus includes taxes already in place) and Q is the quantity of tobacco purchased.

Є = price elasticity of tobacco demand: $(\Delta Q \div \Delta P) \times (P \div Q)$, where ΔQ is the change in quantity and ΔP is the change in price, due to the imposition of a higher tobacco tax.

ΔT = fractional change in the original tobacco price, due to increases in tobacco taxes: $\Delta P \div P = \Delta t \div P$.

Note that the share of income spent on non-tobacco goods and services (ß) = $1 - \alpha$. This means that

$\Delta ß = 1 - \Delta\alpha$

In other words, the change in the fraction of income spent on non-tobacco income must equal minus the change in the fraction of income spent on tobacco. Hence to get a rough measure of the impact of higher tobacco taxes on the poor, it is necessary to know three parameters: α, Є, and Δt. These parameters vary from one country to the next.

Analyze the Parameters

The most striking aspect of Equation 6.8 is that the impact on non-tobacco expenditures is small if Є is close to negative one. Estimates vary, but for low-income groups this parameter is indeed often close to negative one. For example, Warner (1990) finds this parameter for Papua New Guinea to be less than –1. If Є equals negative one, then the amount spent on non-tobacco items remains unchanged when tobacco taxes increase. If Є is less than negative one, then expenditures on non-tobacco items actually increase when tobacco taxes increase. Thus, if the welfare of poor households is measured by non-tobacco expenditures, then the poor are not adversely affected by higher tobacco taxes when $-1 \geq$ Є.

For the poor in developed economies, estimates of Є are –0.8 or higher. For instance, Townsend *et al* (1994) finds a value for Є of –1.0 for the lowest socioeconomic group in the United Kingdom. Values for Є are probably in this range for low- and middle-income countries, as Hu's (1997) estimate for China suggests. China (with a population of 1.2 billion and per capita income estimated in 1999 to be US$3,600, adjusted to reflect differences in purchasing power) has a value of Є lying in the range –0.6 to –0.8. The value of Є varies from country to country (see **Tool 3. Demand Analysis** for a further discussion on estimating price elasticity of tobacco demand).

If α is small, then the impact of tobacco tax increases on non-tobacco expenditures will also be small. If the proportion of income spent on tobacco is relatively small to begin with, then increases in tobacco

taxes will have a small impact on the amount spent on non-tobacco items.

Another issue is how large $\Delta\alpha$ can become. The largest economically possible value of ϵ is zero—that is, completely inelastic demand, which means that when the price of tobacco increases, the quantity demanded does not change. While the price elasticity is never zero for groups, it can be zero for individuals. In this case $\Delta\alpha$ depends only on α and ΔT. For example, if the price of tobacco is doubled so that $\Delta T = 1$, tobacco's share of expenditures doubles from α to $2 \times \alpha$. If $\alpha = 0.2$ and $\Delta T = 0.1$ (i.e., a tax increase that boosts the price of tobacco by 10 percent), then non-tobacco expenditures fall by 0.02 (2 percent) when demand is perfectly inelastic.

An Example

Consider that cigarettes in the United States average US$3.00 per pack of 20. Hence a smoking habit of two packs per day costs about US$2,200 per year. The poverty level in the United States for a single person is about US$9,000 per year. Hence the share of tobacco expenditures for a single poor person averages $\alpha' = 1{,}100 \div 9{,}000 = 0.24$.[8] There are no good estimates of ϵ for low-income groups in the United States, but suppose the long-term price elasticity is around –0.8; this is consistent with estimates for teenage smokers in the United States and with the estimates by Townsend *et al* (1994) for the United Kingdom. If taxes are raised so that the price of cigarettes increases by US$0.30 (i.e., from US$3.00 to US$3.30), then $\Delta T = \Delta P \div P$ = US$0.30 ÷ US$3.00 = 0.1. Inserting these numbers into Equation 6.8 gives

$$\Delta\alpha = \alpha \times (1 + \epsilon) \times \Delta T = 0.24 \times (1 - 0.8) \times 0.1 = 0.0048$$

Thus if the price of cigarettes increase by US$0.30, then on average non-tobacco expenditures for households with a heavy smoker fall by 0.48 percent. Overall, the total amount of the decline in non-tobacco expenditures by the poor will probably be even lower than 0.48 because overall smoking prevalence for the poor in the United States is less than 100 percent—the prevalence rate among poor adults is about 40 percent. Assuming the typical household has two adults (which is probably high, as poor households in the United States typically have less than two adults), the prevalence rate for households is 80 percent, in which case the decline in non-tobacco expenditures for all poor is about 0.38 percent. The impact of the tobacco price increase can be easily offset by an adjustment in the earned-income tax credit, which would also benefit the non-smoking poor.

[8] Assuming this value approximates the share of income spent on tobacco by low-income households.

VI. Poverty and Tobacco-Related Illness

Tobacco control policies reduce smoking prevalence and intensity, which subsequently cause a decline in tobacco-related illnesses. This in turn leads to a decline in deaths and an increase in life expectancy. Thus a principle benefit of tobacco control policies to the poor is improved health and a longer and more productive life.

In light of this, it is necessary to establish that tobacco-related illnesses are both present among the poor and have a significant impact on their quality of life and life expectancy. This is established by conducting two exercises. First, project the loss of life that would occur in the absence of tobacco control policies and determine how much tobacco control measures reduce loss of life. Second, examine the current rates of tobacco-related illness among the poor.

Currently, life expectancy in developing countries at birth is about 65 years, equivalent to the life expectancy of 63 years in the United States in 1940. From 1940 to 1980, in the United States there was a surge in tobacco-related illness and mortality to the point where now there are about 450 thousand annual deaths attributed to tobacco consumption. If the current trend in developing countries continues, epidemiologists project that those countries will experience a similar upsurge in tobacco-related illness. The standard rule of thumb is that 50 percent of current smokers will die from a tobacco-related illness and that one-half of this group will die in middle age.

The list of tobacco-related diseases is extensive. The following diseases are linked to tobacco consumption:

- cardiovascular diseases (heart attacks, congestive heart failure, strokes)
- respiratory diseases (tuberculosis, emphysema, asthma)
- cancers (lung, mouth, throat, bladder, pancreas, kidney)

Since most cases of lung cancer are attributable to tobacco consumption (90 percent for men), the incidence of lung cancer in a

population is a very good marker of the impact of tobacco consumption on mortality and life expectancy.

Estimate Tobacco-Related Deaths and Disability Adjusted Life Years Lost

A simple way to project future death rates is to examine the relationship between past smoking and subsequent death rates. The relationship between rates of lung cancer mortality and per capita cigarette consumption twenty years earlier is stated as:

$Y = 5.5 + 0.0248X$[9]

where: Y = the lung cancer rate per 100,000 adults ages 35–69.

X = the per capita cigarette consumption per adult 20 years earlier.

A rule of thumb suggests that for every lung cancer death, there are three times more deaths from other tobacco-related illnesses. To determine the number of Disability Adjusted Life Years Lost (DALYs) attributable to tobacco-related illnesses, multiply the number of lung cancer deaths by 36.[10] Total DALYs lost per 100,000 persons is thus given by

$DALYs = 36 \times Y$

To determine the DALYs lost for the entire population, divide the population by 100,000 and multiply this fraction by DALYs:

$Total\ DALYs = 36 \times Y \times (P \div 100{,}000)$

where: P = the entire population.

DALYs take into account the reduced quality of life from debilitating illnesses that precede death, as well as years of life lost due to premature death. Estimating DALYs provides a more comprehensive measure of the impact of tobacco-related illness than premature mortality estimates alone. Use caution in applying this formula, however, as the underlying relationship between smoking and lung cancer deaths can be very different for each country.

The approach outlined here provides, at best, an informed guess about the health impact of smoking. For more details on these techniques and calculations, refer to the chapter on poverty and smoking in Jha and Chaloupka (2000), and Peto *et al* (1992, 1994).

[9] The parameters of this equation are estimated using 1970 per capita cigarette consumption and 1990 lung cancer mortality rates for ages 35 to 69 for selected developed countries. The fit of this equation to the data is respectable, as measured by R^2 ($R^2 = 0.365$). This equation and a brief discussion can be found in "Global Patterns of Smoking and Smoking-Attributable Mortality", Chapter 2 in Jha and Chaloupka (2000).

[10] The value of 36 is the smoking impact ratio discussed by Peto *et al* (1992, 1994).

An Example

Suppose the lowest-income quintile of a country consists of 5 million adults, the prevalence rate is 50 percent, and the average smoker consumes two packs a day. The average number of cigarettes smoked by a smoker annually is 14,600—calculated by multiplying the average number of packs smoked per day by the number of cigarettes in a pack by the number of days in the year:

$14{,}600 = 20 \times 2 \times 365$

Since the prevalence rate is 50 percent, the average number of cigarettes smoked per person in the lowest-income quintile is 7,300 (that is, $14{,}600 \times 0.50$). Therefore, using the equation above, $X = 7{,}300$ such that:

$Y = 5.5 + 0.0248 \times 7{,}300 = 186.54$

This is the annual lung cancer mortality rate for a population of 100,000. The constant (5.5) is interpreted as the number of total lung cancer deaths not attributable to smoking so that the remainder (about 181) of these lung cancer deaths is attributable to smoking. To determine the total death rate attributable to tobacco consumption, multiply 181 by 3 to achieve the total death rate attributable to tobacco of 543 per 100,000.

Putting this in perspective, in the United States the death rate per 100,000 is 864.7 (this is the raw death rate and is not age-adjusted). Hence, the total number of premature lung cancer deaths in 20 years is expected to be about 9,052 (181×5 million $\div$ 100,000) and the total annual premature deaths attributed to tobacco are about 27,156 ($3 \times 9{,}052$). The number of DALY's lost is about 325,872 ($36 \times 9{,}052$). These numbers probably underestimate actual loss of life and DALYs among the poor.

Calculate the Health Impact of Higher Tobacco Taxes

If tobacco taxes are raised by 10 percent, consumption of tobacco declines by 8 percent. In the previous example, this means adult per capita consumption declines from 7,300 to 6,716 cigarettes per year. Using the equation above, this implies, that the lung cancer death rate declines from 181 to 166—a reduction of 15 lives per 100,000. The decline in annual deaths attributed to tobacco, twenty years later, is 45 per 100,000. If the poor population is 5 million, then the annual number of averted deaths is 2,250 (50×45). The DALYs saved is 27,000 ($36 \times 15 \times 50$). Thus a 10 percent increase in tobacco prices annually averts 2,250 premature deaths and saves 27,000 DALYs, among the poor.

VII. Tax Incidence

Understand How the Burden of Tax is Shifted

Economists find it useful to distinguish between the statutory burden and the economic burden of taxation. The statutory burden of a tax is the party responsible for paying the tax, as designated in the original tax legislation. For example, if a bakery is required to pay to the central government's treasury a certain amount for each loaf of bread sold, then the bakery bears the statutory burden of taxation. The economic burden can be different because the bakery is able to shift the burden of the tax onto another party. For example, a bakery can shift the tax forward onto its customers (the consumers) by raising the price of bread by the amount of the tax. Alternatively, a bakery can shift the burden onto factors of production by reducing the wages of its employees.

The likelihood and method of shifting a tax burden depends on how various parties respond to higher costs. To continue the example, if consumers respond by substantially reducing their purchases of bread, the ability of a bakery to shift the tax forward onto consumers is curtailed. Likewise, if a wage reduction results in employees seeking work elsewhere, then the ability to shift the tax onto workers is limited. This degree of tax shifting depends on the responsiveness of consumers and workers to changes in cost—that is, shifting depends on *price elasticity*. However, the degree of shifting also depends on the *supply elasticity* of bakeries. If bakeries supply bread perfectly elastically, then consumers bear the burden of taxation. That is, the number of bakeries decreases until the price of bread rises by the full amount of the tax, so that the price that bakeries receive net of tax is the same as before the tax is implemented.

In the economics of tobacco control, it is typically assumed that the supply of tobacco products is perfectly elastic. That is, there is a belief that there is a competitive world market for tobacco products and that, in the long-term, the tobacco industry is a constant cost industry. Therefore, tobacco taxes are borne by the consumers of tobacco products, and an increase in tobacco taxes results in an increase in the price consumers pay equal to the tax increase.

The importance of these concerns varies in magnitude.

- It is necessary to know the fraction of income spent on tobacco products for various income groups. If the fraction of income spent on tobacco products is, for the poor, small, then the impact of higher tobacco taxes on the poor is diminished.
- It is also important to assess the progressivity of the entire tax system; thus, compute total taxes paid for each income level. If the overall tax system is relatively progressive, then concerns about the distributional impact of higher tobacco taxes are less salient.
- Finally, it is necessary to know the price elasticity of tobacco demand for the poor.

Examine the Entire Tax System

Understand the distributional impact of the entire tax system in order to place the distributional effects of tobacco taxes in proper perspective. Admittedly, this is a complicated undertaking. Pechman and Okner (1974), who examine the distributional burden of the U.S. tax system in the 1960s, offer the prototype for this exercise. Replicating their study for a given country requires a great deal of data and analysis. The principal conceptual issue complicating any analysis of tax burden is the determination tax incidence, which takes into account the possibility that the individuals or firms bearing the statutory burden of taxation may not bear the actual economic burden. Instead, taxed entities may be able to shift the actual burden of taxation onto some other group.

For example, the corporate income tax is a tax imposed on the profits of incorporated firms; corporations are required to make a payment to the Ministry of Finance based on their reported profits for a given year. The immediate perception is that this leads to less profit distributed to shareholders, and hence the burden of the tax is borne by stockholders. But there are other possibilities. Firms can respond to the tax by raising the price of their output, thus shifting the tax burden onto consumers. Another possibility is that the tax lowers the return on capital invested in the corporate sector, causing, in the long-term, a reallocation of capital to unincorporated sectors, depressing the rate of return on capital throughout the economy. Capital throughout the economy then bears the burden of corporate taxation. Further, a fall in the rate of return of capital can lead to a reduction in savings. With less capital to work with, workers are less productive and wages decline. Labor, then, carries the ultimate burden of the tax.

In short, a study of the tax burden must consider the various possibilities for shifting tax burdens among different groups. Pechman and Okner (1974) deal with the issue of tax incidence by considering a range of different incidence scenarios for various

taxes, and then examining how changes in incidence assumptions affect their conclusions.

Obtain an Overview of the Tax System

Gain a rough picture of the overall tax burden by considering some of the basic features of the tax system. A standard approach is to use incidence assumptions that are regressive (that is, make assumptions that tend to impose the greatest tax burden on low income groups). Consider also whether there are multiple taxing entities. For example, cities, municipalities, provinces, and other administrative units may impose taxes in addition to those imposed by the central government. For an initial overview, only focus on those taxes imposed by the central government.

Study Income Taxes

Examine any income taxes and their impact on the poor.

1. Are the poor essentially exempted from income taxes?
2. If not, what are the effective rates imposed on the poor?
3. How progressive is the income tax rate structure? Are there loopholes or exemptions that make the income tax less progressive than the rate structure alone suggests? For example, are any forms of income (e.g., certain types of interest income, capital gains) tax exempt?

It is typical to assume the incidence of the personal income tax falls on the taxed individual (i.e., income taxes are borne entirely by the taxed individual). Compute average income taxes paid for each income quintile.

Study Excise and Sales Taxes

Consider excise and general sales taxes.

1. List all specific excise taxes that are imposed.
2. Determine the average amount consumed by each income quintile so that the average amount of taxes paid by quintile can be estimated.
3. Note whether the poor disproportionately consume goods subject to excise taxation. To establish a worse case scenario (i.e., the most regressive case), assume sales (and VAT) taxes and corporate and business taxes are borne entirely by consumers.
4. Using these assumptions, estimate average taxes paid for each income quintile. Be sure to include tobacco excise tax payments in these estimates.

If average taxes paid decline with income, then the overall tax system is progressive (i.e., any propensity of tobacco excise taxes to adversely affect the poor is offset by presence of other more progressive taxes in the system). Accordingly, the distributional impact of tobacco taxes is muted by the overall tax system. Of course, one can further reduce adverse distributional impacts of tobacco excise taxes by lowering some other tax that is borne primarily by the poor.

This assessment assumes the entire burden of taxation falls upon the consumer, and is based on a simple framework in which the long-term supply curve for tobacco products is horizontal—this is the case if tobacco products are competitively supplied by a constant cost industry. If this assumption is not approximately valid, then shift some of the burden of taxation away from consumers. Of course, the burden of taxation on the poor is then reduced. The benefit is less severe distributional consequences of tobacco taxes. The drawback is that the effectiveness of a given tobacco tax increase in reducing consumption is blunted.

Briefly, the following scenario might unfold.

1. Tobacco taxes rise.
2. Tobacco companies lose customers and respond by lowering the wholesale price.
3. The retail price of tobacco products declines.
4. The net change in tobacco prices is less than the increase in tobacco taxes.

In theory, increasing taxes can further offset wholesale price declines. In practice, this may be hampered by bureaucratic and political lags.

Study Property Taxes

In addition to taxing income and transactions, taxes can also be levied on various forms of wealth. An important type of wealth tax is the property tax, which can be levied on different forms of wealth such as land, buildings, automobiles, industrial equipment, and more personal forms of wealth such as jewelry. Property taxes are most commonly imposed on buildings, houses, commercial property, and land.

The incidence of property taxes (that is, who bears the ultimate burden) is the subject of controversy. Traditional view holds that property taxes are borne by the consumers of the services generated by property (see Netzer, 1966). If this is valid, property taxes can be regressive or perhaps proportional. However, more recent scholarship emphasizes that property taxes are shifted onto the owners of all types of capital. In this case, for most economies property taxes are probably progressive since higher-income groups disproportionately earn income from capital ownerships.

To properly and effectively apply property taxes, the standard procedure is to investigate a range of incidence assumptions and determine the sensitivity of conclusions about the tax system to such assumptions. If property taxes are an important factor, it is typical to consider the two alternatives discussed here: property taxes borne by consumers, and property taxes borne by the owners of capital.

Determine Net Taxes Paid

Post-tax income (Y´) is determined by subtracting average quintile taxes paid from quintile average income, as such:

$$Y' = Y - T$$

where: Y = average income.

T = average taxes paid (income, sales, excise, payroll, and property taxes).

Determining tax incidence is difficult; taxes can be shifted from consumers on to producers and vice versa. Hence, even if households are not by law liable for a given tax, from an economic perspective they may be bearing the burden of the tax because of tax shifting. For example, corporate income taxes legally are borne by corporations, but they may pass the burden of such a tax onto consumers by raising the price of their output. On the other hand, households may bear the statutory burden of taxation, but market forces may cause the economic burden to shift to suppliers. For instance, the imposition of a kerosene tax causes the price to fall, so that the net change in consumer price is less than the nominal size of the tax.

It is standard to examine an array of incidence assumptions. Typically, however, payroll and income taxes are assumed to fall upon the taxpayer while excise and sales taxes fall upon consumers (see Pechman and Okner, 1974).

Measure Inequality

The standard measure of income inequality is the Gini coefficient. While this is not necessarily the best index of inequality, it is relatively easy to calculate and widely used.[11] The Gini coefficient takes on values between 0 and 100,[12] but in actual practice it typically lies between 20 and 50 (though there are a few countries with a Gini coefficient exceeding 60). When the index is 0, incomes are equal; when the index is 100, one family earns all of a country's income and all other families earn zero income. Thus the higher the Gini coefficient, the greater the degree of inequality. The World

[11] Litchfield (1999) provides a good discussion of inequality indices.

[12] The Gini coefficient is sometimes reported as a number between 0 and 1. The World Bank normalizes the index so that it lies between 0 and 100.

Bank gives the distribution of income by quintiles and provides Gini coefficients for many countries (www.worldbank.org/poverty/data/wdi2000/pdfs/table2_8.pdf). A brief, relatively non-technical overview of the Gini coefficient is available at (www.panix.com/~dhenwood/Gini_supplement.html).

An equation for the Gini coefficient (G) is stated formally as:

$$G = \frac{1}{2N^2\overline{Y}} \sum_{i=1}^{N} \sum_{j=1}^{N} \left| Y_i - Y_j \right|$$

where: Y_i = household *i*'s income.

$\overline{Y}$ = mean income.

N = the number of households.

Note that if all incomes are equal, then the summed equation is zero and G = 0. For example, if N = 2, Y_1 = 25, and Y_2 = 75, then the equation becomes:

G = (1 ÷ (2(4)(50)) (0 + 50 + 50 + 0)) = ½.

If the N households are ordered from wealthiest to poorest, so that 1 corresponds to the poorest household while N is the wealthiest, then the Gini coefficient is written as

$$G = \frac{1}{N} \sum_{j}^{N} \sum_{i<j}^{N} \left| y_j - y_i \right|$$

where: y_i = the *i*th household's share of total income.

This means that quintile shares of total income can be used to compute Gini coefficients. In this case, y_i = the income share of the ith quintile and N = 5 in the formula above.

Determine the Pre- and Post-Tax Gini Coefficient

To assess the impact of the tax system on the distribution of income:

1. Compute the income shares of income quintiles prior to tax payments.
2. Using this data, compute the pre-tax Gini coefficient.
3. Compute the post-tax distribution of income by quintile shares, including tobacco taxes.

If the Gini coefficient is smaller in step 3 than the Gini coefficient for pre-tax income in step 2, then the tax system is overall progressive. Thus even if the tobacco taxes, taken in isolation, are regressive, other components of the tax system are sufficiently progressive so that the overall tax system reduces on net income inequality. This means that concerns about the equity impact of tobacco taxes are not as compelling as might otherwise be the case. Of course, it is also useful to compute the Gini coefficient in the

absence of a tobacco tax increase to assess how much the imposition of tobacco taxes raises the Gini coefficient. Typically the increases are small.

An Example

Consider the quintile data presented in Table 6.3. Assume average post-tax income reflects increases in tobacco taxes. The lowest quintile earns 7 percent of income (y1 = 7), the second lowest earns 11.6 share of total income (y2 = 11.6), the middle quintile earns a 16.1 share of total income, the second highest quintile earns a 22.7 share of income, and the highest quintile earns 42.6 share of total income.[13] Summing the differences between income shares results in a value of 164.6 (as shown in Table 6.4). Dividing this value by 5 gives a Gini coefficient of 32.9. (Typically this estimate of the Gini coefficient, utilizing quintile average income shares, is somewhat lower than the actual Gini coefficient computed using actual households income data. Thus for Algeria, the Gini coefficient is 35.3).

In this example the tax system reduces income, as made evident in the fourth column of Table 6.3. The assumption is that average post-tax income reflects higher tobacco taxes. For each quintile the post-tax share of income is calculated by totaling income, then dividing each quintile's average income by total income, and multiplying by 100. In this example, total post-tax income is the sum of column four, which equals 8,390. So the first entry in column five is 660 ÷ 8,390 × 100 = 7.8 (because of rounding errors, there are small discrepancies in Table 6.3).

Table 6.3. Impact of Tobacco Taxes on Income

	Average Pre-Tax Income	Income Share†	Average Post-Tax Income‡	Post-Tax Income Share††
Lowest Quintile	700	7.0	660	7.8
Second Lowest Quintile	1,160	11.6	1,020	12.2
Middle Quintile	1,610	16.1	1,370	16.0
Second Highest Quintile	2,270	22.7	1,930	23.0
Highest Quintile	4,260	42.6	3,410	41.0
TOTAL	10,000	100.0	8,390	100.0

† (Income ÷ Sum of Income) × 100
‡ Average Pre-Tax Income – Net Taxes Paid
†† (Average Post-Tax Income ÷ Total Post-Tax Income) × 100

[13] This data applies to the country of Algeria.

Using the post-tax income shares, compute income share difference (shown in Table 6.5). Determine the Gini coefficient by dividing the sum of the share differences (154.4) by 5 to get 30.9. Hence, the originally estimated Gini coefficient (above) drops from 32.9 to 30.9. The conclusion is that the tax system generates a pattern of disposable income that is more equitable than would exist in the absence of the tax system. Since the Gini coefficient declines, even taking into account higher tobacco taxes, the tax system remains progressive and increases equity. In this case, the imposition of tobacco taxes does not lead to an increase in inequity, at least as measured by the Gini coefficient, and concerns about the fairness of the tobacco tax increase are less compelling.

Compute Gini Coefficients with a Spreadsheet

A Microsoft Excel spreadsheet is provided as an electronic addendum to this Tool to compute Gini coefficients from quintile data. Data that the investigator must supply is indicated in blue. To fully utilize the spreadsheet, the following information for each income quintile is required (these are quintile averages):

- income
- expenditure
- property income
- dividends
- housing expenditures
- non-tobacco excise tax payments

Table 6.4. Income Share Difference for Pre-Tax Income

	y1 = 7.0	**y2 = 11.6**	**y3 = 16.1**	**y4 = 22.7**	**y5 = 42.6**	**TOTAL**
y1 = 7.0	0 (y1 – y1)	4.6 (y2 – y1)	9.1 (y3 – y1)	15.7 (y4 – y1)	35.6 (y5 – y1)	65.0
y2 = 11.6		0 (y2 – y2)	4.5 (y3 – y2)	11.1 (y4 – y2)	31.0 (y5 – y2)	46.6
y3 = 16.1			0 (y3 – y3)	6.6 (y4 – y3)	26.5 (y5 – y3)	33.1
y4 = 22.7				0 (y4 – y4)	19.9 (y5 – y4)	19.9
y5 = 42.6					0 (y5 – y5)	0
TOTAL	0.0	4.6	13.6	33.4	113.0	164.6

- sales taxes (VAT taxes)
- tobacco tax payments
- total corporate income taxes collected

If data is not available, there are several options. First, treat the data as missing by assigning it a value of zero. Second, if total amounts are available from, say, National Income and Product Account data or the Ministry of Finance, then apportion totals according to income shares.

There are two sets of incidence assumptions to invoke; one is a set of progressive assumptions, and the other is a set of typically more regressive assumptions. The incidence assumption is indicated in red. The progressive scenario assumes that the burden of property taxes falls on property income and that corporate taxes fall on shareholders and property holders. The regressive scenario assumes that corporate taxes are shifted to the consumers of corporate output and that property taxes function as a tax on the consumption of housing services. Both the Gini coefficients and the change in the Gini coefficient are indicated in green.

Consider a Minimalist Approach

In the absence of detailed data about the structure of taxes and sources of income, it is useful to undertake the following exercise. Suppose that average income by quintile is available. For each quintile, determine the corresponding income tax liability associated with average quintile income. Then determine for each quintile average tobacco taxes paid. If total excise tax payments are available, apportion them into quintiles according to the quintile

Table 6.5. Income Share Difference for Post-Tax Income

	y1 = 7.8	**y2 = 12.2**	**y3 = 16.0**	**y4 = 23.0**	**y5 = 41.0**	**TOTAL**
y1 = 7.0	0 (y1 – y1)	4.4 (y2 – y1)	8.2 (y3 – y1)	15.2 (y4 – y1)	33.3 (y5 – y1)	61.0
y2 = 11.6		0 (y2 – y2)	3.8 (y3 – y2)	10.8 (y4 – y2)	28.8 (y5 – y2)	43.4
y3 = 16.1			0 (y3 – y3)	7.0 (y4 – y3)	25.0 (y5 – y3)	32.0
y4 = 22.7				0 (y4 – y4)	18.0 (y5 – y4)	18.0
y5 = 42.6					0 (y5 – y5)	0
TOTAL	0.0	4.4	12.0	33.0	105.0	154.4

share of tobacco taxes paid. Then sum the tax payments, income, and tobacco excise taxes (and other excise taxes if available) for each quintile and compute after tax quintile income. For the pre-tax income and resulting post-tax income, calculate the Gini coefficients and examine the change in Gini coefficients; if the Gini coefficient declines for post-tax income, this provides some evidence that the overall tax system is progressive.

Ultimately, the entire fiscal system is relevant in determining the impact of higher tobacco taxes. This means that, in addition to taxes, one should also consider *all* government expenditures and transfer payments in determining the impact of government activity on the distribution of income. Government expenditures on health, education, housing, as well as direct cash transfers to low income families must be assessed and calculated. Such government expenditures, in conjunction with taxes, are then jointly taken into account in determining the overall progressivity of the fiscal system. Compute and compare the Gini coefficients, both before and after taking into account all taxes and expenditures. If the Gini coefficient after the impact of the entire fiscal system is taken into account declines, then the overall fiscal system is progressive.

VIII. Conclusion

The objection that higher taxes injure the poor is a very potent argument against one of the prime methods of tobacco control. This Tool identifies ways of investigating the impact of higher tobacco excise taxes on the poor. Since the amount and quality of data, as well as the amount of time and resources available for analysis, may vary, a range of methodological options are suggested. Thus both approaches that are bare bones in nature as well as methodologies that are state of the art are proposed.

A fundamental point is that there is no reason for higher tobacco taxes to disproportionately injure the poor, so long as policies are well designed. For instance, higher taxes can be offset in a variety of ways. Other taxes on commodities used by the poor can be reduced. And tobacco tax revenue can be earmarked for expenditures that primarily benefit the poor, such as health clinics, capital development projects, or education.

Additionally, because of the way the poor respond to higher tobacco taxes, the impact of higher taxes can be ameliorated. Thus, if the poor respond by significantly reducing tobacco consumption, then impact on the welfare of the poor may, on average, be slight, though this depends on the magnitude of their responses.

Finally, it is important to keep in mind that the health consequences of tobacco consumption are much more disruptive and severe for the poor. With little access to health care and little or incomplete knowledge about some aspects of health and medicine, mortality and disability rates among the poor are much higher when they acquire tobacco related illnesses.

In short, this Tool's basic policy conclusions and suggestions are very straightforward. Tobacco tax increases can be offset by changes in the pattern of government expenditures or by lowering other taxes paid by the poor. Further, it is possible that, at the aggregate level, the impact of higher tobacco taxes on the poor may not be as severe as is sometimes put forth. Most of the material in this Tool examines when this second assertion is likely to be true. If it is not true, the first policy option is always available to remedy the impact of higher taxes.

IX. Additional References

Becker, G., and Murphy, K, (1988), "A theory of rational addiction," *Journal of Political Economy,* 96, 675–700.

Bobak, M., Jha, P., Nguyen, S., and Jarvis, M., (2000) "Poverty and smoking," in Jha and Chaloupka eds., *Tobacco Control in Developing Countries*, Oxford: Oxford University Press, pages 41–61.

Gajalakshmi, G. K., Jha, P., Ransom, K., and Nguyen, S., "Global patterns of smoking and smoking-attributable mortality," in Jha and Chaloupka eds., *Tobacco Control in Developing Countries*, Oxford: Oxford University Press, pages 11–39.

Hu, T., (1997), "Cigarette taxation in China: Lessons from international experiences," *Tobacco Control*, 6, 136–140.

Jha, P and Chaloupka, F., (2000) eds., *Tobacco Control in Developing Countries*, Oxford: Oxford University Press.

Litchfield, J., (1999), "Inequality measures and tools," unpublished World Bank report (available at www.worldbank.org/poverty/inequal/methods/index.htm).

Meara (1999), "Why is health related to socioeconomic status?" unpublished paper, Harvard Medical School.

Netzer, D., (1966), *Economics of the Property Tax*, Brookings Institution.

Pechman, J., and Okner, B. (1974), *Who Bears the Tax Burden?* Brookings Institution.

Peck, R., Chaloupka, F., Jha, P., and Lightwood, J., (2000), "A welfare analysis of tobacco use," in Jha and Chaloupka eds., *Tobacco Control in Developing Countries*, Oxford: Oxford University Press, pages 131–151.

Peto, R., Lopez, A.D., Boreham, J., Thun, M., and Heath, C.J., (1992), "Mortality from tobacco in developed countries: Indirect estimation from national vital statistics," *Lancet*, 339, 1268–1278.

Peto, R., Lopez, A.D., Boreham, J., Thun, M., and Heath, C.J., (1994), *Mortality from Smoking in Developed Countries 1950–2000: Indirect Estimates from National Vital Statistics*, Oxford: Oxford University Press.

Poterba, (1989), "Lifetime incidence and the distributional burden of excise taxes," *American Economic Review*, 79 (May), pages 325–330.

Rosen, H., (1999), *Public Finance*, Fifth Edition, Irwin McGraw-Hill.

Sen, A., (1982), *Poverty and Famines*, Oxford: Oxford University Press.

Sullivan, M., (2000), "Taxing the 'sins' of the poor: Do two wrongs make a right," *State Tax Notes***,** v. 1 18 (17), April 17, 2000, pages 1377–1381.

Townsend, J., Roderick, P., and Cooper, J., (1994), "Cigarette smoking by socioeconomic group, sex, and age: Effects of price, income and health publicity," *British Medical Journal*, 309, (6959), pages 923–927.

Warner, K., (1990), "Tobacco taxation as a health policy in the third world," *American Journal of Public Health*, 80, 529–530.

World Bank Report, (1999), *Curbing The Epidemic: Governments and the Economics of Tobacco Control*, World Bank Publication.