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National Income, Inequality and Global Patterns of Cigarette Use

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Abstract

Declining tobacco use in high-income nations and rising tobacco use in low- and middle-income nations raises questions about the sources of worldwide patterns of smoking. Theories posit a curvilinear influence of national income based on the balance of affordability and health-cost effects. In addition, however, economic inequality, gender inequality and government policies may moderate the rise and fall in smoking prevalence with national income. This study tests these arguments using aggregate data for 145 nations and measures of smoking prevalence circa 2000. The results show nonlinear effects of national income for males that take the form of an inverted U, but show linear effects for females. They also show non-additive effects of economic inequality for males that moderate both the rise and decline of smoking with national income and non-additive effects of gender equality for females that moderate the positive effect of national income.

Introduction

Although cigarette use has declined in high-income, more developed countries, it has grown substantially in middle- and low-income, less- developed countries (Jha and Chaloupka 2000; World Bank 1999). To illustrate, cigarettes consumed per adult age 15 and over fell from 1970 to 1990 by 9 percent in high-income nations and rose by 64 percent in middle- and low-income nations – a net increase in world consumption of 18 percent (World Health Organization 1997). The pattern of change has continued since then. Today, about 82 percent of the world's 1.1 billion smokers reside in middle- and low-income countries (Sorensen et al. 2005), and smoking in many developing nations has come to exceed that in more developed nations.

These trends have progressed further for men than women but apply to some degree to both genders. Today, about 35 percent of men in developed countries and 50 percent in developing countries smoke (Mackay and Eriksen 2002). For women, the pattern is reversed; about 22 percent in developed countries and 9 percent in developing countries smoke. Much as for men, however, the direction of change among women differs across level of development. Cigarette use has fallen for women in many high-income nations, but use by women in middle- and low-income nations – after a period of low levels and little change – appears primed to move upward (Mackay 1998). Forecasts suggest that by the year 2025 about 20 percent of women worldwide will smoke (Ernster et al. 2000).

Growing smoking across the developing world obviously raises public health concerns (Satcher 2001; Sugarman 2001; Warner 2005). The global spread of cigarettes will limit the benefits for longevity of other forces of development, medicine, and public health (Ezzati and Lopez 2003a, 2003b). By some estimates, tobacco kills 5 million people each year, with

about half the deaths occurring in developing nations (WHO 2004). Rising cigarette use in the developing world will almost certainly increase tobacco-related deaths in decades to come. Even the relatively low rates of smoking among women in low- and middle-income nations worry experts because of the potential for large future increases and health problems to follow (Mackay 1998).

In addition to worsening a public health problem, the global patterns of change raise questions about the underlying causes. Why does the direction of change differ across levels of development? Are global patterns of smoking a direct function of national income and related economic characteristics? And how do the patterns of change across the world differ for men and women? Despite numerous descriptions of worldwide patterns of smoking (Gajalakshmi et al. 2000; Mackay and Eriksen 2002; WHO 1992, 1997; World Bank 1999), few studies have taken an analytic approach to answering these questions. Several arguments in the literature posit changes in the incentives for male and female smoking with economic development and higher income, but they have not been fully developed or tested in a global context. This study thus presents a hypothesis concerning the nonlinear influence of national income on smoking and then extends the hypothesis by considering the moderating forces of inequality and government restrictions on smoking. It tests the predictions with cross-sectional, aggregate data on nations in all regions of the world and at all levels of economic development.

Such tests involve more than an effort to understand one narrowly defined health behavior – they also relate more broadly to patterns of global stratification. For example, current changes in smoking worsen worldwide health inequality. With smoking rising in low-income, high-mortality nations and falling in high-income, low-mortality nations, the behavior reinforces other sources of cross-national disparities in longevity. Sociological efforts to understand national differences in health care access (Casas-Zamora and Ibrahim 2004), food security (Jenkins and Scanlon 2001), and infant mortality rates (Moore et al. 2006) can be supplemented by efforts to understand another crucial component of national health and well-being – the use of tobacco products.

Theory and Hypotheses

National Income

Two mechanisms relate personal income, and by extension, national income to smoking (Cutler and Glaeser 2006). The first, mechanism involves the affordability of manufactured cigarettes. In low-income, primarily agricultural nations, the large majority of the population will not have the cash income to purchase manufactured cigarettes in large numbers. Although some will use locally grown tobacco to make their own tobacco products, the level of smoking will remain low because of the lack of resources. As national income grows, however, citizens who are sensitive to cost can better afford manufactured cigarettes and their stimulating and addictive properties (Chaloupka et al. 2000). This reasoning implies that, given similarities in the price of cigarettes, middle-income nations will have higher smoking prevalence than low-income nations and that income will have a positive relationship with smoking in developing nations.

The second mechanism comes into operation as nations reach still higher income levels. Although the opportunity to purchase cigarettes continues to increase with further income growth, another counterbalancing mechanism emerges. In high-income nations, the cost to health and longevity from cigarette smoking increases and creates a negative incentive to smoke (Gajalakshmi et al. 2000). When mortality is high as in low-income nations, the health cost of using cigarettes remains relatively low – the poor perceive that they will die early whether or not they smoke (Lawlor et al. 2003). However, as higher levels of income

and economic development extend longevity, smokers face a greater penalty in health and smaller increases in life expectancy than non-smokers (Rogers et al. 2005). The health costs of smoking thus come to outweigh the short-term pleasures. This reasoning implies that high-income nations will have lower smoking prevalence than middle-income nations and that income will have a negative relationship with smoking at upper income levels.

The combination of affordability and the health-cost effects of rising income for smoking suggests an inverted U-shaped, nonlinear relationship of national income with smoking (Cutler and Glaeser 2006). The arguments predict that smoking rises with income among low-income nations, changes little with income among middle-income nations, and declines with income among high-income nations. However, the nonlinear relationship between national income and smoking prevalence may differ by gender. The adoption and spread of tobacco use by women typically lags a decade or two behind that of men (Department of Health and Human Services 2001; Lopez 1995). This lag implies that the effects of income growth on smoking may be delayed for women. The later adoption of cigarettes by women may make them less responsive than men to income growth. Eventually, smoking will rise, peak and then decline among women, just as it does for men (Pampel 2001), but the pattern does not yet appear as strong for women as men.

Economic and Social Inequality

Arguments about income and smoking need to consider the distribution as well as the average income of nations. There is little literature on this relationship, but it follows from arguments about national income that inequality in the distribution of income should inhibit the rise and fall of smoking that occurs with rising average income. In low-income nations, economic inequality limits the income of large parts of the population and the affordability of cigarettes. Even with rising average income, most citizens will remain unable to afford cigarettes, and smoking will not rise as much as it does under conditions of equality. In high-income nations, economic inequality limits the health benefits of income growth for much of the population. Without the majority of the population sharing in the longevity benefits of higher income, they will have less to gain from stopping smoking and more to gain from the short-term benefits of nicotine. Additionally, inequality in high-income nations may increase feelings of relative deprivation and chronic stress, which lead to use of cigarettes as a coping mechanism (Wilkinson 1996). When not shared, rising income will do little to meet the psychosocial needs of the disadvantaged, overcome the damaging effects of deprivation, and change the motivations for smoking among low-income groups (Siahpush et al. 2006). Under conditions of inequality, then, high levels of income will do less to reduce smoking.

These arguments imply an interactive relationship involving income, economic inequality and smoking. By influencing the access of the population to a given level of income, economic inequality moderates the nonlinear influence of income. When economic inequality is high and disadvantaged groups do not share the benefits of economic growth, income will have weaker positive effects at lower income levels and weaker negative effects at higher income levels. By the same logic, the influence of economic inequality will depend on income levels. Inequality reduces smoking at lower income levels by limiting the affordability effect but increases smoking at higher income levels by limiting the health-cost effect. On average, it may have neither positive nor negative effects. Its influence may be evident only when considered in combination with income.

Another form of inequality may prove particularly important for women. Rather than the distribution of income, the distribution of social rights – access to work and choice in family duties – may most affect female smoking (or more precisely, the influence of income on female smoking). The reasoning follows the logic of that for economic inequality. Under

conditions of gender inequality, women lacking access to work and personal income and facing restrictions on personal behaviors such as smoking will not have the opportunities to respond to increases in income with greater smoking (Kaplan et al. 1990; Waldron et al. 1988). In terms of both the ability to afford cigarettes and to act in nontraditional ways, gender inequality in low-income nations will inhibit the positive effect of income. Among high-income nations, gender inequality will limit the health benefits of nonsmoking. Assuming that inequality in power and lack of access to resources damage the health of women (Mason 1997; Riley 1997), giving up smoking will do less to improve their health. Under conditions of gender inequality, smoking will fall less among women in high-income nations.

This argument again implies interactive relationships. Gender inequality will moderate the nonlinear relationship of national income and smoking. Under conditions of gender inequality, initial increases in income will do less to allow women to purchase cigarettes, while later increases in income among women will do less to raise the health costs of smoking. Gender equality may not have strong direct effects on relative levels of female and male smoking (Pampel 2001, 2007), but this finding could stem from the masking result of the interaction. The effects of gender inequality instead may show in facilitating and inhibiting the influence of income.

Government Policies

Along with components of inequality, government policies that affect the price and access to cigarettes may influence smoking and the effects of income. First, the price of cigarettes, which varies across nations because of the imposition of government excise taxes, can affect the affordability and use of cigarettes (Jha and Chaloupka 2000; World Bank 1999; WHO 1997). All else equal, higher prices and higher taxes will reduce smoking. However, the nonlinear effects of income may make the effects of price more complex. Higher prices through taxes may inhibit the affordability of cigarettes and the positive effect of income on smoking in middle-and low-income nations. They may also speed the decline in smoking with income growth in high-income nations. In other words, high cigarette prices will moderate the rise and facilitate the fall of smoking with national income.

Second, legal restrictions on advertising and sales may have much the same effect by making it harder to use income for cigarettes (Ranson et al. 2000). Regulations of ingredients, requirements for labels and packaging, and bans or restrictions on advertising, sales to minors, stores able to sell the products, and smoking in public buildings may reduce smoking directly (DHHS 2000). They may also, much like cigarette prices, interact with national income by reducing the positive effect of income in middle-and low-income nations and strengthening the negative effect in high-income nations.

Summary

The theory and hypotheses imply both nonlinear and non-additive effects of the cross-national determinants of smoking. Such arguments about national income, inequality and government policies, although implicit in thinking about smoking, have not been tested directly. The tendency is instead to search for linear and additive relationships that, despite their ease of interpretation, may not reflect the complexity of the processes determining smoking prevalence. This study aims to test for the more complex but possibly more accurate curvilinear and interactive relationships.

Methods

Nations

The aggregate data on nations of the world analyzed here come from published figures for (in most cases) 145 nations with data on smoking prevalence (the Appendix lists the nations by region). The nations represent all regions, levels of development and rates of cigarette use, and contain 5.6 billion people, more than 90 percent of the World's population. Despite the large number of countries, the sample more fully represents high-income nations with established data-gathering procedures. It also includes several small countries with populations of less than 1 million. However, estimates that downplay the importance of small nations with weighting based on population size do not appreciably change the results.

Smoking Prevalence

Figures on the percentages of males and females who smoke come from the second edition of the Tobacco Control Country Profiles compiled for the latest year available, usually the late 1990s or early 2000s (Shafey et al. 2003) and supplemented for a few nations with data reported in *The Tobacco Atlas* by Mackay and Eriksen (2002). For all 145 nations, the means for male and female smoking prevalence equal 40.4 percent and 16.9 percent, respectively. The figures are compiled from separate national surveys rather than from a single set of standardized instruments. Thus, the surveys may differ in design, measures, samples and quality. However, the data contain information on the characteristics and questions of the surveys that can be used to control for measurement bias. In addition, the results can be checked for regional patterns of smoking that are due in part to differences in survey quality and for the, excessive influence, of outlying cases that are due in part to flawed measures.¹

In most cases, the surveys measure current cigarette smoking of adults ages 18 and older for the full adult population. However, some surveys deviate from this standard. Separate dummy variables are created from information provided by the TCCP to measure 1.) if the sample is based on urban residents or those in a major city rather than the full population, 2.) if the definition of smoking requires daily use rather than any recent use, and 3.) if the definition includes use of other tobacco such as indigenous products, pipes and chew. Also, a variable measures year of survey because some of the data come from earlier years than others. Lastly, two variables measure the lower age and the upper age of the survey respondents. When all these variables are included in the models, however, only the dummy variable for inclusion of other tobacco in survey questions consistently influences smoking: Broadening the definition of tobacco most increases the smoking of women, who are likely to use non-cigarette products in agricultural areas (Waldron et al. 1988). This variable remains in the models presented in the tables, while the other measurement variables with insignificant effects are excluded.

Independent Variables

Real gross domestic product per capita in hundreds of U.S. dollars, created using purchasing power parities, comes from the TCCP web pages (Shafey et al. 2003). Figures available on GDP for the 145 nations in 1975, 1980, 1985, 1990, 1995 and 2000 make it possible to examine lagged effects of income on smoking. Because older smokers became addicted to cigarettes decades ago, income in previous decades may influence later smoking. At the

¹To offer still more checks of robustness, the results were replicated using two other data sources. 1.) The figures from *The Tobacco Atlas* data differed enough from the TCCP for some nations to warrant a separate analysis. 2.) Figures reported for a much smaller sample of about 72 nations around 1990 (WHO 1997) do more than the TCCP to adjust the measures for comparability. The key findings emerge with both these alternate measures of smoking.

same time, younger smokers may respond more to current rather than past income in starting to smoke. In using lagged values, however, there is an alternative to selecting one of the available years (such as a lag of 30, 25, 20, 15, 10 or 5 years). Instead, GDP is measured as the average of the available years, thus reflecting lags of various length and averaging past influences.² The mean of the averaged variable is 65.27 (or \$6,527). Otherwise, the averaged GDP measure is logged to both reduce skew and to reflect percentage differences across nations. Both logged GDP and logged GDP squared are included in the models to capture non-monotonic nonlinearity.

GDP relates to the processes underlying changes in the affordability and health costs of cigarettes. By increasing average income, GDP increases the ability to purchase cigarettes – unless the prices of cigarettes rise even faster. Yet evidence indicates that, although prices tend to rise with GDP, they rise more slowly than GDP itself. Consider some examples reported in Guindon et al. (2002) on how prices relative to income fall with GDP. The price of a pack of Marlboro cigarettes in 2000 U.S. dollars is \$3.71 in the United States, \$1.55 in Mexico, \$1.24 in India, and \$1.58 in Kenya. However, a measure of the minutes of labor required to purchase a pack, which controls for wage and income levels, changes the rankings: It equals 158 in Kenya, 102 in India, 49 in Mexico, and 18 in the United States. In addition, the correlation of GDP with a measure of cigarette prices relative to GDP equals $-.71$ for the nations studied here. GDP thus appears to serve as a limited but useful proxy for affordability of cigarettes and other non-essentials that is available for all nations with smoking data.

Less easily measured than GDP, income inequality takes the form of the Gini coefficient, which exists for only 106 nations (World Bank 2005). Seldom available for years before 1990, income inequality cannot be lagged – though the slower rate of change in income inequality than national income means current values will approximate past values. More problematic, data on the distribution of income are extracted from reports of income obtained in surveys of uneven quality. Variation across nations in the definitions used for households, income sources and populations by the surveys no doubt create error. Such error may bias the relationship of inequality with smoking. Even so, comparative researchers use the measure widely and find that it affects health-related outcomes (e.g., Wilkinson and Pickett 2006).³

Gender inequality comes from a scale based on five measures of the independence of women from family duties and patriarchal family norms: 1.) the total fertility rate (World Bank 1983, 1993; World Resources Institute 2003); 2.) the female percentage share of the literate population (World Resources Institute 2003), 3.) the female share of tertiary school enrollment (World Resources Institute 2003), 4.) the female share of the nonagricultural labor force (World Bank 2003), and 5.) the female share of the legislature (United Nations 2001). To allow for a lag, all the items except one are measured for either 1970 or 1980 (depending on availability of data). The exception, female share of the legislature, is available only for circa 2000. The scale has an alpha reliability of .816, a mean of zero and a standard deviation of 1 (and is coded so that nations with high inequality receive high scores). Although low fertility, independence from marriage, and participation in school,

²When the year of measurement of smoking prevalence precedes 2000, the averaged measure of GDP excludes later years. Thus, when smoking is measured in 1995, the averaged GDP uses, the years from 1975 to 1995 but not 2000.

³The income inequality measure is adjusted for household size. However, nations differ on whether they use data on income received or expenditures. In comparing inequality based on the two types of data, Deininger and Squire (1996) find that expenditure data produce Gini coefficients that on average are lower by 6.6 points than income data produce. Following their recommendation, I add 6.6 to the Gini coefficient of nations reporting expenditure data. This minimizes the influence of one source of measurement error. The measure has a mean of 43.0, a standard deviation of 10.5, and ranges from 24.7 to 70.7.

work and politics do not guarantee equality, they relate to increases in nontraditional opportunities outside the family.

Three measures tap national differences in government policies. First, the cost of cigarettes is measured by the price of a pack of Marlboros in U.S. dollars as a ratio to GDP per capita in 2000. Second, the percentage cost of cigarettes that comes from excise taxes isolates the government component of cigarette prices and the possible effects of government policy on cigarette costs and smoking. Both these measures come from Mackay and Eriksen (2002), who report figures on cost for 83 nations and on taxes for 60 nations. Third, a measure of government restrictions is available for all nations used in the analyses. It comes from a scale of nine items ($\alpha = .722$) on the existence of advertising, sales, and indoor smoking bans and regulations (Shafey et al. 2003).⁴ A problem with all three measures comes from their timing. For most countries, regulations and tax increases have been adopted in the past decade and will have had little time to change the smoking habits of the populations.

Estimation

The models are estimated with ordinary least squares but calculate Huber/White “sandwich” estimates of robust standard errors (Greene 1999) with STATA 9.0. For this sample of nations with diverse sizes of the populations and economies, the robust standard errors adjust for possible heteroscedasticity in the regression errors. In addition, aggregate cross-national models are subject to the influence of outlying and influential cases and omitted variables. For outlying and influential cases, use of robust regression provides a check on the OLS results. Robust regression (as opposed to robust standard errors) drops cases with excessive influence (i.e., Cook’s D is greater than 1) and weights other cases through an iterative procedure based on the inverse of the absolute residual from the OLS estimates. To minimize omitted-variable bias, the models control for cultural and historical differences with dummy variables for the regions listed in the Appendix. Nonspurious effects should show influence within as well as between regions (i.e., hold with the regional controls).⁵

Results

National Income

In support of the primary hypothesis, Table 1 demonstrates the nonlinear influence of national income on smoking prevalence for males. The significant positive coefficient for logged GDP and the significant negative coefficient for logged GDP squared reflect the initial rise, leveling off, and fall of smoking with increases in income. Plotting the predicted values of smoking prevalence by logged GDP for males in Figure 1 reveals the inverted U-shaped relationship predicted by the hypothesis. The peak occurs at GDP of \$2,774 (when averaged over the years from 1975 to 2000, approximately the value for Morocco, Georgia and Guatemala). At the extremes of GDP, nations as different as Tanzania and the United States have approximately the same predicted smoking prevalence of 25 percent. However, the former nation has yet to experience the rise in smoking that comes with early income growth, while the latter nation has experienced the substantial decline that follows advanced income growth.

⁴The means and cases for the variables are as follows: cigarette cost (\$1.96, 83), cigarette cost/GDP (.03, 83), percent excise tax (57.8, 60), and government restrictions (0.0, 145).

⁵The correlations of the log of GDP with the other independent variables are as follows: $-.53$ with the Gini coefficient, $-.55$ with gender equality, $-.71$ with cigarette cost, $.40$ with excise taxes, and $.41$ with government restrictions. Although generally not high enough to produce severe instability in estimates, the correlations can nonetheless accentuate the influence of outlying cases and further justify checks for robustness and regional controls.

The influence of national income on female smoking prevalence does not support the nonlinear hypothesis. In the first column of Table 2, neither logged GDP nor logged GDP squared have significant coefficients. The graph of predicted values for females in Figure 1 instead shows a near linear increase in female smoking with income. The upward trend in female smoking combined with the downturn in male smoking leads to near parity at the highest income levels. However, no downturn occurs at higher income levels for females.

Income Inequality

Examining the moderating influence of income inequality on the nonlinear effects of national income supports the hypothesis. The second column in Table 1 first adds income inequality to the model for males. It has a negative effect, with the unequal distribution of income on average lowering smoking. Yet this effect hides contrasting influences at high and low levels of income. The third column next demonstrates an interactive effect of income inequality. To make it easier to compare the effects of national income across groups, income inequality is dichotomized into low values (coded zero) and high values (coded 1). The product terms of recoded inequality by logged GDP and logged GDP squared both reach statistical significance. The negative coefficient of inequality by logged GDP moderates the positive coefficient of logged GDP, while the positive coefficient of inequality by logged GDP squared moderates the negative coefficient of logged GDP squared.

Figure 2 presents the differences visually by plotting the predicted values of male smoking prevalence for logged GDP and two groups of nations. Nations with low inequality show a steep rise in smoking followed by a steep fall as income increases. Nations with high inequality show a more modest rise and fall in smoking. By restricting access to the consequences of higher income for purchasing cigarettes and then for experiencing the health costs of cigarettes, income inequality moderates the nonlinear influence of national income.

The nonlinear and non-additive effects contained in column 3 appear robust. Estimates from robust regression that minimize the potential distorting influence of outliers and highly influential cases reveal effects that are comparable to the OLS estimates (column 4). Estimates with controls for six region dummy variables likewise indicate that the results do not stem only from differences across regions (column 5). The t-ratios of the interaction terms for GDP logged and squared fall below conventional significance levels, but the size of the coefficients continue to indicate different curves for nations with low and high inequality.

Gender Inequality

For females, Table 2 focuses on gender inequality (as income inequality has little relationship with smoking of women). As shown in column 2, national income (treated as a linear term given the insignificant nonlinear coefficients in column 1) raises female smoking prevalence, while gender inequality has little influence. However, column 3 allows national income to interact with gender inequality (which is dichotomized to make for more interpretable results). The interactive model gives more meaningful results. The significant interaction term indicates that gender inequality moderates the positive effect of national income. Figure 3 graphs the predicted values of this model. For nations with low gender inequality, national income increases female smoking, while for nations with high gender inequality, national income has no influence. The model reveals no evidence of a downturn in female smoking at the highest income levels, but the results suggest that restrictions on female activities outside the family limit the ability of rising income to raise smoking.

The results for females are less robust than those for males, however. Robust regression to minimize outliers changes the coefficients only slightly and indicates that the findings do not result from a few unusual cases. Yet, controlling for the region dummy variables reduces the combined effects of income and gender inequality to insignificance. High smoking of women in Western and Eastern Europe combined with low smoking of women in nations of Africa, the Middle East, and Central and South America largely account for the effects of income and inequality. Little evidence emerges to demonstrate that within-region differences in income and gender inequality affect female smoking.

Government Policies

When added to the models, measures of government policy – prices, taxes and restrictions – show little influence on male or female smoking (table not presented). To summarize, none of the policy variables interacts with income. Moreover, the variables do little to directly or additively affect smoking. Only the tax variable for males reduces smoking significantly (and only for a small sample).

Discussion

Rising smoking in low- and middle-income nations and declining smoking in high-income nations suggests two mechanisms that relate national income to smoking and might account for the divergent patterns. At lower income levels, an affordability mechanism refers to the increased ability to purchase more cigarettes with higher income; at higher income levels, a health-cost mechanism refers to the greater health costs of smoking that accompany income growth and extended longevity of nonsmokers. The balance of these incentives should lead to a curvilinear relationship of national income with smoking. At the same time, economic and gender inequality should moderate the rise and fall of smoking with income by restricting the access of populations to higher income used for purchasing cigarettes in low-income nations and for improving health in high-income nations. Further, government restrictions that limit access to cigarettes should also shape the influence of income on smoking. The results find support for the arguments about income and inequality among males but only partially among females.

For males, regression models that allow for nonlinear effects of national income and non-additive effects of income inequality support the theoretical arguments. Further, these models prove surprisingly robust given the complexity of the relationships. Not only do they include quadratic terms for national income and product terms of income inequality by the quadratics, they also produce significant and meaningful relationships. The results do not stem from a few influential and outlying cases or from omitted variables associated with regional traditions and culture. For females, however, the findings less clearly support the hypotheses. Income increases female smoking prevalence but does not reduce it at the highest levels. Gender inequality suppresses the positive effect of income, but the relationship disappears with controls for regional dummy variables. At best, the female results support only the first half of the income argument – higher income, greater access to cigarettes and newfound freedom to act in nontraditional ways increase female smoking.

Although it does not figure in the models tested here, an argument about cigarette diffusion is consistent with the pattern of income effects. Epidemiologists have described a pattern of change in smoking prevalence that resembles a disease epidemic in its rise and fall (Lopez et al. 1994). As cigarettes begin to spread in a population, usage grows steadily to a peak and then declines (though does not disappear). The mechanisms behind the change involve processes of social innovation, learning and distinction. In developed nations, smoking began with the adoption of the innovative behavior by high socioeconomic (SES) groups, diffused through the population to low SES groups, and came to be rejected first by high

SES groups (Ferrence 1989; Huisman et al. 2005). In developing countries, smoking has spread most among low SES groups in urban areas, likely skipping high SES groups altogether (Bobak et al. 2000; Pampel 2005). Females also go through the rise and fall of the cigarette epidemic but lag several decades behind males in the start and the peak. For both sexes, then, cigarette use follows a standard pattern of rise and decline that stems from social as well as economic processes.

This curvilinear pattern of change posited by the cigarette diffusion argument to occur over many decades within nations matches the curvilinear cross-sectional relationship between income and male smoking. Also consistent with the cigarette diffusion argument and the lag in the epidemic among women is the linear relationship of national income with female smoking. The more recent adoption of cigarettes by women throughout the world may mean that the stage of diffusion involving a downturn has not yet emerged for most nations. Although female smoking has fallen in some high-income nations such as the United States, it has not yet reached levels high enough in middle-income nations to reveal the cross-sectional curvilinear pattern apparent for males. Such changes among women may follow in the next decades.

The curvilinear relationship of income with smoking suggests a scenario for the future. Male cigarette use likely will continue to grow in low-income/low-smoking nations, begin or continue the downturn in middle-income/high-smoking nations, and decline or level off in high-income/low-smoking countries. Female cigarette use likely will grow in both low- and middle-income nations and decline only in high-income nations that are farther along in the cigarette diffusion process. Although government policies have little influence in the results, this may come from the recent imposition of restrictions in most countries. The effects instead may show more strongly in years to come. Comprehensive anti-smoking policies, including taxes on cigarette sales and perhaps even a global treaty on tobacco control, may help to slow the rise or speed the decline in smoking prevalence. The policies may emerge as particularly important in reducing the expected future growth in female smoking.

However, making predictions for individual nations on the basis of cross-national comparisons has limitations. The low smoking in low-income nations, high smoking in middle-income nations, and low smoking in high-income nations suggest that smoking rises and falls over time with income growth within nations. Such change has been observed in some high-income nations with data on cigarette consumption over the past century (DHS 2001), but most nations lack the long time-series data needed to test the theories directly.

The data analyzed here have other limitations. Unlike individual-level data, the aggregate data do not distinguish among the groups of men and women within nations who are most likely to adopt the habit. For example, smoking data by SES would allow one to examine income effects more directly, and smoking data by age would allow one to examine cohort differences and historical changes in cigarette use. In addition, cross-national surveys of cigarette prevalence face problems of comparability. The analysis attempts to control for measurement error related to definitions and samples, minimize bias by controlling for regional differences in smoking, and validate the results by searching for robust effects. Still, the need remains for improvements in the quality of global figures on smoking prevalence, particularly among low-income nations.

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Figure 1.
Predicted Percentage Male and Female Smokers by GDP

Figure 2.
Predicted Percentage Male Smokers by Income Inequality and GDP

Figure 3.
Predicted Percentage Female Smokers by Gender Inequality and GDP

Table 1
Unstandardized Regression Coefficients and T-ratios for Determinants of Male Smoking Prevalence

Variable ^a	OLS (1)	OLS (2)	OLS (3) ^b	Robust(4) ^{b,c}	w/Region (5) ^{b,d}
GDP Logged	32.42**	38.66**	67.35**	70.83**	57.81**
	5.49	5.85	4.92	4.60	3.23
GDP Logged ²	-4.88**	-6.00**	-9.43**	-9.71**	-7.92**
	-6.28	-6.65	-5.42	-4.77	-3.22
Income Inequality	-.39*		65.12*	78.29*	70.31*
				2.18	2.42
Income Inequality*			-36.93*	-42.24*	-36.61*
GDP Logged			-2.28	-2.24	-2.02
Income Inequality*			4.49*	5.06	4.29
GDP Logged ²			2.05	1.90	1.67
Constant	-8.33	1.88	-67.99	-78.50	-63.86
R ²	.239	.340	.356		.452
N	145	106	106	106	106

Notes:

^a All models control for survey questions that ask about use of any tobacco rather than use of cigarettes or smoking

^b Income inequality dichotomized

^c Estimates from robust regression

^d Dummy variable controls added for regions

* p < .05

** p < .01

Table 2
Unstandardized Regression Coefficients and T-Ratios for Determinants of Female Smoking Prevalence

Variable ^a	OLS (1)	OLS (2)	OLS (3) ^b	Robust (4) ^{b,c}	Robust (5) ^{b,d}
GDP Logged	4.79	2.67	5.53**	6.02**	2.89
	.91	2.44	3.46	4.17	1.29
GDP Logged ²	-.23				
	-.32				
Gender Inequality	-1.10	16.86*	17.72*	2.40	17.46
	-.81	2.05	2.40	1.75	
Gender Inequality*		-5.12*	-5.71**	-4.18	
GDP Logged		-2.60	-3.06	-1.58	
Constant	.71	4.23	-6.73	-8.72	-6.28
R ²	.104	.176	.213		.332
N	145	135	135	135	135

Notes:

^a All models control for survey questions that ask about use of any tobacco rather than use of cigarettes or smoking

^b Gender inequality dichotomized

^c Estimates from robust regression

^d Dummy variable controls added for regions

* p < .05

** p < .01

Appendix

List of Nations by Region

Region	Nations
Western Europe and High Income	Andorra, Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland Ireland, Italy, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, San Marino, Spain, Sweden, Switzerland, United Kingdom, United States
Eastern Europe	Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia, Slovakia, Slovenia, Ukraine, Yugoslavia
Sub-Sahara Africa	Cote d'Ivoire, Djibouti, Gambia, Ghana, Guinea, Kenya, Lesotho, Malawi, Mauritius, Namibia, Nigeria, Rwanda, Seychelles, South Africa, Sudan, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe
Americas	Argentina, Bahamas, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Panama, Paraguay, Peru, Saint Vincent and the Grenadines, Saint Lucia, Trinidad and Tobago, Uruguay, Venezuela
Central and East Asia	Bangladesh, Cambodia, China, India, Japan, Korea Republic, Laos, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Singapore, Sri Lanka, Thailand, Viet Nam
Pacific Islands	Brunei Darussalam, Cook Islands, Fiji, Indonesia, Kiribati, Malaysia, Micronesia, Nauru, Niue, Palau, Papua New Guinea, Philippines, Samoa, Tonga, Tuvalu, Vanuatu
Middle East and North Africa	Algeria, Bahrain, Cyprus, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Kyrgyzstan, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, Turkey, Turkmenistan, United Arab Emirates, Uzbekistan, Yemen