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ABSTRACT

While Americans are less healthy than Europeans along some dimensions (like obesity), Americans are significantly less likely to smoke than their European counterparts. This difference emerged in the 1970s and it is biggest among the most educated. The puzzle becomes larger once we account for cigarette prices and anti-smoking regulations, which are both higher in Europe. There is a nonmonotonic relationship between smoking and income; among richer countries and people, higher incomes are associated with less smoking. This can account for about one-fifth of the U.S./Europe difference. Almost one-half of the smoking difference appears to be the result of differences in beliefs about the health effects of smoking; Europeans are generally less likely to think that cigarette smoking is harmful.

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I. Introduction

Americans have one of the lowest smoking rates in the developed world. As Figure 1 shows, 19.1 percent of adult Americans smoke, as opposed to 34 percent of Germans or Japanese and 27 percent of the French or English. The American smoking rate is 10 percent less than the average among developed nations shown in the figure. This is the lowest rate in this sample apart from Sweden. This remarkable abstinence is all the more remarkable because there are many other areas where Americans are not notable for the healthy behavior. For example, among the same sample of countries, America has easily the highest obesity rate (see Figure 2), and our consumption of alcohol per adult is in the mean of the sample.[1] In this essay, we try to understand why smoking is so low in the United States.

America's abstinence from tobacco is not some long-standing aspect of U.S. culture; rather, it is very recent. As Figure 3 illustrates, over the 20th century, cigarette smoking in the U.S. saw a remarkable rise from 267 cigarettes per capita in 1914 to over 4,300 cigarettes per capita in 1963 before plummeting to just over 2000 per capita today. Through the 1960s, the U.S. had much higher per capita tobacco consumption than any Western European country. Figure 4 plots smoking rates per adult in 2000 on smoking rates in 1980 across countries. The line is the 45 degree line, so the distance between the point and line shows the extent that smoking declined between 1980 and 2000. America had the largest drop of any non-Scandinavian country in the sample.

We examine three potential explanations for the low level of smoking in the U.S. relative to other developed countries. First, we ask whether the effective price of cigarettes, which reflects both taxes and other regulations on tobacco, is higher in the U.S. Second, we look at whether higher American income levels might explain the lower level of U.S. cigarette consumption, if better health is a luxury good. Third, we ask whether

[1] This fact might suggest that American obesity and smoking are, in fact, negatively linked, where reductions in smoking led to higher obesity. There is little evidence to support this view. In general, across people there is no correlation between smoking and obesity (Cutler and Glaeser, 2005) and across countries the correlation is also essentially zero.

differences in beliefs about the consequences of smoking might be responsible for American exceptionalism.

It is clearly not the case that low cigarette smoking in the U.S. is the result of higher cigarette prices. Cigarettes are, on average, 37 percent cheaper in the U.S. than in the European Union. For example, the average price per pack in the United Kingdom[2] is $6.25 while the average price per pack in the U.S. is $3.60. The average tax per pack is 86 cents in the U.S. and 206 cents in France. Using standard estimates of the elasticity of cigarette consumption with respect to price, these facts suggest that holding everything else constant, Americans would smoke 20 percent more than Europeans. Cross-national results on regulation are similar. If anything, tobacco consumption in the U.S. is less regulated than in most European countries, and controlling for regulation only makes American exceptionalism more extreme.

The relationship between income and cigarette consumption across countries is non-linear. Cigarette consumption first rises with income and then declines. Our model in section 2 suggests that this can be interpreted as the confluence of two opposing effects: higher income levels make it easier to afford more cigarettes, and also increase the costs of death and disease. Within country estimates of income elasticities are much smaller than these cross-country estimates. As such, the ability of income differences to explain smoking differences between the U.S. and Europe depends primarily on one's beliefs about micro vs. macro estimates of income elasticities. If one believes that there is a social multiplier so that macro estimates are indeed many times higher than micro estimates, and the estimated macro estimates are correct, then income differences can explain roughly one-quarter of the U.S./Europe difference. If one believes that the micro-estimates are correct and the macro estimates are spurious reflections of omitted variables, then income differences can, at best, explain one tenth of the U.S/Europe difference.

[2] These are legal prices. There may be some smuggling of cigarettes in the UK, which we do not account for.

Finally, we turn to differences in beliefs about the health effects of smoking between the U.S. and Europe. Public opinion surveys suggest that Americans have some of the strongest beliefs that cigarettes are extremely harmful. Furthermore, there is an extremely strong negative correlation across individuals between beliefs about the harms of smoking and smoking, and a somewhat weaker correlation between the same variables across countries. Of course, cognitive dissonance (Akerlof and Dickens, 1982) suggests that this relationship might exist because smokers like to think that their habit isn't harmful. To address this possibility, we look only at beliefs among non-smokers, and again find a relationship between beliefs and smoking. Even among non-smokers, the US has some of the strongest anti-smoking beliefs.

A simple decomposition suggests that these belief differences can explain between one-quarter and one-half of the difference in smoking rates between the U.S. and Europe. We present some evidence suggesting that these differences in beliefs are themselves the result of concerted government action emphasizing the harms of smoking.

In the next section, we present a brief model that sets out the potential causes of lower cigarette consumption in the United States. In Section III, we review the evidence on price, tax and regulation differences between the U.S. and Europe. Section IV examines the relationship between income and cigarette consumption, showing that up to one-quarter of the difference between the U.S. and Europe can be explained by higher income in the United States. Finally, Section V discusses the causes and consequences of differences in beliefs about the health consequences of smoking. The last section concludes.

II. Theoretical Determinants of Smoking

In this section, we present a simple model of cigarette consumption, beliefs and income, and use the model to theories we shall test. We assume a discrete time model where individuals receive income Y in each period. Individuals discount the future with discount factor β. To focus on the key issues, we assume there is no borrowing or

lending between periods and the only decision in each period is whether or not to smoke. Smoking is a one-zero choice that carries financial cost of P_C and yields utility of *S*, which differs across individuals.

In each period, the probability of surviving until the next period is believed to δ for non-smokers and $\delta - \Delta$ for smokers. These beliefs can be changed, but we assume they are the same for everyone at a point in time. The utility flow if dead is normalized to zero. The flow of utility for non-smokers is *U(Y)* and the flow of utility for smokers equals $U(Y - P_C) + S$. The stationary nature of this problem means (somewhat counterfactually) that individuals will always make the same decision about smoking each period. Total expected discounted utility for smokers equals: $\frac{U(Y - P_C) + S}{1 - \beta(\delta - \Delta)}$ and for non-smokers equals $\frac{U(Y)}{1 - \beta\delta}$. Smokers trade off the flow benefits of enjoying cigarettes against both the cash costs of smoking and the costs in terms of lost health. With these assumptions, Proposition 1 follows:

Proposition 1: There exists a value of S>0, denoted S*, at which individuals are indifferent between smoking and not-smoking. Individuals with values of S greater than S* strictly prefer smoking and individuals with values of S less than S* strictly prefer not smoking. The value of S* is rising with P_C, β, δ and Δ.

The value of S* suggests that the population will be split between those who smoke and those who don't smoke based on the heterogeneous preference for tobacco. If S is distributed with a cumulative distribution F(S) and density f(S), then the share of people who smoke will equal 1-F(S*), and an increase in S* will cause smoking to fall by –f(S*).

The comparative statics of the model are straightforward. Since greater mortality risk is a primary cost of cigarette consumption, people who are more patient and value the future more will smoke less. Rising prices will generally cause fewer cigarettes to be

consumed. Higher taxes on cigarettes will raise prices and should reduce consumption. Some regulations, as bans on smoking indoors, may also act to raise the effective cost of consuming cigarettes, though regulations could matter through other channels as well.

The comparative statics on δ can be seen as reflecting the complementarities across health risks. When individuals have a low probability of survival (i.e. a low value of δ), then the health costs of smoking are discounted heavily, and smoking becomes more attractive. If one is likely to die from other reasons, one tends to worry less about the harms from smoking.[3] The comparative static on Δ can be interpreted as either relating to the actual impact of cigarette smoking on health or to the perceived impact of cigarette smoking on health. As individuals perceive that cigarettes are more harmful, they will smoke less.

The comparative static on income is somewhat more complex:

Proposition 2: The value of S* is rising with Y if and only if $\frac{1-\beta\delta+\beta\Delta}{1-\beta\delta} > \frac{U'(Y-P_C)}{U'(Y)}$.

If $\lim_{Y\to 0} U'(Y) = \infty$, $\lim_{Y\to\infty} \frac{U'(Y-P_C)}{U'(Y)} = 1$ and $-\frac{U''(Y)}{U'(Y)}$ is strictly increasing with Y, then there exists a value of Y below which $\frac{\partial S^*}{\partial Y} < 0$ and above which $\frac{\partial S^*}{\partial Y} > 0$.

Income has two important effects on consumption, which work in opposite directions. Higher levels of income mean that the cash cost of cigarettes is less important; thus, there will be higher smoking as people get richer. Countervailing this, however, is that the value of life increases with income and this will lead to less smoking. Under some cases – when the health effect becomes relatively more important as income rises – these two effects can lead to a non-monotonic relationship between income and cigarette consumption. This will be the case if, for example, U(.) is a power function.

[3] The heavy use of cigarettes among soldiers during wartime may be one particular example of this phenomenon.

To further investigate the comparative static on beliefs about the harms of smoking, we examine how beliefs about smoking interact with other characteristics of individuals. Our next proposition describes how changes in Δ affects different groups sorted along other margins.

Proposition 3: An increase in Δ will cause a greater decrease in smoking among: (i) those with higher income; (ii) those with a higher baseline probability of survival (δ); and (iii) those who are more patient (a higher value of β).

Proposition 3 tells us that if there is a change in beliefs about the mortality risks of smoking then we should expect to see a greater reduction in smoking among people who are rich, patient or likely to live long lives if they don't smoke. The intuition behind these results is that the value of living longer is greater for those who value the future highly, or who are likely to live or who get more utility from living. Thus, information suggesting a way to live longer will be adopted more readily by those groups.

This effect is very different from the effect of an increase in prices. Because rich people care relatively more about survival and less about additional cash outlays than the poor, prices should have a smaller impact on the rich than on the poor. Price increases will have the same effect on people who differ only in discount rates or baseline levels of survival. We state this, and related results, formally in proposition 4.

Proposition 4: An increase in the price of cigarettes, P_C, will cause a greater decrease in the share of the less rich that smoke. Cigarette price increases will have the same effect on people with different discount rates or different baseline levels of survival.

Propositions 3 and 4 offer a general test of whether differences in smoking between the U.S. and Europe differ because of beliefs or prices. If beliefs differ, then we should expect the reduction in U.S. smoking to be concentrated among the wealthy, patient and healthy. If prices differ, then we should expect differences in smoking to be concentrated

among the poor and we should expect no differences in groups on the basis of health or patience.

Finally, we extend the model to allow for social interactions in smoking. We assume that utility from smoking equals $S + g \bullet Share_{smo\ker s}$ where S is an individual specific taste for smoking and g is a constant which reflects the impact of having other smokers to interact with. Smoking interactions might occur because of social norms (smoking among non-smokers becomes stigmatized) or because of habit persistence in tobacco consumption (being around smoke increases the desire to smoke). It is straightforward to show that:

As in Propositions 3 and 4, we assume that there is always someone who smokes and someone who doesn't smoke, and that $\overline{S} - \underline{S} > g$, where $\overline{S}$ and $\underline{S}$ are the upper and lower bounds of the taste for smoking. This implies that:

Proposition 5: The share of the population in a country that smokes will be declining with P_C, β, δ and Δ, and the negative impact of these variables on smoking will be larger with g. Assuming that the distribution of tastes for smoking is uniform within the population on the interval $\left[\underline{S}, \overline{S}\right]$ and that there is always someone who smokes, the impact of any other variable across groups will equal $\frac{\overline{S} - \underline{S}}{\overline{S} - \underline{S} - g} > 1$ times the impact of these variables within groups.

As is usual, positive complementarities cause there to be a social multiplier, so that exogenous characteristics that affect smoking become quantitatively more important Becker and Murphy, 2000, Glaeser, Sacerdote and Scheinkman, 2003). As a result, within country estimates of coefficients may understate the importance that these coefficients can have on cross-country smoking patterns.

Our model suggests a relatively straightforward empirical implementation. We estimate equations for smoking at the individual and group level, relating the smoking decision to income, prices, and beliefs about the harms of tobacco. The regression is of the form:

$$(1)\quad Share_{Smoker} = \alpha + \beta_{Price}\,\mathrm{Price} + \beta_{Belief}\,Belief + \beta_{Income}\,Income$$

This specification then implies that:

$$(2)\quad \begin{aligned} Difference\ in\ Share_{Smoker} &= \beta_{Price}(\mathrm{Price}_{EU} - \mathrm{Price}_{US}) + \beta_{Belief}(Belief_{EU} - Belief_{US}) \\ &+ \beta_{Income}(Income_{EU} - Income_{US}) \end{aligned}$$

Our objective is to provide estimates of the differences in cigarette prices, beliefs about cigarette risks, and income between the U.S. and the European Union, as well as to estimate the impact of these variables on the share of the population that smokes. With these estimates we can decompose the difference in smoking patterns between the U.S. and Europe.

III. Data

Data on tobacco consumption are plentiful, but not always consistent. Almost all countries have some data on tobacco consumption, typically from national surveys. We use these data as much as possible. A compendium of such data is kept by the World Health Organization.[4]

For some of our analyses, we wish to examine subgroups of the population, for example by income or education. While most surveys will have such data, tabulations of national data frequently do not contain such detail. In addition, we want to know about beliefs about the harms of smoking, which are measured far less frequently. For these analyses, we use the Eurobarometer survey in 1994, matched with the US National Survey of Drug

[4] See especially the World Health Organization's Health for All Database, http://www.euro.who.int/hfadb.

Use and Health of the same year. Unfortunately, Eurobarometer did not survey all countries. Thus, we are restricted to 14 European countries in these analyses.

In addition, average smoking rates from the Eurobarometer data are somewhat different from average smoking in official national data. For the 14 countries with both sources of data, the correlation coefficient is 0.50. The greatest difference is in Denmark, where official data from a survey conducted by PLS Consult and the Danish Council on Smoking and Health show substantially smoking rates that are 11 percentage points less than the Eurobarometer data. It is possible that differences in specific questions or samples explain these differences, though we cannot be sure without access to the raw data. Other large differences are in France, Finland, Italy, and the Netherlands. We use the reported national data as we can, to ensure the largest possible sample size, and use the Eurobarometer data for questions involving socioeconomic aspects of smoking or beliefs about the harms of smoking. Fortunately, the two estimates are relatively similar when we substitute one for the other..

As shown below, income has a large and non-linear effect on smoking. When we examine bivariate relationships between smoking and other factors (prices, regulations, or beliefs), it is important to have a relatively homogeneous sample of countries by income. Within Europe, the major income outlier is Greece, with a per capita income that is 60 percent below the European average ($10,607 in Greece versus $25,858 in Europe in 2000) and 25 percent below the next lowest country (Spain, at $14,138). For this reason, we omit Greece from many of our regressions, though we present raw data for Greece in the tables and show the country in the figures.

IV. Differences in Prices, Taxes and Regulation between the U.S. and Europe

A long economic literature on smoking has focused on the impact of cigarette prices on smoking. This literature began by using time series data within the U.S. (Schoenberg, 1933) and expanded to looking at cross-state variation created by differences in excise taxes (Maier, 1955). More modern estimates have become increasingly sophisticated and

relate cigarette smoking to either lagged or expected cigarette prices (Baltagi and Levin, 1986, Becker, Grossman and Murphy, 1994). The most compelling estimates follow Lyan and Simon (1968) and use within state variation, examining the response of consumption to a change in the state excise tax on cigarettes.[5]

Lyan and Simon (1968) estimate the price elasticity of smoking at -.51. Chaloupka (1991) estimates long run price elasticities between -.27 and -.36 for the entire population. As Proposition 4 in the previous section suggests, Chaloupka finds higher price elasticities for poorer members of society. Becker, Grossman and Murphy (1994) estimate short-run price elasticities ranging from -.36 to -.44 and long-run price elasticities ranging from -.73 to -.79. Gallet and List (2002) perform a meta-analysis of papers on cigarette demand and find a mean price elasticity of -.48. While there is a considerable range from -.27 to -79, these estimates all suggest that differential cigarette prices can explain differences in cigarette consumption over time and space.

The first two columns of Table 2 show prices and excise taxes across developed countries in 2000 (in US dollars). The last column reports the price of cigarettes relative to the cost of 1 kilogram of bread – the normalization correcting for value added taxes on other commodities that might distort consumption decisions. These prices are the price of the cheapest national brand, and do not account for any smuggling or non-market transactions. Stories of such transactions are present in some countries abound. For example in 2002 the Italian police allegedly broke up a smuggling ring that smuggled three million Euros worth of cigarettes from Romania into Italy each month.[6] However, data on illegal sales are not generally available.

The table makes clear that price differences cannot explain why Americans smoke less than Europeans. Nominal cigarette prices are higher in the US than abroad, but prices relative to other commodities are lower. At least part of this is because the tax on cigarettes is much lower in the US than in much of Europe. Indeed, cigarette prices are

[5] These results seem reasonably persuasive despite the possible endogeneity problem – high taxes might be put in place when states are experiencing an exogenous decline in cigarette smoking.
[6] See http://www.crji.org/arhiva/e_020312.htm

generally higher in Europe than in the US. Relative to other commodities, prices in the US are 37 percent lower than in Europe. With an elasticity of -.5, this implies that smoking should be nearly 20 percent greater in the U.S.

As Figure 5 shows, there is little correlation across countries between the cost of cigarettes (measured relative to the cost of bread) and cigarette consumption across developed countries. Indeed, the U.S. has both relatively low prices and relatively low consumption. The regression line is slightly positive, although not statistically significant. While it is possible that forces like greater smuggling of cigarettes in Europe than in the U.S. might mean that our price estimates overstate the differences across countries, the graph makes it clear that it is extremely unlikely that the U.S. actually has much higher cigarette prices than other countries.

Cash outlays are one component of cigarette costs; the time cost is another. Evans, Farrelly and Montgomery (1999) have shown that workplace bans on smoking have a significant impact on cigarette consumption within the U.S. The bans are effective, at least in part, because they raise the cost of smoking. We also calculated a regulation index within the U.S. based on the number of types of places where cigarette smoking is banned: government workplaces, private workplaces and restaurants. We assign a 1 to each state where smoking is prohibited, a 0.5 to each state where smoking is restricted to specific areas, and a 0 if there is no regulation. As a simple summary measure, we sum the presence of a ban in the three settings. The data to construct the regulatory index come from the Center for Disease Control.

As Figure 6 shows, there is a negative 38 percent correlation coefficient between this regulation index and the share of smokers in a state. A statistically significant negative relationship result persists even when we control for a wide range of other controls including tobacco prices and income. As such, it is at least possible that greater regulation of smoking in the U.S. might be a cause of the lower smoking rate in America.

To make cross country comparisons, we look at the same government regulations across European countries. Data on cigarette restrictions come from the World Health Organization Tobacco Control Database. While there are some discrepancies between these reports and what we know about regulation in the U.S., we have decided to use the WHO estimates rather than to create our other alternative measures. These measures are generally corroborated by the World Bank data as well.[7]

Table 3 lists the principle forms of regulation on tobacco usage in public places in the United States and the European nations. In each case, we give the country a 1 if smoking is prohibited in that setting, a 0.5 if there are partial restrictions or voluntary agreements, and 0 if there is no regulation. It is apparent that the U.S. is not particularly regulatory. The U.S. does have some regulations on consumption in public places, but most European countries do as well. While it is possible that U.S. regulations are more seriously enforced than their European counterparts, and certainly the US has private restrictions on smoking in workplaces that may be less prevalent in other countries, the U.S. doesn't stand out relative to the other countries in formal regulations. Indeed, the average of the index for the European Union is 1.97, compared to the value of 1.0 in the U.S. Since the U.S. is less regulated than the European Union, it seems hard to believe that this variable explains less American smoking.

Figure 7 shows the relationship between our regulation index and smoking rates across countries. As the regression lines shows, there is no statistically significant relationship between the two. A literal interpretation of this regression suggests that regulations are irrelevant for smoking decisions. Of course, the evidence provided by Evans et al. (1999) and the US states provides far more compelling results that regulation does matter. Rather, we interpret the cross-country results as suggesting that measurement of regulations and their enforcement at the country level are so noisy that it is impossible to say anything cleanly about the role of regulation in smoking. While our conclusions thus need to be interpreted with some care, the U.S. does not appear to tax or regulate tobacco

[7] See http://www1.worldbank.org/tobacco/brieflist_db.asp

consumption particularly highly, making these explanations unlikely to account for the lower smoking rate in the US.

V. Income and U.S./Europe Differences

We now turn to the relation between income and smoking across countries. There is a rich body of evidence on the income elasticity of demand for cigarettes. Unfortunately, estimates from this literature differ substantially from study to study (Gallet and List, 2002). Given that our model suggests a possible non-monotonic relationship between income and cigarette consumption, the lack of a clear consensus on the income elasticity of smoking is not so surprising.

Early estimates of the income elasticity of smoking were based on national time series or cross-state information. For example, Maier (1955) reports generally positive income elasticities using cross state data. Gallet and List (2002) report 24 papers estimating income elasticities for tobacco using state or provincial data; the median income elasticity across these estimates is .3.

We have several ways to estimate the income elasticity of smoking. One method is with international data. Income and smoking rates are available for 75 countries. Figure 8 shows the relation between smoking and the log of per capita income in those countries. The regression line allows for a quadratic relationship, as suggested by the model. The quadratic fits reasonably well:

$$Share\ \ Smoking = \underset{}{-76.5} + \underset{(30.5)}{26.9}\ln(GDP) - \underset{(7.36)}{1.65}\ln(GDP)^2 \underset{(.43)}{};\qquad R^2=.20.$$

where ln(GDP) is the logarithm of per capita GDP in 2000 in U.S. dollars and standard errors are in parentheses beneath coefficient estimates. The maximum predicted value is reached at an income of $3,200. The effect of a 1 log point increase in per capita GDP is -7.7 at the income of the U.S. Even with its high income, however, the US is a negative

outlier; smoking is lower in the US than one would expect by income alone. The residual for the US is about -6 percent.

We can get a similar estimate of the income elasticity of spending using data from US states. Figure 9 shows that the correlation between per capita income and smoking across states within the U.S. is negative. A one log point increase in income is associated with a 7.8 percent decrease in the smoking rate in a univariate regression. This is very similar to the international data.

Individual-based estimates of cigarette consumption show weaker estimates. For example, Gallet and List (2002) report ten papers estimating the income elasticity of demand for tobacco using individual data, with the median elasticity estimate across those papers being .06, which is both small and positive.

In Table 1, we show smoking rates across income quartile within the U.S. and Europe. We also show smoking rates by broad education category. Smoking declines with income (or education) in the United States. The difference is large; smoking rates for those in the top quintile are one-third lower than smoking rates for those in the bottom quintile. In Europe the relationship between smoking and income is flat. As a result, the gap between the U.S. and Europe is smallest among poorer individuals and greatest among the rich.

Using the U.S. data, we estimate a non-linear income elasticity, where a discrete variable that takes on a value of one for regular smokers is regressed on country dummies and the logarithm of income and the logarithm of income squared.[8] The probit regression yields the estimate:

$$Smoker = \underset{(.372)}{.330}\ln(Income) - \underset{(.019)}{.024}\ln(Income)^2 + Country\ Dummies;$$

[8] Only monthly income is asked about in the Eurobarometer data. To get a more precise income elasticity, we use the annual data available in the U.S.

There are 15,213 observations. The coefficients on income and income squared are not statistically significant. They are also somewhat smaller than the national data. An increase in incomes of $10,000 per person would reduce smoking rates by 2.1 percent.

It is not completely clear what income elasticity to use for the US-Europe comparison. We consider first the elasticity in the international data. The mean income of the European countries that we have included is about $25,000 dollars in 2000. The U.S. income in the same year is about $36,000, for a difference of about 36 percent. Using the equation above, this translates into a predicted difference in smoking rates of 2.6 percent (roughly .36*-7.7), or one-quarter of the total difference in smoking between the US and Europe.

Our individual level estimates of the income elasticity of smoking are smaller than the macro estimates, so calculations using the micro estimates suggest that the income differences can explain even less of the cross-country differences.[9] Indeed, since the median income elasticity estimate shown by Gallet and List (2002) is positive, using that estimate would make the puzzle even larger.

VI. Differences in Beliefs about the Health Consequences of Smoking

Finally, we turn to the impact of beliefs about smoking on smoking rates. We start our analysis with survey evidence on beliefs about the health consequences of smoking, leaving aside for the moment where those beliefs come from. In 1994, the Eurobarometer survey asked respondents whether they "tend to agree or disagree: smoking causes cancer and death". We code people who "tend to agree" as believing that smoking is harmful. To match this with U.S. data, we used the 1994 National Survey of Drug Use and Health, which asks "how much people risk harming themselves physically and in other ways when they smoke one or more packs of cigarettes per day: no risk,

[9] The non-linear relationship means that inequality should also be considered when looking at the smoking differences across countries. We leave this for future work.

slight risk, moderate risk, or great risk?" For comparability with the Eurobarometer questions, we consider people who think that smoking has a moderate or great risk.[10]

These particular survey questions are obviously imperfect. Cancer is only one health consequence of smoking. In many cases, the relevant question is not whether smoking causes cancer but rather the increased probability of developing cancer that results from smoking behavior. Nonetheless, this is the best data that we have.

Table 4 shows the distribution of beliefs across countries about whether smoking causes cancer. The first column reports the share of the entire population believing that smoking causes cancer. The U.S. has one of the highest rates of believing that smoking is harmful; 91 percent of Americans report believing that smoking causes cancer. Given the high proportion of Americans that believe in UFOs and the literal truth of the bible, this must represent one of the most remarkable instances of the penetration of scientific results in the country. Beliefs about the cancer-causing role of cigarettes in some European countries, like Finland, Greece, Norway, and Portugal, are almost identical to those in the U.S., but in other places beliefs are far weaker. For example in Germany only 73 percent of respondents said that they believed that smoking causes cancer.

One possible interpretation of this data is that exogenous trends in smoking affects beliefs about the harms of cigarettes, through a form of cognitive dissonance. Smokers may persist in believing that cigarettes don't cause cancer because their habits are more justifiable if they refuse to believe that there are health consequences of their actions. To address this, columns 2 and 3 show beliefs about the harms of smoking among non-smokers and smokers respectively. This concern does not appear to be evident. Both smokers (83 percent) and non-smokers (94 percent) in the US strongly believe that smoking By contrast, 52 percent of German smokers and 84 percent of German non-smokers shared that belief. Beliefs appear to be specific to the society, much more than o the individual who smokes or not.

[10] It is not entirely clear what level of risk corresponds to "tend to agree" in the Eurobarometer data. One might also include those who believe there is a slight risk of smoking. In this case, the beliefs about the harms of smoking would be higher still in the United States.

An added piece of evidence supporting the view that Europeans and Americans differ in their beliefs about smoking is the differential relationship between income and smoking in the US and Europe. The model above emphasized the cross-effect between beliefs and income. If smoking is thought to be harmful, then we should particularly see high income people avoid smoking, because they have a greater demand for healthy life. This is exactly what table 1 shows; in comparison to Europe, it is the richer groups of the US population who smoke the least.

We use several methods to quantify the impact that these beliefs differences have on the smoking rate. We begin with time series evidence and then turn to cross-individual, cross-state and cross-country evidence. Lung cancer did not become prevalent in the US until cigarette use became relatively common. As seen in Figure 3, this occurred in the first third of the 20th century. Thus, scientific evidence about the link between smoking and cancer dates from that era. The first published article alleging a link between cigarette smoking and lung cancer appeared in the *American Journal of Cancer* in 1932 (McNally, 1932). The article was relatively speculative, though; more concrete evidence linking cigarettes and cancer was published eighteen years later by Wynder and Graham (1950) in the *Journal of the American Medical Association*. This was followed by a 1954 Sloan-Kettering study that reported experiments where tar from cigarettes had caused cancerous tumors in mice (Sloan-Kettering, 1954).

Popular knowledge about the harms of smoking almost certainly dates from *Readers' Digest*, which ran an article in 1952 titled "Cancer by the Carton." The news was picked up by other newspapers and media outlets, including even Edward R. Murrow's (a particularly famous smoker) *See It Now* television program. These early reports and the related publicity created the first cigarette cancer scare in the early 1950s. The 1950s saw nascent public beliefs form about the harms of smoking. In a January 1954 Gallup survey, 41 percent of people answered 'yes' to the question "Do you think cigarette smoking is one of the causes of lung cancer, or not?"

Figure 3 shows the time path of cigarette smoking during this time period. From 1933 to 1952, cigarette smoking rose every year. Indeed, between 1920 and 1952, cigarette consumption fell only during the bleakest years of the great depression (confirming the positive income elasticity of cigarette consumption at lower income levels). Between 1952 and 1954, cigarette smoking took its first dramatic drop. From 1952-1953 smoking dropped by 3 percent, followed by an additional 6 percent the following year. While it is possible that this drop was due to something other than changing beliefs about the health risks of cigarettes, contemporary observers certainly thought that the decline in smoking was the result of the health scare. For example, the treasurer of the American Tobacco Company said in 1954 that "there is a tendency to ascribe the drop in cigarette consumption almost entirely to the so called 'cancer scare'." (*New York Times*, May 7, 1954, p.35).

The reaction in the marketplace proceeded along several dimensions. On the one hand, manufacturers and the public responded by making cigarettes somewhat safer. Use of filtered cigarettes rose from less than 2 percent in 1952 to more than 20 percent in 1955. Edward R. Murrow on the air linked the rise of filtered cigarettes to heightened fears about the dangers of cigarettes. On the other hand, the cigarette industry fought back through advertising. Using their vast advertising budgets and spending on their own rival research (which unsurprisingly found that cigarettes were harmless), cigarette companies were able to overcome the negative publicity associated with these early studies. Smoking rose again from 1954 through 1963.

Increasing evidence in the medical community showed the harms from smoking, and in 1964, the Surgeon General issued his famous warning about the health consequences of smoking. In 1966, the Federal Trade Commission required cigarettes to be sold with a label warning that "cigarettes may be hazardous to your health." Both the federal government and private groups like the American Cancer Society mounted campaigns meant to increase awareness of the health consequences of smoking. The fruits of this campaign are apparent in public opinion surveys. In 1960, 50 percent of Americans believed that cigarette smoking was one of the causes of lung cancer. By 1969, the share

was 71 percent (Cutler and Kadiyala, 2003). One sees this in the consumption data as well. In 1964 alone, cigarette smoking fell by 3 percent, and smoking was down by 8 percent by 1970.

Since the 1950s, beliefs about the harms of smoking have cemented. The Gallup Organization (Gallup, 1981) documented a rising belief that smoking was dangerous. By the 1980s, Viscusi (1992) finds that people actually overestimated the health risks of smoking. As noted above, over 90 percent of Americans now believe that smoking causes cancer.

A strong circumstantial case links the decline of smoking to the expansion of information about the harms of smoking. In addition to figure 3, data on the share of people who have ever smoked show a decline beginning in cohorts coming of smoking age after 1964. Other evidence about the link between perception and smoking comes from individual correlations between beliefs and actions. Smoking rates among those who believe that smoking a pack or more of cigarettes per day has a great risk are only 23 percent, compared to 52 percent among those who do not believe that link.[11] If beliefs causally affect smoking (and not the reverse, as with cognitive dissonance), it suggests a large impact of beliefs on actions.

One way to get around the reverse relationship between smoking and beliefs is to consider subsets of the population where beliefs are not reflective of actions. Specifically, we consider how smoking rate in a state or country is related to the beliefs of *non-smokers* about the harms of smoking. Of course, if beliefs are formed through a social learning process, then the beliefs of non-smokers in high smoking states may reflect the influence of other variables that are related to smoking. But we do not have any obvious alternative to this strategy.

[11] In a probit regression, where we also control for age, gender, race education and income, the effect of believing that smoking is a great risk drops to 27 percent.

Figure 10 shows cross-state data on smoking rates and the share of non-smokers who believe that smoking is a great risk.[12] There is a clear negative relation between the two. A one percent increase in the share of non-smokers who think that cigarettes cause cancer is associated with a 0.6 percent decrease in the share of people who smoke cigarettes. This cross- state relationship is robust to controlling for income, price, a regulation index, education and a dummy variable for states that produce tobacco. The coefficient on beliefs drops only to .5 including all of these controls.

We complement the analysis across US states with cross-country evidence. Figure 11 shows the relationship across countries between the share of non-smoking respondents who believe that cigarettes cause cancer and the share of smokers.[13] The regression line is negative and roughly the same magnitude as the state data; a one percent increase in the share of the population that thinks that cigarettes causes cancer is associated with a .47 percent decrease in the share of the population that smokes. Because of the small number of observations, the coefficient is not statistically significant.

If one assumes that beliefs are formed independently of smoking rates, we can use these estimates and ask how much of the difference between U.S. and European cigarette consumption is associated with differences in beliefs. The difference in beliefs between the U.S. and Europe is about 7 percentage points overall and 4 percent among non-smokers. Using the state level estimate of the impact of beliefs on smoking or the international evidence, the more widespread belief about the harms of smoking explains between 2 and 4 percent lower smoking rates in the US – the former taking only the difference in beliefs among non-smokers and the latter taking the difference in beliefs overall. These translate into 20 and 40 percent of the total smoking difference across countries. On the whole, our evidence suggests that differences in beliefs are the most important factor explaining the differences in smoking between the U.S. and Europe.

[12] Note that the mean differs from Table 4 because we use only the share of people reporting that smoking is a great risk, rather than a great or moderate risk. We do this to highlight the certainty of beliefs.
[13] We use Eurobarometer data for smoking rates, since we are using the beliefs data from that survey.

VII. Conclusion

There is a dramatic difference in smoking rates between the U.S. and Europe. This difference is largest for the most educated and richest members of the two regions, but applies throughout the distribution. This difference is not longstanding, and it exists despite the fact that along many other dimensions (witness obesity) Europeans are far healthier than Americans.

There is no evidence that this difference is the result of cigarette taxes or direct government regulation of cigarettes. Cigarettes are taxed more highly in Europe than in the United States. Some of the difference between the U.S. and Europe – perhaps a quarter – is the result of higher U.S. incomes. There appears to be something of smoking Kuznets curve where cigarette consumption first rises and falls with income. Both the US and Europe are on the downward slope of the Kuznets curve, where higher incomes are associated with less smoking.

The most important factor, however, appears to be differences in beliefs about the health consequences of smoking between the U.S. and Europe. Ninety-one percent of Americans think that cigarettes cause cancer; only 84 percent of Europeans share that view. Using different estimates of the relation between beliefs and cigarette consumption, we estimate that this difference can explain between one-quarter and one-half of the total smoking difference between the U.S. and Europe. Moreover, the history of cigarettes within the U.S. suggests that American beliefs about smoking seemed to come about only after substantial information about the harms of smoking were presented – first by private researchers, then by the Federal government. 'Soft paternalism'[14] is a major factor in lower rates of smoking.

The possibility of a feedback from smoking to beliefs about smoking suggests that the impact of this information may be even larger than we have estimated. In areas where

[14] We distinguish information campaigns from 'hard paternalism', including regulating smoking and raising taxes.

fewer people smoke, non-smoker sentiment might be stronger, leading to a further reduction in cigarette use.

As a final thought, it is worth wondering why the U.S., with its lower propensity towards regulation and paternalism generally, had more effective interventions in the changing of beliefs about smoking. U.S. smoking history suggests that entrepreneurial actions on the part of anti-smoking interest groups were quite important. Initially, the American Medical Association and later organizations specifically focused on cancer and heart disease effectively used the market for ideas both directly to influence beliefs and indirectly, by influencing the government. By contrast, European pressure groups were much weaker and less effective at influencing public opinion and policy. According to this view, while greater U.S. entrepreneurship and economic openness led to more smoking during an earlier era (and still leads to more obesity today), it also led to faster changes in beliefs about smoking and ultimately less cigarette consumption.

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Appendix: Proofs of Propositions

Proof of Proposition 1: At $S = S^* = \frac{\beta\Delta U(Y)}{1-\beta\delta} + U(Y) - U(Y - P_C)$, the utility from smoking and not smoking are equal. Since the utility from smoking is monotonically and continuously increasing in S, and the utility from not smoking is independent of S, for values of S>S*, smoking strictly dominates not smoking and for values of S<S*, not smoking strictly dominates smoking.

Differentiation then yields $\frac{\partial S^*}{\partial P_C} = U'(Y - P_C) > 0$, $\frac{\partial S^*}{\partial \beta} = \frac{\Delta U(Y)}{(1-\beta\delta)^2} > 0$, $\frac{\partial S^*}{\partial \Delta} = \frac{\beta U(Y)}{1-\beta\delta} > 0$, and $\frac{\partial S^*}{\partial \delta} = \frac{\beta^2 \Delta U(Y)}{(1-\beta\delta)^2} > 0$.

Proof of Proposition 2: Differentiation yields: $\frac{\partial S^*}{\partial Y} = \frac{(1-\beta\delta+\beta\Delta)U'(Y)}{1-\beta\delta} - U'(Y - P_C)$ which is positive if and only if $1 + \frac{\beta\Delta}{1-\beta\delta} > \frac{U'(Y-P_C)}{U'(Y)}$. Further differentiation then yields $\frac{d}{dY}\left(\frac{U'(Y-P_C)}{U'(Y)}\right) = \frac{U''(Y-P_C)U'(Y) - U'(Y-P_C)U''(Y)}{U'(Y)^2}$, which is strictly negative if $\frac{-U''(Y-P_C)}{U'(Y-P_C)} > \frac{-U''(Y)}{U'(Y)}$. This is always true if $-\frac{U''(Y)}{U'(Y)}$ is strictly decreasing in Y. The assumption $\lim_{Y\to 0} U'(Y) = \infty$ guarantees that for some value of Y sufficiently close to P_C, $\frac{U'(Y-P_C)}{U'(Y)} > \frac{1-\beta\delta+\beta\Delta}{1-\beta\delta}$, and the assumption $\lim_{Y\to\infty} \frac{U'(Y-P_C)}{U'(Y)} = 1$ guarantees that for some sufficiently high value of Y, $\frac{1-\beta\delta+\beta\Delta}{1-\beta\delta} > \frac{U'(Y-P_C)}{U'(Y)}$. Thus, there must exist a value of Y at which $\frac{1-\beta\delta+\beta\Delta}{1-\beta\delta} = \frac{U'(Y-P_C)}{U'(Y)}$. Monotonicity then implies that for levels of Y greater than that, $\frac{\partial S^*}{\partial Y} > 0$ and for levels of Y less than that, $\frac{\partial S^*}{\partial Y} < 0$.

Proof of Proposition 3: Within any two groups, the impact of an increase in Δ on the share of the group that smokes will equal $-f(S^*)\frac{\partial S^*}{\partial \Delta} = -f(S^*)\frac{\beta U(Y)}{1-\beta\delta}$. If S is uniformly distributed then this becomes $\frac{\beta U(Y)}{1-\beta\delta}$ times a negative constant. Differentiation shows that this quantity is clearly greater for groups with more income, higher values of β and higher values of δ.

Proof of Proposition 4: Within any two groups, the impact of an increase in P_C on the share of the group that smokes will equal $-f(S^*)\frac{\partial S^*}{\partial P_C} = -f(S^*)U'(Y-P_C)$. If S is uniformly distributed then this becomes $U'(Y-P_C)$ times a negative constant. This is declining in Y and independent of β and δ.

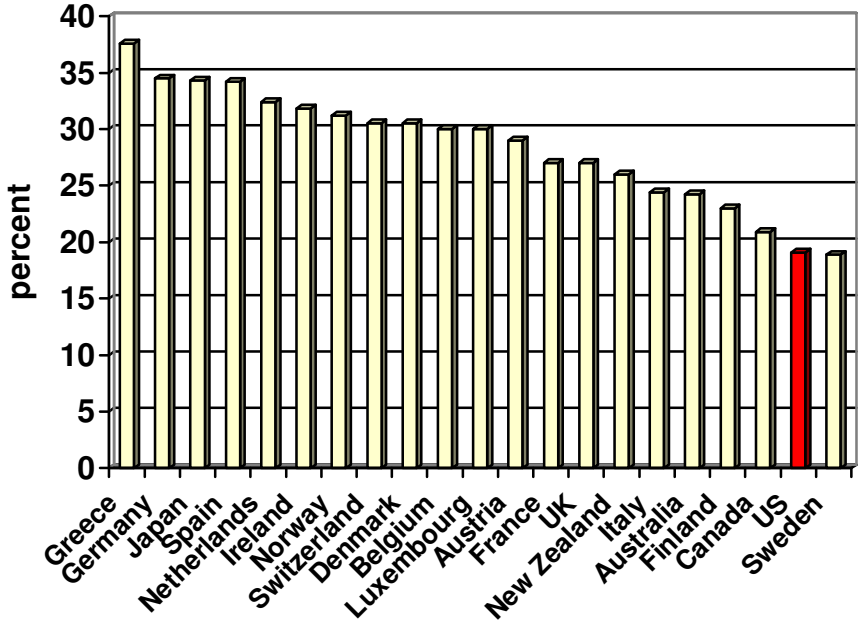
Proof of Proposition 5: Now $S^* = \frac{\beta\Delta U(Y)}{1-\beta\delta} + U(Y) - U(Y-P_C) - g \bullet Share_{smoker s}$. Across population subgroups the derivative of the share smoking will equal $\frac{-1}{\overline{S}-\underline{S}}\frac{\partial S^*}{\partial x}$ holding $Share_{smoker s}$ constant, which yields derivatives of $\frac{-U'(Y-P_C)}{\overline{S}-\underline{S}}$, $\frac{-1}{\overline{S}-\underline{S}}\left(\frac{\Delta U(Y)}{(1-\beta\delta)^2}\right)$, $\frac{-1}{\overline{S}-\underline{S}}\left(\frac{\beta\Delta U(Y)}{(1-\beta\delta)^2}\right)$ and $\frac{-1}{\overline{S}-\underline{S}}\left(\frac{\beta U(Y)}{1-\beta\delta}\right)$ for P_C, β, δ and Δ respectively. Across countries $Share_{smoker s} = \frac{\overline{S}-S^*}{\overline{S}-\underline{S}}$, so the equation can be solved to yield:

$S^* = \frac{\overline{S}-\underline{S}}{\overline{S}-\underline{S}-g}\left(\frac{\beta\Delta U(Y)}{1-\beta\delta} + U(Y) - U(Y-P_C) - g \bullet \frac{g\overline{S}}{\overline{S}-\underline{S}}\right)$. The derivative of the share of cigarette smokers with respect to any variable equals $\frac{-1}{\overline{S}-\underline{S}}\frac{\partial S^*}{\partial x}$, which equals

$\frac{-U'(Y-P_C)}{\overline{S}-\underline{S}-g}$, $\frac{-1}{\overline{S}-\underline{S}-g}\left(\frac{\Delta U(Y)}{(1-\beta\delta)^2}\right)$, $\frac{-1}{\overline{S}-\underline{S}-g}\left(\frac{\beta\Delta U(Y)}{(1-\beta\delta)^2}\right)$ and $\frac{-1}{\overline{S}-\underline{S}-g}\left(\frac{\beta U(Y)}{1-\beta\delta}\right)$

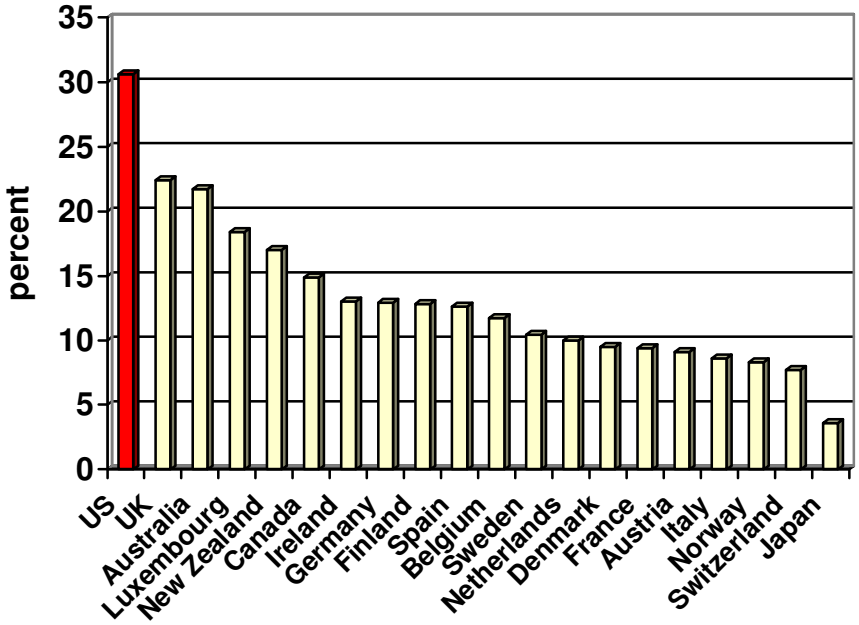
for P_C, β, δ and Δ respectively. All of these are decreasing in g, so as g gets larger the impact of all of these variables on aggregative smoking consumption will increase. Furthermore, the ratio of the relationship between these variables across subgroups within country to the relationship between these variables and smoking across countries will equal $\frac{\overline{S}-\underline{S}}{\overline{S}-\underline{S}-g}>1$.

Figure 1: Smoking Rates in Developed Countries, 2000



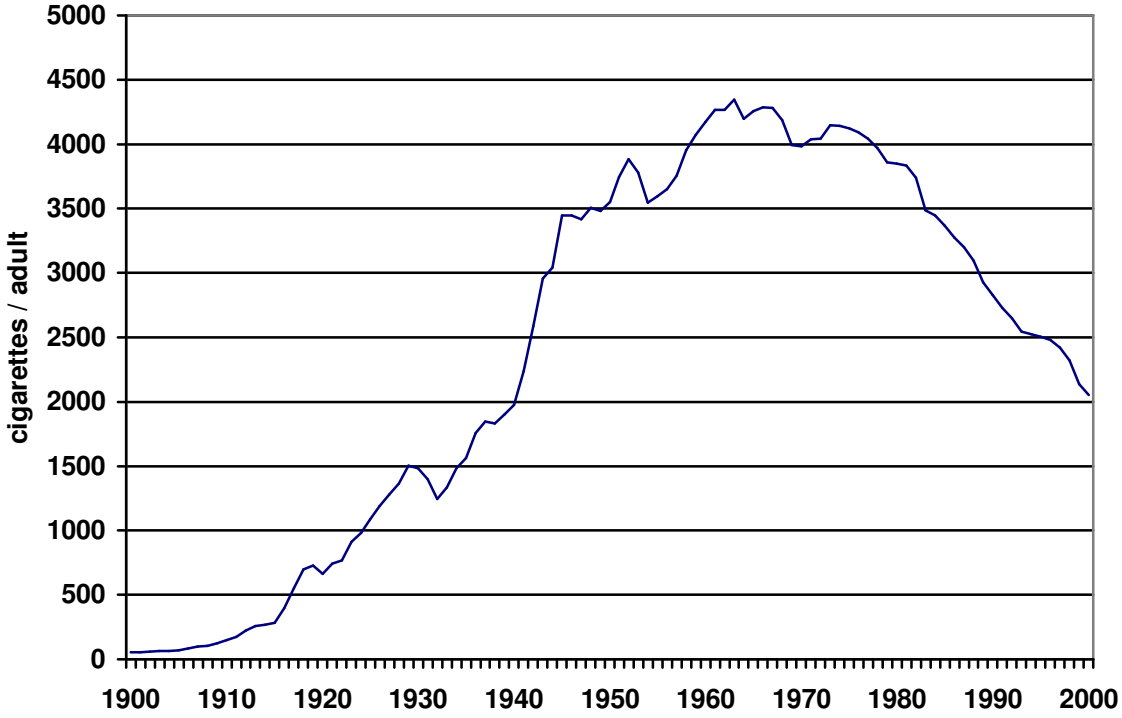
Source: World Health Organization.

Figure 2: Obesity Rates in Developed Countries, 2000



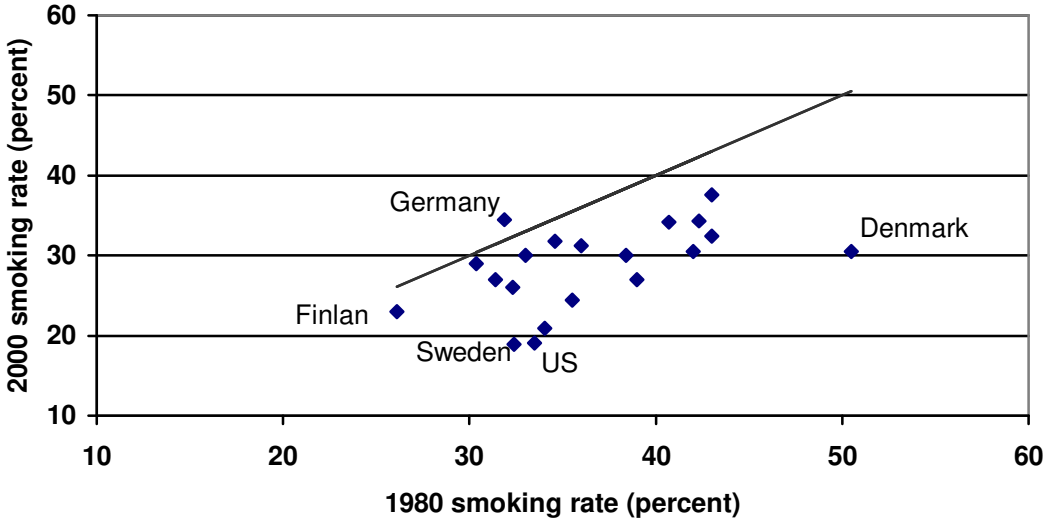
Source: OECD Health Statistics. Data are for about 2000 in all countries.

Figure 3: Cigarette Smoking in the United States



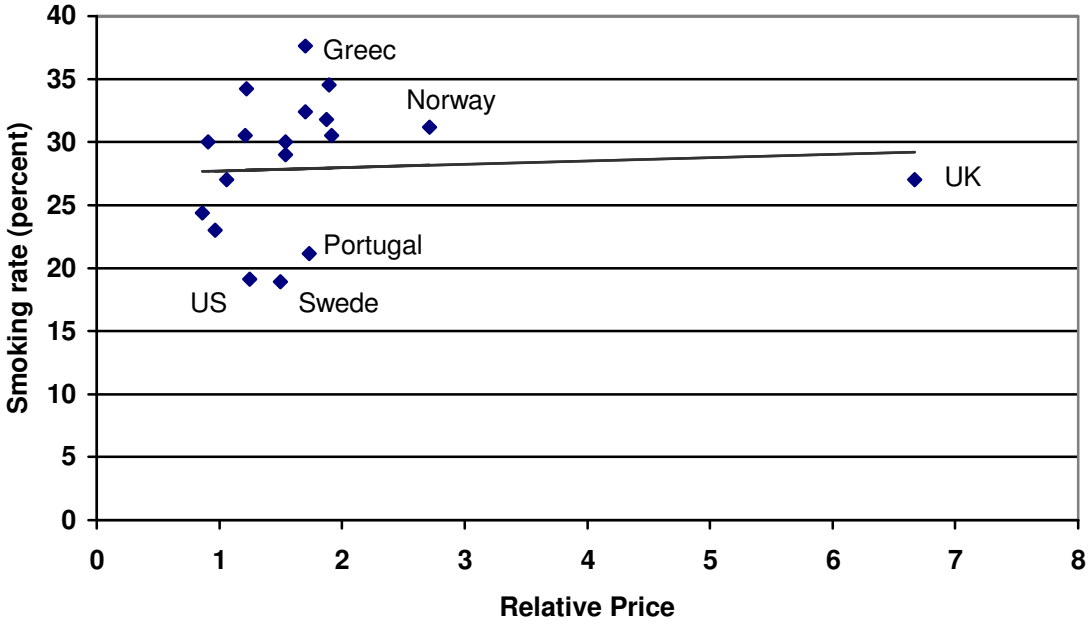
Source: Centers for Disease Control and Prevention.

Figure 4: Smoking Rates in 1980 and 2000



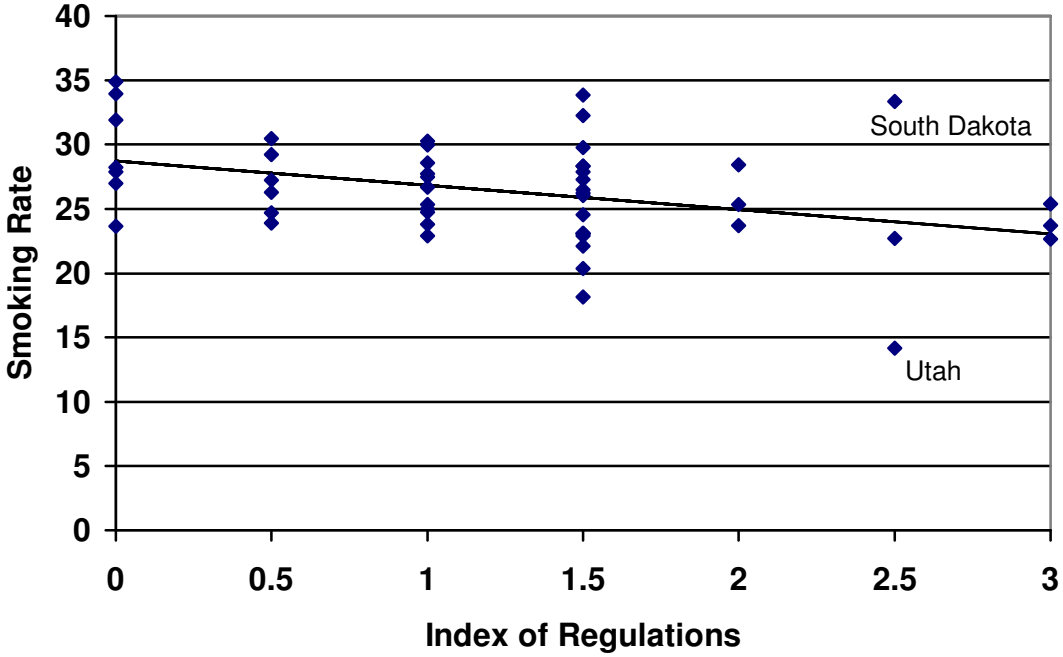
Source: World Health Organization.

Figure 5: Cigarette Smoking and the Relative Price of Tobacco



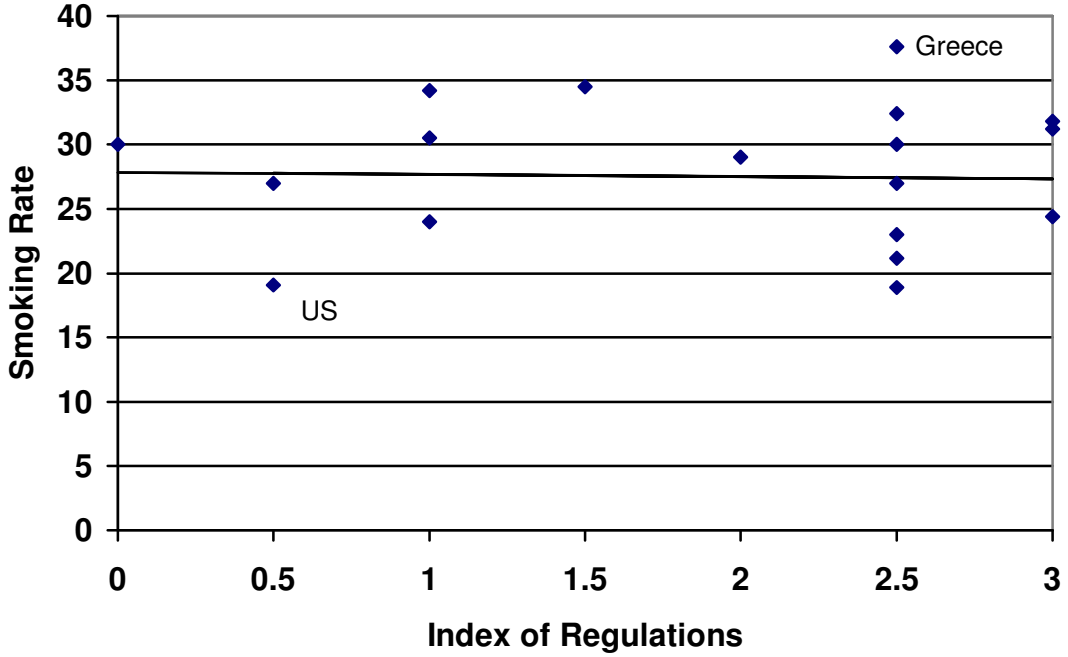
Source: World Health Organization. Regression excludes Greece.

Figure 6: Smoking and Regulations in US States



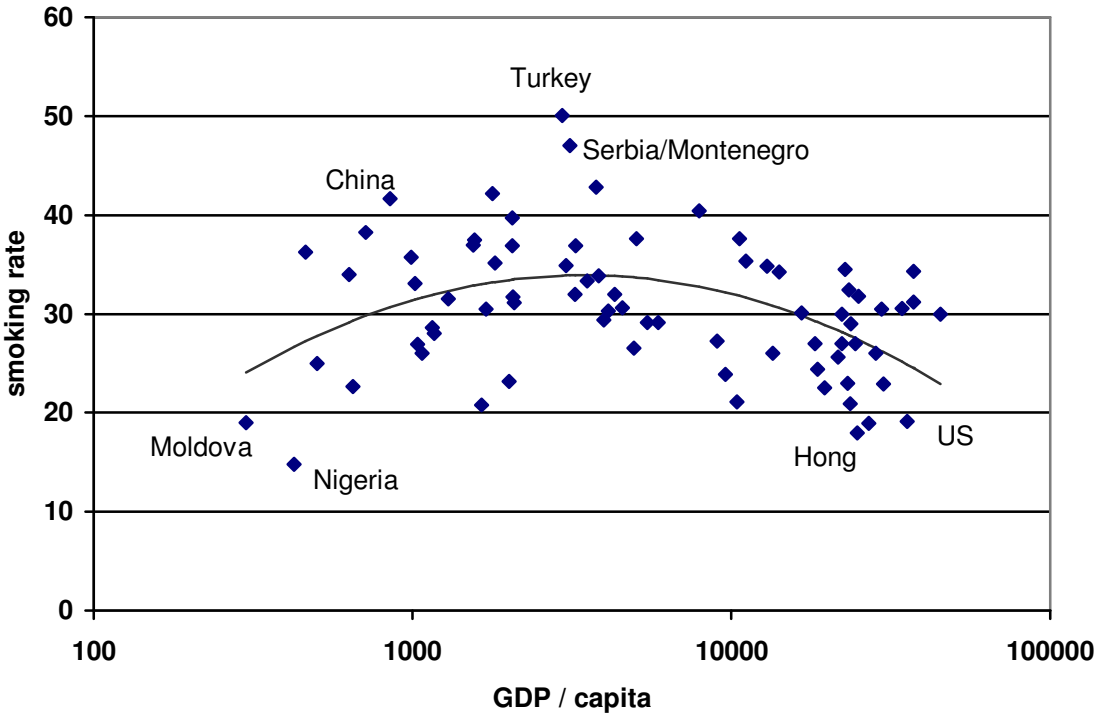
Source: Centers for Disease Control and Prevention.

Figure 7: Smoking and Regulations Across Countries



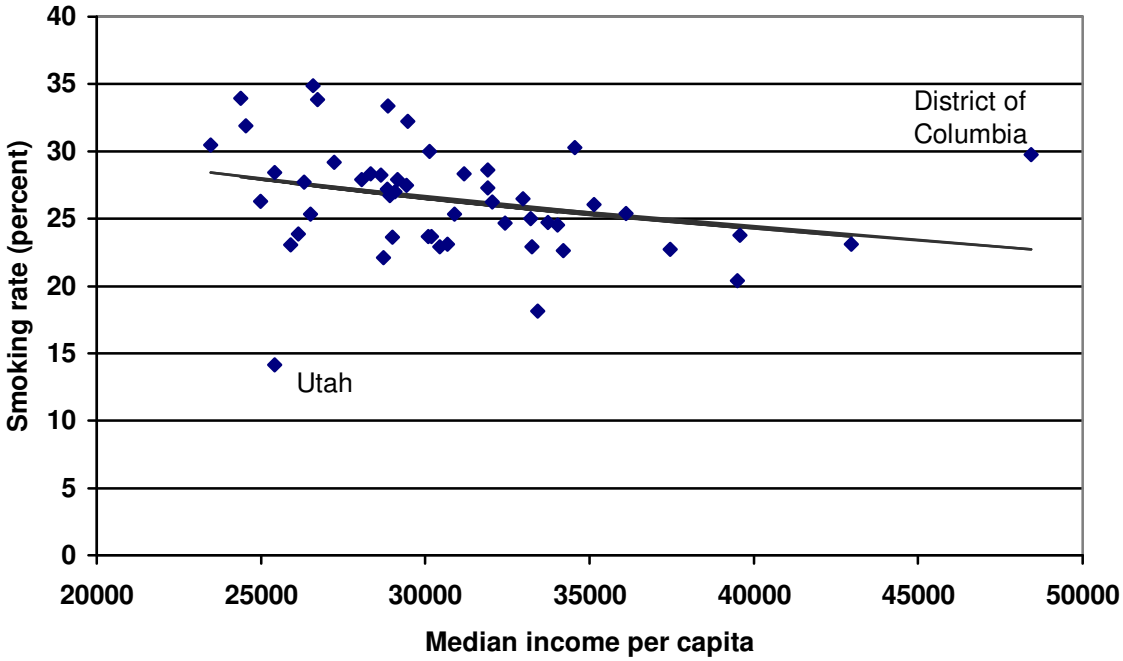
Source: World Health Organization. Regression excludes Greece.

Figure 8: Smoking and Income, International Data



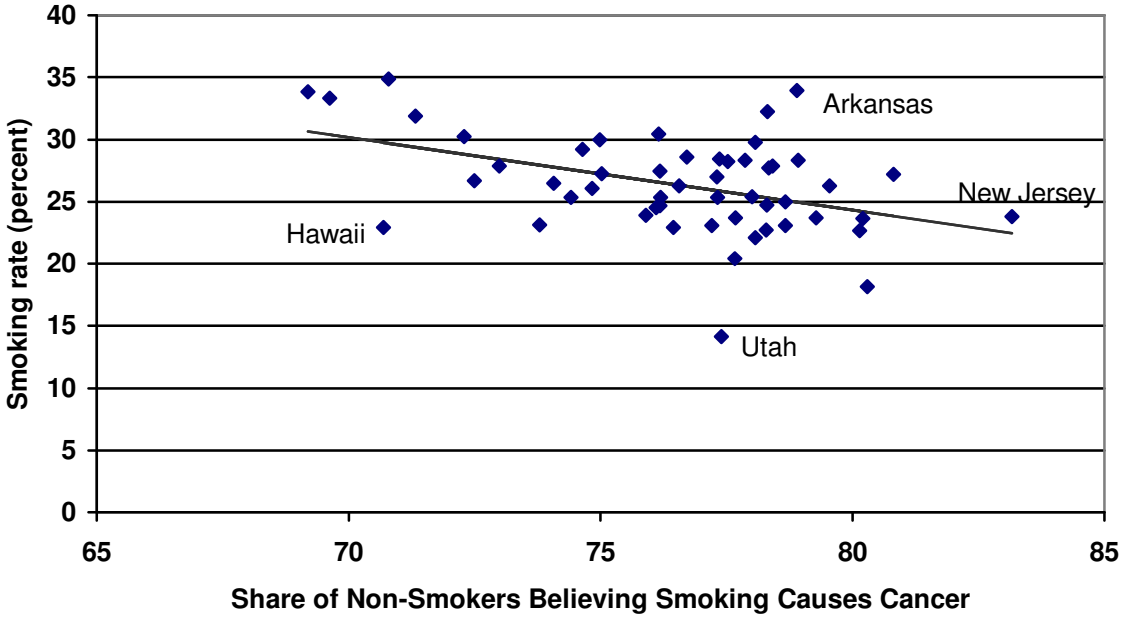
Source: World Health Organization and World Bank.

Figure 9: Smoking and Median Income, States



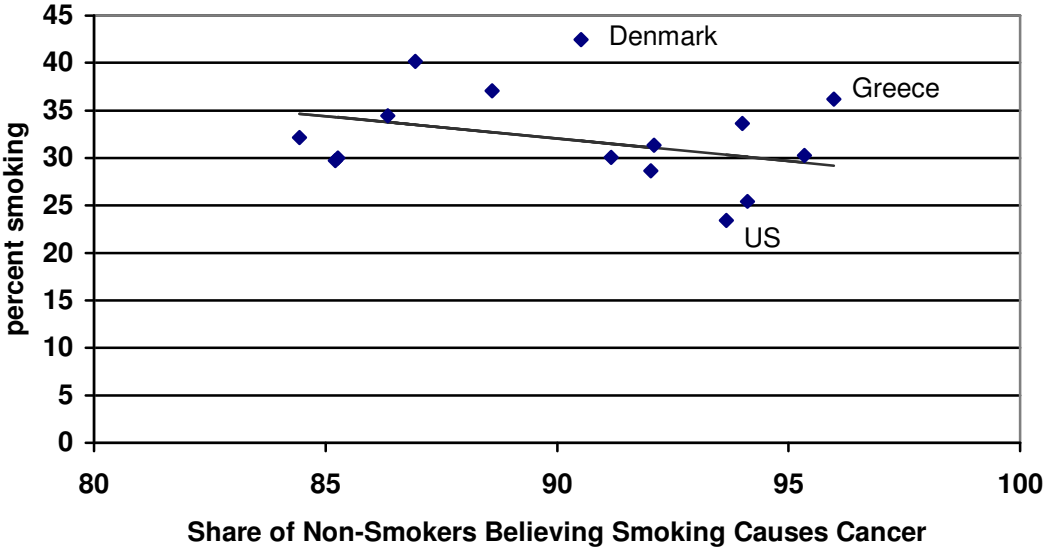
Source: Centers for Disease Control and Prevention and Census Bureau. The regression line is estimated using the logarithm of per capita income as the dependent variable.

Figure 10: Smoking and The Beliefs of Non-Smokers About the Harms of Smoking, States



Source: Centers for Disease Control and Prevention and National Survey of Drug Use and Health.

Figure 11: Smoking Rates and Beliefs About Smoking, Cross Country Data



Source: Authors' tabulations of Eurobarometer survey data and National Survey of Drug Use and Health. Regression excludes Greece.

Table 1: Smoking Rates in Developed Countries (percent)

	Smoking Rate		Rate by Income Quartile				Rate by Education	
Country	Official 2000	Survey 1994	Top	2nd	3rd	Bottom	>12 years	<12 years
Austria	29	--	--	--	--	--	--	--
Belgium	30	30	30	35	30	28	30	30
Denmark	31	42	34	48	44	38	42	46
France	27	37	37	36	37	37	41	34
Finland	23	30	--	--	--	--	--	--
Greece	38	36	41	41	40	22	44	31
Germany	35	32	36	33	30	27	34	32
Ireland	32	30	32	28	32	30	26	35
Italy	24	30	28	32	29	28	33	29
Luxembourg	30	29	25	21	36	36	29	29
Netherlands	32	40	36	35	38	45	43	39
Norway	31	34	--	--	--	--	32	44
Portugal	21	25	32	24	28	11	37	22
Spain	34	34	30	38	38	24	42	31
Sweden	19	--	--	--	--	--	--	--
Switzerland	31	--	--	--	--	--	--	--
UK	27	31	20	32	32	33	22	36
European average	30	33	32	34	35	30	35	33
US	19	23	21	24	29	31	22	25

Source: Official smoking data for 2000 are from the World Health Organization's Health for All Database, and are generally compiled from national surveys. All other data are authors' tabulations. European data are from Eurobarometer and are for the population aged 15+ in 1994. US data are from the National Survey of Drug Use and Health and are also for the population aged 15+ in 1994. Germany is West Germany, and the UK includes Northern Ireland. The European average is for countries that have complete data (e.g., excluding Norway).

Table 2: Cigarette Prices in the US and Europe

Country	Price after tax of local brand (US$)	Tax (US$)	Price Relative to Bread
Austria	3.04	2.22	1.5
Belgium	2.93	2.20	1.5
Denmark	4.00	3.36	1.9
Finland	3.35	2.45	1.0
France	2.75	2.06	1.1
Germany	2.75	1.98	1.9
Greece	1.64	1.20	1.7
Ireland	4.47	3.35	1.9
Italy	1.93	1.41	0.9
Luxembourg	1.90	--	0.9
Netherlands	2.56	1.84	1.7
Norway	6.48	5.05	2.7
Portugal	1.77	1.43	1.7
Spain	1.15	0.83	1.2
Sweden	3.64	2.51	1.5
Switzerland	2.80	1.46	1.2
UK	6.25	4.88	6.7
European average	3.22	2.39	1.9
US	3.60	0.86	1.2

Sources: World Health Organization "The Tobacco Atlas" 2002. Guindon, Tobin, Yach 2002. The UK includes Northern Ireland. The European average is for all countries with complete data.

Table 3: Cigarette Regulation in the US and Europe

		Smoke Free Workplace		
Country	Total	Government	Private	Restaurants
Austria	2.0	1.0	1.0	0.0
Belgium	2.5	1.0	1.0	0.5
Denmark	1.0	0.5	0.5	0.0
Finland	2.5	1.0	1.0	0.5
France	2.5	1.0	1.0	0.5
Germany	1.5	0.5	0.5	0.5
Greece	2.5	1.0	1.0	0.5
Ireland	3.0	1.0	1.0	1.0
Italy	3.0	1.0	1.0	1.0
Luxembourg	0.0	0.0	0.0	0.0
Netherlands	2.5	1.0	1.0	0.5
Norway	3.0	1.0	1.0	1.0
Portugal	2.5	1.0	1.0	0.5
Spain	1.0	0.5	0.5	0.0
Sweden	2.5	1.0	1.0	0.5
Switzerland	1.0	0.5	0.5	0.0
UK	0.5	0.0	0.0	0.5
European average	1.97	0.76	0.76	0.44
US	1.05	0.49	0.25	.31

Sources: World Health Organization, Tobacco Control Database, CDC State database. Data are for around 2000. UK includes Northern Ireland.

Table 4: Belief Differences Across Countries

	Percent Believing Smoking is Harmful		
Country	Total	Non-Smokers	Smokers
Belgium	78	85	63
Denmark	85	91	78
Finland	91	95	81
France	82	89	72
Germany	73	84	52
Greece	91	96	83
Ireland	85	91	73
Italy	77	85	57
Luxembourg	86	92	73
Netherlands	81	87	72
Norway	90	94	83
Portugal	92	94	84
Spain	84	86	78
UK	87	92	75
European average	84	90	73
US	91	94	83

Sources: Authors tabulations. European data are from Eurobarometer and are for 1994. US data are from the General Social Survey and are for 1994. Germany is West Germany. UK includes Northern Ireland.