SIEPR Discussion Paper No. 07-02

Playing with Fire: Cigarettes, Taxes and Competition from the Internet

By
Austan Goolsbee
University of Chicago, GSB,
American Bar Foundation and NBER

Michael Lovenheim
SIEPR, Stanford University

Joel Slemrod
University of Michigan,
Office of Tax Policy Research and NBER

September 2007

Stanford Institute for Economic Policy Research
Stanford University
Stanford, CA 94305
(650) 725-1874

PLAYING WITH FIRE: CIGARETTES, TAXES AND COMPETITION FROM THE INTERNET*

by

Austan Goolsbee
University of Chicago, GSB,
American Bar Foundation and NBER

Michael Lovenheim
SIEPR, Stanford University

Joel Slemrod
University of Michigan,
Office of Tax Policy Research and NBER

Abstract

This paper documents the rise of the Internet as a source of cigarette tax competition for states in the United States. Using data on cigarette tax rates, taxable cigarette sales and individual smoking rates by state from 1980 to 2005 merged with data on Internet penetration, the paper documents that there has been a substantial increase in the sensitivity of taxable cigarette sales that is correlated with the rise of Internet usage within states. The estimates imply that the increased sensitivity from cigarette smuggling over the Internet has lessened the revenue generating potential of recent cigarette tax increases substantially. Given the continuing growth of the Internet and of Internet cigarette merchants, the results imply serious problems for state revenue authorities.

*We wish to thank Jonathan Gruber, James Poterba, Raj Chetty and participants at seminars at UC Berkeley, the University of Chicago, and the NBER Summer Institute for helpful comments. We also thank Jane Dokko, Peter Katuscak, Pablo Pena, Svetla Tzenova and Jongsang Park for research assistance, and the American Tax Policy Institute and the Searle Freedom Trust for financial support.

I. Introduction

Cigarette taxes have traditionally presented policymakers with a benign tradeoff between revenue and public health. On one hand, if demand is inelastic, raising cigarette taxes can generate substantial revenue with low excess burden. On the other hand, if cigarette taxes are ineffective at raising revenue because of behavioral responses, they will reduce consumption, thereby saving lives and preventing disease.

Cigarette smuggling, however, endangers this happy tradeoff. If increasing cigarette taxes only serves to increase smuggling, these taxes may be ineffective at both raising revenue and reducing consumption. In this context, the rise of the Internet and the availability of tax-free, mail-order cigarettes presents a potentially serious threat to the efficacy of local cigarette taxes. When people can buy online, raising tax rates may generate little revenue while at the same time doing nothing to improve health. Instead, people simply become more sensitive in where they choose to buy their cigarettes.

Cigarette tax evasion over the Internet has become an issue of first-order importance in the last several years as many states have significantly raised their cigarette taxes to help close their budget deficits. Since January, 2002, some 36 states and the District of Columbia have increased their cigarette tax rates, expecting to raise significant revenues based on the view that demand for cigarettes in the absence of cigarette smuggling is relatively inelastic.[1] This paper will examine whether the rise of the Internet has made taxable cigarette purchases more responsive to state tax rates, thereby reducing the revenue-generating potential of these taxes without the associated smoking reductions.

[1] There is an extensive literature on the demand for cigarettes including Becker, Grossman, and Murphy (1994) and Gruber and Koszegi (2001). Evans et al. (1999) and Chaloupka and Warner (2000) survey the literature. There is, of course, a tension in policy toward smoking since at the same time policy makers want to raise revenue from smokers, they would like to reduce the amount of smoking for health reasons. Evans et al. (1999) and Hu et al. (1995) examine the impact of various non-tax public policies to reduce smoking.

Cigarettes are a natural place to look for the impact of tax evasion because state excise tax rates on cigarettes are particularly high relative to other consumption taxes and because avoidance and evasion, both informal and organized, is rampant.[2] For example, Internet cigarette merchants located on Native American reservations (where state excise taxes levied on wholesalers often do not apply) and in states with low cigarette taxes have dramatically increased. Although Internet sales are technically subject to cigarette taxes remitted by the consumers to the states where the cigarettes are consumed, little tax is actually collected from these online sales (GAO, 2002; 2003). Indeed, the state of New York has attempted to ban Internet cigarette merchants completely and has argued that it alone loses some $500 to $600 million per year of revenue from Internet, "800 number," and Indian reservation sales (REA, 2002).

In this paper we make use of survey data on Internet use by state and across time as well as state data on taxable cigarette sales and on actual smoking to investigate how the growth of the Internet has affected the elasticity of taxable cigarette sales. The results suggest the rise of online shopping has dramatically increased the sensitivity of in-state purchases to state tax rates. The price elasticity of taxable cigarette sales has risen most in those places where the Internet has grown the fastest (holding other things equal) and, in magnitude, increased the sensitivity of taxable cigarette sales to state tax rates by over 60 percent. There is no reason to believe that the growth in Internet use would affect cigarette consumption absent the presence of online price savings, which implies the increased tax sensitivity is due

[2] Becker, Grossman, and Murphy (1994), Coats (1995), Thursby and Thursby (2000), Yurekli and Zhang (2000), Farrelly, et al. (2001), and Gruber, Sen and Stabile (2003) all document ways that smuggling and proximity to low-tax neighbors make cigarette sales more sensitive to tax rate changes. Lovenheim (2007) shows the sensitivity of consumption to the home state price varies systematically by how close consumers live to lower-price borders and estimates between 13-25 percent of cigarettes are purchased in lower-price localities. Slemrod (2007) demonstrates how changing the enforcement regime affected the tax responsiveness of sales in Michigan.

to Internet smuggling. Our results also imply that the observed increases in the price elasticity of taxable sales since 2000 (Yurekli and Zhang, 2000; Keeler et al., 2001; Stehr, 2005) can be explained largely by the growth in Internet penetration over this time period.

The overall impact of Internet growth on tax revenue thus far appears to be modest, but the impact on the ability of tax increases to generate revenue has been sizable. We estimate the tax increases of 2001 to 2005 might have caused states to collect about 8 percent less revenue than would have been expected without any tax-free Internet sales.

The paper proceeds as follows. Section II discusses the cigarette retail industry and the role of the new Internet sites. Section III presents a model of taxable cigarette sales and Internet penetration, and our data and empirical methodology are described in Section IV. Section V shows the basic results on taxable cigarette sales, presents taxable sales elasticities, and discusses the revenue implications of our findings. Section VI presents estimates of the relationship between cigarette taxes, Internet use, and Internet smuggling. Section VII shows tests of robustness, and Section VIII concludes.

II. The Cigarette Industry

With the growth of the Internet, many websites offering cigarettes for sale online have arisen. A General Accounting Office (GAO) report identified the names and addresses of some 147 such sites in 2002 and said there might be 400 or more such sites in existence (GAO, 2002). With names like www.taxfreecigarettes.com, www.notaxsmokes.com and www.0taxcigs.com, it is clear that vendors are aware of the opportunities the Internet provides for tax evasion. Virtually all of the online merchants are physically located either on

American Indian Reservations (and thereby need not remit state excise taxes[3]) or in tobacco-producing states like North Carolina, Kentucky, or Virginia, where state cigarette excise taxes are very low.

While these sites facilitate avoiding state excise taxes (which are usually collected from the wholesaler), they do not eliminate the legal obligation to pay them. By state law, an individual is supposed to pay the excise tax on any cigarettes they consume in their state of residence, even if the cigarettes are purchased elsewhere and brought into the state or received by mail. Like the use tax on mail order purchases, though, few people comply

Given the substantial variation in tax rates on cigarettes around the country, it is not surprising that cross-border shipments would proliferate or that there would be laws designed to contain them. The Jenkins Act, a federal law, requires anyone that sells cigarettes for a profit to a customer across state lines (other than to a licensed distributor) to report the brand and quantity of the sale as well as the name and address of the customer to the buyer's state's tobacco tax authority.

Violating the Jenkins Act, however, is only a misdemeanor and the penalty cannot exceed a $1000 fine (or 6 months in prison). Further, enforcement of the act is left to the Department of Justice and the FBI, who have not actively pursued such cases. Indeed, many of the online sellers of cigarettes specifically claim on their websites that they do not comply with the Jenkins Act (which is illegal) or that the Jenkins Act does not apply to them as Indian tribes (which is not true). The GAO reported, of the websites they examined, almost 80 percent either claimed the Jenkins Act did not apply or they refused to comply and would keep all customer information secret.

[3] There are some states that have either laws or tribal compacts that call for the remittance of state taxes on reservation sales to non-tribal members. While the tax enforcement mechanisms differ across states that tax Native American Reservation sales, evasion is still thought to be extensive.

Another law, the Contraband Cigarette Trafficking Act of 1978, makes it a federal crime to transport more than 60,000 cigarettes (i.e., 300 cartons) across state lines without proof that state taxes have been paid but, apparently for this reason, most of the online sites specifically limit purchases to less than 300 cartons. As with the Jenkins Act, enforcement is apparently weak.

Because the states do not have enforcement authority regarding the federal Jenkins Act, there is little they can do to curb online cigarette tax evasion, as described in the existing GAO reports (GAO, 2002; 2003). New York has tried banning the delivery of cigarettes ordered online and began enforcing that ban in 2003 by threatening fines for delivery companies and by threatening to close down merchants within the state, many of which are operated on the Seneca Indian lands in upstate New York (*Business Review*, 2003). California has tried to notify Internet merchants and California residents directly. From May, 1999 to September, 2001 they notified 167 Internet vendors and 23,500 residents, but collected only $1.4 million in taxes, penalties, and interest (GAO, 2002). In 2005, the Attorney Generals of New York, California, and Oregon negotiated a deal with the major credit card companies to stop processing payments of illegal Internet cigarette sales (Consumeraffairs.com, 2005), making the transactions more difficult. However, other forms of payment have proliferated such as direct debit.

The federal government is also concerned about the issue. Congress has proposed legislation that would strengthen reporting requirements, raise violations of the Jenkins Act to a felony and reduce the number of cigarettes required to qualify as contraband from 60,000 10,000 (Glasner, 2003). More recently, Congressman John M. McHugh (R-NY) introduced a

bill that would outlaw the shipping of tobacco products by the U.S. Postal Service (Lewis, 2007). Other mail carrier services already ban the shipping of tobacco products.

While online cigarette sales have garnered much interest from politicians and government agencies, there is little information on the most basic of issues such as the volume of online cigarette sales. Forrester Research (2001) predicted online sales of cigarettes would exceed $5 billion by 2005, equal to about 14 percent of total sales, causing $1.4 billion in lost tax revenue.

The Behavioral Risk Factor Surveillance System (BRFSS) data on cigarette usage that we will use below contains some further information on Internet cigarette sales. For one state, Oregon, the BRFSS included in 2003 a question that asked whether the smoker has purchased cigarettes online or through the mail. More than 6 percent said yes (BRFSS Oregon, 2004). A second piece of indirect evidence comes from the frequency with which people use search engines to look for sites related to online cigarette sales. Search engines like Google and Yahoo sell advertisements whose prices depend on the number of consumers that search on a given term. Using Overture's *Keyword Selector Tool*, we computed the number of searches conducted in March 2004 for terms associated with buying cigarettes online.[4] The results indicate that at Overture, there were about 350,000 searches for the month (4.2 million at an annual rate) using the basic search definitions and 734,000 searches using a broader definition of the search terms (8.8 million annually). Scaling these numbers up by Overture's estimated

[4] The Keyword Selector Tool is available at http://inventory.overture.com/d/searchinventory/suggestion. The search terms we looked up were "cigs," "cheap cigarettes," "discount cigarettes," "cheap Marlboro," "discount Marlboro," "tax free cigarettes," "low price cigarettes," "cheapest cigarettes," "cigarettes online," "cigarettes price," "buy cigarettes," those same terms replacing the word "cigarettes" with "cigs" and also including the proposed variants suggested by the *Keyword Selector Tool* that referred to buying cigarettes online (the tool is designed to show other search terms that are similar to the one you enter that consumers also searched). We excluded anything that referred specifically to other countries or had nothing to do with buying online such as "current cigarette tax rate." For a broader definition of online buying we also tried including "cigarettes" alone as well as the brand names alone (like "Marlboro"), though these are not associated only with online buying.

market share implies that there are between 13 and 28 million searches per year for terms related to buying cigarettes online.[5] We do not know how many of these searches turned into purchases nor how many searches a typical customer might do in a year, but these numbers likely understate the true magnitude if only because people that purchase online from a merchant may return directly to that merchant in the future rather than going back through the search engine. To be sure, such estimates are only suggestive. Virtually all expert observers agree, however, that online cigarette sales have been growing very rapidly in the last several years.

It is easy to understand why demand would be high for online cigarettes if most or all of the tax savings associated with online sales are passed on to consumers, rather than being captured by online merchants through higher pre-tax prices. To check this assertion, in the fall of 2003 we gathered data on in-store retail prices from several merchants in Ann Arbor, Michigan and compared them to the prices available at the top five domestic cigarette sites listed at Google for the search phrase "tax free cigarettes."[6] We did this for the top ten cigarette brands, as identified by Advertising Age (2002).[7] Weighting the ten brands by their national sales volume, we found that prices online were $27.33 a carton when pre-tax prices in the stores were $25.83. At that time Michigan taxes (including sales tax) amounted to $14.80 per carton, so the average online site was apparently passing about 90 percent of the tax savings through to the consumer. This is likely to be a lower bound on the cost savings,

[5] The search engine market shares come from Web Side Story (http://www.websidestory.com/pressroom/pressreleases.html?id=219&ctl=x08x087h27h2) and assume that the Overture numbers represent all searches not included in the market shares of Google or Yahoo (the Yahoo market share statistics do not include Overture searches). This is obviously an upper bound for the size of Overture so the calculation puts a lower bound on the total number of searches.

[6] The retail merchants were Walgreen, Meijer, K-Mart, Campus Corner, and Kroger. The online sites were taxfreecigarettes.com, travelingsmoke.com, dutyfreetaxfree.com, tobaccobymail.com and 4cheapcigs.com. All of these sites are located on Indian reservation land in New York State. A similar analysis using merchants in Chicago showed a similar pattern as the one reported in the paper.

[7] These brands were Marlboro, Newport, Doral, Camel, Basic, Winston, GPC, Kool, Salem, and Virginia Slims.

because with even a minor amount of search online one can find lower prices for any particular brand (using the minimum price among the online sites yielded prices lower than the pre-tax prices in the retail stores), and because a significant fraction of locally-purchased cigarettes are actually bought one pack at a time, at a higher per-pack price than would apply if buying by the carton. So it seems clear that online sites are, indeed, a way for customers to evade local cigarette taxes to save money when buying cigarettes. If raising cigarette taxes induces consumers to seek out tax-free cigarettes, the rise of tax-free online cigarettes may very well increase the price sensitivity of taxed sales. The remainder of this paper seeks to identify and quantify this effect empirically.

III. A Model of Taxable Cigarette Sales and Internet Use

To motivate our empirical methodology and to help interpret our results, this section presents a model explaining the theoretical relationships between cigarette taxes, Internet use, and taxable cigarette sales. We start by defining p as the pre-tax wholesale price of cigarettes and t as the per-pack excise tax rate of cigarettes, including sales taxes. Let σ be the distribution of the taste for cigarettes given by the pdf $g(\sigma)$ and the cdf $G(\sigma)$. Let f be the fixed cost of buying cigarettes over the Internet and assume it is distributed by the pdf $h(f)$ and the cdf $H(f)$. We further assume that the characteristics of people who have an Internet connection are independent of both σ and f and that the distributions of f and σ are independent of each other.

The per-pack savings from purchasing over the Internet is the tax rate, t, and the per-period cost is given by f.[8] Individuals with an Internet connection will purchase cigarettes

[8] This cost may be due to the hassle of purchasing cigarettes online and/or the disutility associated with breaking the law.

tax-free if the utility value of doing so exceeds the utility value of purchasing cigarettes legally, that is when:

$$v(p, y\text{-}f, \sigma) > v(p+t, y, \sigma), \tag{1}$$

where y is exogenous income. The individual demand function for cigarettes for those who purchase over the Internet is $d(p, \sigma)$, which is decreasing in price and increasing in tastes, and is $d(p+t, \sigma)$ for those who buy taxed cigarettes.

We define f^* as the value of f that satisfies $v(p, y\text{-}f, \sigma) = v(p+t, y, \sigma)$. In words, f^*, which varies across people with σ, is the cost at which a consumer is indifferent between smuggling and not smuggling; any consumer with $f<f^*$ will smuggle and those who face $f \geq f^*$ will not. Among those who are connected to Internet, the fraction of consumers buying tax-free cigarettes can be written:

$$b(t) = \int_{-\infty}^{\infty}\int_{0}^{f^*} h(f)g(\sigma)dfd\sigma \tag{2}$$
$$= \int_{-\infty}^{\infty} g(\sigma)H(f^*(t,\sigma))d\sigma$$

By Leibnitz's rule, the derivative of $b(t)$ with respect to t is $\int_{-\infty}^{\infty} g(\sigma)h(f^*)\frac{\partial f^*}{\partial t}d\sigma$, which is positive because the threshold cost f below which consumers will be induced to smuggle will increase as t increases, thus increasing the fraction of those connected to the Internet who smuggle cigarettes.

Aggregate demand for tax-free cigarettes can be expressed as:

$$S(p,t) = I\int_{-\infty}^{\infty}\int_{0}^{f^*} d(p,\sigma)h(f)g(\sigma)dfd\sigma$$

$$= I \int_{-\infty}^{\infty} d(p,\sigma) g(\sigma) H(f^*(t,\sigma)) d\sigma, \tag{3}$$

where I is the fraction of the population with Internet access. Aggregate demand for taxable cigarettes can then be written as:

$$T(p,t) = (1-I) \int_{-\infty}^{\infty} \int_{0}^{\infty} d(p+t,\sigma) h(f) g(\sigma) df d\sigma + I \int_{-\infty}^{\infty} \int_{f^*}^{\infty} d(p+t,\sigma) h(f) g(\sigma) df d\sigma$$

$$= (1-I) \int_{-\infty}^{\infty} d(p+t,\sigma) g(\sigma) d\sigma + I \int_{-\infty}^{\infty} d(p+t,\sigma) g(\sigma) (1 - H(f^*(t,\sigma))) d\sigma. \tag{4}$$

Differentiating T with respect to t yields:

$$T_t(p,t) = (1-I) \int_{-\infty}^{\infty} d_t(p+t,\sigma) g(\sigma) d\sigma + I \int_{-\infty}^{\infty} d_t(p+t,\sigma) (1 - H(f^*)) g(\sigma) d\sigma$$

$$+ \quad I \int_{-\infty}^{\infty} d(p+t,\sigma) (-h(f^*) \cdot \frac{\partial f^*}{\partial t}) g(\sigma) d\sigma. \tag{5}$$

Note that the sign of equation (5) is unambiguously negative. The first term represents the fact that an increase in t will reduce quantity demanded for those who do not have Internet access, and the second term represents the fact that quantity demanded will fall with a tax increase for those who are connected to the Internet but do not smuggle, holding the smuggling proportion fixed. Both of these groups face the price $p+t$ for cigarettes. The third term in equation (5) is negative because f^* is increasing in the tax rate – if cigarette taxes increase, some consumers will be induced to purchase tax-free over the Internet, reducing taxable sales.

How does an increase in Internet use affect the response of taxed sales to the tax rate? To see this, we differentiate (5) with respect to I, yielding:

$$T_{tI}(p,t) = -\int_{-\infty}^{\infty} d_t(p+t,\sigma)g(\sigma)d\sigma + \int_{-\infty}^{\infty} d_t(p+t,\sigma)(1-H(f^*))g(\sigma)d\sigma$$
$$+ \int_{-\infty}^{\infty} d(p+t,\sigma)(-h(f^*)\cdot\frac{\partial f^*}{\partial t})g(\sigma)d\sigma$$
$$= \int_{-\infty}^{\infty} d(p+t,\sigma)(-h(f^*)\cdot\frac{\partial f^*}{\partial t})g(\sigma)d\sigma - \int_{-\infty}^{\infty} d_t(p+t,\sigma)H(f^*)g(\sigma)d\sigma. \quad (6)$$

The first term in equation (6) is negative, but the second term is positive. Thus, although we show later that empirically greater Internet penetration has been associated with a *higher* responsiveness of taxed sales to state cigarette taxes, in this model it is not logically impossible that more Internet use could reduce the absolute value of the taxed cigarette response. The intuition for this result is when Internet use increases, fewer consumers purchase cigarettes at stores. Thus, a tax increase has less of a depressing effect on taxed sales the more people use the Internet. This effect is offset to the extent a higher tax increases the fraction of Internet users who purchase tax-free cigarettes – all the tax revenues from their sales are lost.

An important result from equations (5) and (6) is the response of taxable sales to tax rates is affected by the Internet penetration rate as well as by the rate of Internet users who purchase tax free. This result is relevant because we can measure *I* but not *b(t)* in the data.

IV. Methodology and Data

1. Data

We measure Internet penetration using large cross-sectional micro survey data that contain information on Internet use by respondents within a state for a given year. As detailed in Section III, using Internet penetration instead of the rate of Internet smuggling is valid as

long as, conditional on the tax rate, Internet penetration is proportional to the rate of Internet smuggling.

Our primary data source is the computer supplements to the Current Population Survey (CPS) that asks respondents about Internet usage in 1989, 1993, 1997, 1998, 2000, 2001, and 2003.[9] The survey questions we utilize ask whether respondents use the Internet. Unfortunately, the CPS wording changes from year to year. The 2001 and 2003 surveys inquire about Internet use from any location, whereas in 1998 and 2000 the surveys ask about Internet usage in the home and outside the home separately. In 1997, the CPS survey asks for Internet usage at home, work, and school separately, whereas prior to 1997, the survey questions concern only whether the respondent uses a modem and has email.[10] We define a respondent as connected to the Internet if they answer "yes" to any of the Internet usage questions in the 1997-2003 surveys or if they have email or a computer with a modem in the 1989 and 1993 surveys. We then construct an Internet penetration measure by state and year consisting of the share of respondents in each state and year that were Internet connected. The share of the state that had online access in each year will be our measure of the potential for Internet use for cigarette purchases.

Because the CPS Computer Supplements yield only seven years of data, we linearly interpolate the state-level Internet penetration rate between survey years to construct a continuous state-level panel from 1980-2005. Prior to fiscal year 1990, we assume Internet

[9] The surveys take place late in the year, so we associate a given year of Internet usage data with the following fiscal year. To be consistent with the timing of the sales data, we define a fiscal year from July 1 to June 30.
[10] There is a 1994 CPS survey that asks only whether the respondent has a computer with a modem. We exclude this survey because the Internet penetration rate is much lower and is "off trend" when these date are utilized. However, we also run specifications in which we impute the 1994 Internet penetration rate by multiplying the share of modem users in 1994 by the share of modem users in 1997 that had Internet access (58 percent). Our results are not sensitive to the inclusion of the 1994 data in this manner.

penetration is zero, though we also investigate a specification in which, for each state, we linearly interpolate the CPS Internet measure between the 1990 level and zero in 1980.

As a check on the CPS data, we will also use data from a large consumer survey conducted by Forrester Research, Inc. as part of the Technographics 2002 program. The survey collected demographic information from a nationally-representative sample of about 80,000 people, including whether they smoke, and posed questions about whether they use the Internet at all, whether they have ever bought something online, and their past history of Internet usage.[11] Using the responses to a question about how long each person has been online, we create a measure of the share of each state's population that was online in a given year from 1995 to the present, following the method of Goolsbee and Brown (2002). For years before 1995, we set the Forrester Internet use measures to zero.[12]

The data on taxable cigarette sales, excise taxes, and the retail prices of cigarettes are taken from *The Tax Burden on Tobacco*, published by The Tobacco Institute until 1998 and updated by Orzechowski and Walker (2006). The tax rate we use is the weighted average over the fiscal year, adjusted to real 2005 dollars using the CPI. Because the retail price is only reported at a point in time (November 1 of the year), we impute an estimate of the average retail price over the fiscal year, though our results were similar using instead the point-in-time measure.[13] See the Data Appendix for details on how each variable in our data was constructed.

---

[11] More details on the Forrester data can be found in Yonish et al. (2001) and Goolsbee (2000).

[12] The Forrester survey data also allows us to compute alternative Internet usage measures, such as the share of people in the state that have bought something online, the share that smoke and have Internet access, the share that smoke and have bought online, and the share of smokers in each state that are online. Varying the measure of Internet access made little difference in the results, so in the interest of space we do not report these results.

[13] To do this imputation, we assume constant linear growth from November to November of each year. Given this assumption and prices from the previous and following years, the formula for the average price in the year is $P=10/144\ (P_{Nov,t-1}) + 106/144\ (P_{Nov,t}) + 28/144\ (P_{Nov,t+1})$.

When we examine how the difference between consumption and taxed sales in states responds to tax and price changes, we utilize data for 1990 to 2000 from the Center for Disease Control's Behavioral Risk Factor Surveillance System (BRFSS). These data provide information on the number of cigarettes smoked per day for people that report being smokers. The BRFSS is a large, nationally and state representative dataset that is meant to provide a comprehensive look at the risky behaviors of individuals in the United States. The data are collected from a random sample of adults (age 18 and over) annually.[14]

Summary statistics for the variables used in our analysis for the years 1980, 1990 and 2000 are presented in Table 1. This table shows clearly the increase between 1990 and 2000 in the real tax rate and the real tax-inclusive price of cigarettes. A major cause of the increase in wholesale prices over this period was from the tobacco settlement, which put in place regulatory charges that, while similar to per-pack taxes, are counted in the pre-tax price of cigarettes. This is one reason we separate the wholesale price and the tax rate of cigarettes in our empirical model below; as the wholesale price increases are occurring largely at the level of the manufacturer, they should drive up the price of all cigarettes and thus have little impact on the propensity to purchase cigarettes online. Since only 30 percent of the total cross-state variance in tax-inclusive cigarette prices in our data comes from variation in wholesale prices, changes in state taxes should cause a much larger change in the incentive to smuggle over the Internet than a commensurate change in the wholesale price.[15] It is also worth noting there is substantial cross-sectional variation in the tax rate as well as across-time variation. Across

[14] More details on the BRFSS can be found in Center for Disease Control (2003).
[15] A valid question arises of where the cross-state variation in wholesale prices comes from. One source is producer price discrimination by state based on numerous demographic characteristics and state legal factors (Keeler et al., 1996). Further, variation in shipping costs may drive some of the cross-sectional variation in wholesale prices.

time, the average (over states) standard deviation in the real tax rate is 24.1 cents. Across states, the average (over time) standard deviation is 20.6 cents.

Table 1 illustrates the rapid growth in Internet penetration over the sample period. For example, in the CPS data, only 5 percent of respondents had online access in 1990, and by 2000 the penetration rate had increased to over 40. As of 2005, the same measure shows almost 65 percent of the sample had access to the Internet. For Internet penetration, most of the variation comes across time, although the variation in Internet usage across states within a year is non-trivial.

2. Empirical Methodology

We first seek to investigate whether the level and tax responsiveness of a state's taxable cigarette sales (denote *q* below) are related to the extent of Internet use in that state (denoted with a subscript i below) in a given year (denoted with a subscript s). Because, we presume, online cigarette sales are driven mostly by tax evasion, it is likely the effect of growing Internet penetration will influence the responsiveness of sales to changes in the tax rate differently than the responsiveness of sales to changes in the wholesale price. As in Section III, let t_{is} be the real per-pack tax rate in state i in year s and let p_{is} be the wholesale (i.e., pre-tax) price. The full, tax-inclusive price of cigarettes can then be written as

$p_{is} + t_{is} = p_{is} * (1 + m_{is})$, where $m_{is} = \frac{tax_{is}}{p_{is}}$ is the equivalent ad-valorem tax rate. The log of the full price can be expressed as $\ln(p_{is}) + \ln(1 + m_{is})$.

To separately identify the effect of changes in the tax and wholesale price of cigarettes on cigarette sales in the presence of Internet smuggling, we regress the logarithm of per-capita taxable cigarette packs sold in the state on the log of the real tax-inclusive price of cigarettes

in the state, a measure of neighboring states' tax-inclusive prices, and real per-capita state income. Then, we add the state's log tax-inclusive price interacted with a measure of Internet penetration as well as the level of Internet penetration by itself. The basic specification is

$$\ln(q_{is}) = \beta_0 + \beta_1 \ln(p_{is}) + \beta_2 \ln(1+m_{is}) + \beta_3 \ln(p_{is}) * I_{is} + \beta_4 \ln(1+m_{is}) * I_{is} + \beta_5 I_{is} \quad (7)$$
$$\beta_6(\ln(p^N(1+m^N))) + \beta_7 Y_{is} + \phi_s + \eta_i + \delta_i * s + \varepsilon_{is},$$

where q_{is} is the per-capita quantity of taxable cigarette packs sold in a given state and year, I_{is} is a measure of the Internet penetration rate in the state (discussed above and in the Data Appendix), $\ln(p^N(1+m^N))$ is the log average real tax-inclusive price of all border states weighted by the population of each border state, and Y_{is} is real personal income per capita in the state.

Because we do not expect to be able to explain all of the cross-state and cross-time variation in taxed sales due to non-tax factors, we also include dummy variables for each state and each year, as well as state-specific linear time trends that control for cross-state heterogeneity in secular sales trends over time. The state-specific time trends as well as the state fixed effects are important to include in state-level sales models because both the level and trend of sales are likely correlated with anti-smoking sentiment within a state, and these changes can be spuriously attributed to changes in smoking behavior due to price and tax changes.

With state and year dummy variables as well as state-specific linear time trends, we are seeking to explain breaks from each state's linear time trend in sales associated with

changes in the wholesale price and tax rate of cigarettes – whether the tax sensitivity has increased most in states where Internet penetration has grown the fastest.[16]

One issue of concern with identifying the parameters of equation (7) is the source of variation that is driving changes in the tax rate. Because variation in *p* is less state-specific, variation in *m* coming from fluctuations in *p* (mechanically because $m \equiv \frac{t}{p}$) will yield estimates of the tax parameters that are biased towards zero. We therefore instrument ln(1+*m*) and ln(1+*m*)**I* with the log of the real per-pack tax rate, the real per-pack tax rate in levels, and the interaction between the log real per pack tax and the Internet penetration rate.[17] Instrumenting the tax rate variables in this manner ensures that the identifying variation of β_2 and β_4 come from variation in state taxes, not wholesale prices.

The elasticities of interest come directly from equation (7). Throughout this analysis, we are interested in the price elasticity of taxable sales, which is the percentage change in taxable sales when the price changes by one percent, holding Internet use constant. In equation (7), price changes can come from two sources: a tax change or a wholesale price change. Because Internet purchases occur due to cross-state variation in prices that is driven predominantly by cross-state variation in taxes, we focus on the price elasticities of taxed sales stemming from changes in state cigarettes taxes. We define the price elasticity with respect to the tax as

$$\varepsilon^{t}_{price} = \frac{\partial \ln(q)}{\partial tax} * tax * \frac{p(1+m)}{tax} = \beta_2 + \beta_4 * I \qquad (8)$$

[16] We ignore the possibility that the extent of Internet use is itself affected by the level of cigarette taxes in a state and therefore the potential tax savings from using the Internet to avoid or evade taxes. Goolsbee (2000) showed this assumption to be true for the case of retail sales taxes, and cigarette taxes are even less likely to motivate people to go online since the amount of money at stake is typically smaller.

[17] We tried using just the log of taxes and just the level of taxes both combined the log tax-Internet penetration interaction term, as well as combinations of higher-order terms and interactions and found similar results to those reported here.

Note equation (8) includes the share of tax in the full price in order to scale the tax elasticity to the price elasticity. Equation (8) is relatively straightforward in the sense that a negative value of β_4 indicates increasing Internet access increases the magnitude of the (negative) response of sales to tax changes – an effect consistent with Internet smuggling.

The taxed sales elasticity due to a tax change when there is no Internet use is β_2. This elasticity gives the percentage change in taxable sales assuming no Internet smuggling occurs, and shows the potential for cigarette prices to alter smoking behavior in the absence of cigarette smuggling.

The third elasticity of interest is the taxed sales elasticity with respect to Internet use. This is the elasticity of taxed sales with respect to a change in the Internet penetration rate and is given by

$$(\beta_3 * \ln(P) + \beta_4 \ln(1+m) + \beta_5) * I. \qquad (9)$$

V. Results

1. Coefficient Estimates

Coefficients estimates from estimation of equation (7) are presented in Table 2. Column (i) of Table 2 presents baseline estimates that exclude Internet penetration. This is a specification very similar to those in the existing literature and the results are similar to previous findings.

In column (ii), we add our CPS measure of Internet penetration discussed in Section IV.1. to the regression in order to estimate the differential effect of price changes on taxable sales that is correlated with changing Internet use. Our results indicate that Internet penetration has been correlated with a changing elasticity. The coefficient on the wholesale price-Internet interaction is -0.360 and on the tax rate-Internet interaction is -1.074. Note,

however, that only the latter term is statistically significant at the 5 percent level. The differential effect of the Internet across prices is due to the fact that changes in the wholesale price largely occur simultaneously across states and Native American Reservations, so the wholesale price differences across states in a given year are likely to include much more noise than differences in the tax component (and thus also have a smaller coefficient).

The effect of Internet penetration on the responsiveness of taxable sales to tax changes also can be seen graphically in Figure 1, which plots taxed sales per capita as a function of the tax rate (1+m) at different Internet usage rates based on parameter estimates from Table 2, column (ii). As the Figure indicates, our estimates suggest that rising Internet penetration makes taxed sales more responsive to increases in taxes.

Including the Internet penetration rate as an explanatory variable provides an important specification test in Table 2. Interpreting Internet penetration as a measure of Internet purchases is predicated on the assumption that absent any incentive to smuggle (i.e., a zero price difference), Internet access should be uncorrelated with taxable sales. Put differently, conditional on the observables, the fixed effects, and the fixed trends, Internet penetration increases should not be correlated with taxable sales decreases absent the effect working through the price difference. The coefficient on *I* is a test of this assertion. As Table 2 illustrates, we cannot reject the null hypothesis that this coefficient is zero at even the 10 percent level of confidence.

The other estimated coefficients in column (ii) have signs as expected. The elasticity of taxable sales with respect to the mean tax-inclusive price of neighboring states is positive and is significantly different from zero at the 10 percent level (i.e., cigarette sales are greater

in a state the higher are the neighbors' tax rates). Furthermore, the estimated elasticity with respect to real per-capita income is positive and significant, but less than one.

In order to check the robustness of our estimates, the next 5 columns of Table 2 show results from estimation of equation (7) using differing Internet access measures and years. In column (iii) we use the CPS Internet measure but linearly extrapolate the Internet penetration rate by state between zero in 1980 and the 1990 rate. (The post-1990 penetration rates used in columns (ii) and (iii) are identical.). In column (iv) we use the alternative data on penetration from Forrester,[18] and in column (v) we first differences the data (using the CPS measure of Internet use). In all of these cases, while some of the other coefficients vary, the coefficient on the internet-tax term interaction is negative, significant and of basically similar magnitude.

Columns (vi) and (vii) deal with the issue of imputed values. Column (vi) restricts the sample to only those years where Internet usage is positive (i.e., no imputed zeros) by looking only at the years after 1989. Column (vii) uses only years in which the CPS actually has observations (i.e., no imputed Internet usage between survey years). In both specifications, estimates are of a smaller magnitude than in the cases using imputed values in the full panel data set. For example, in column (vii), the Internet-log tax rate interaction term is -0.251 and is not significant at even the 10 percent level. However, the sample size is reduced in this specification to 343 and the standard errors are much larger than in previous columns. Thus, while the results are qualitatively similar in column (vii) to previous results, the sample size is too small to make statistical inferences at usual standards of confidence.

[18] Note that the Forrester data we have go only up to 2002 rather than 2005. Furthermore, because of the limitations of the survey question, all Internet penetration is set to zero prior to 1995. That the results change little when these restrictions are imposed implies that most of the identification of the Internet-price effects is coming from years in which Internet penetration was growing at the fastest rate.

2. Elasticity Estimates

While the coefficients in Table 2 give insight into the effect of the Internet on taxable sales and price responsiveness, the parameters of most interest to policy makers are price elasticities of taxable sales. Table 3 shows average elasticity estimates for fiscal year 2000 implied by the results in Table 2. The first row shows the price elasticity due to a tax change in the presence of Internet smuggling (equation 8) and the second row shows the price elasticity with respect to a tax change assuming Internet use is zero. This latter elasticity is the price elasticity of sales in the absence of smuggling and is the elasticity much of the previous literature seeks to estimate.[19] The bottom row of Table 3 contains the Internet taxed sales elasticity (equation 9) – the estimated percentage change in taxed sales due to a one percent increase in Internet penetration.

Across columns (ii)-(vii) in Table 3, the results suggest that sales can be quite elastic with respect to state cigarette taxes in the presence of Internet smuggling. In all columns, the elasticities are greater than unity, with a value of -1.157 in the preferred specification in column (ii). Interestingly, if no Internet smuggling occurred, the price elasticity with respect to tax changes are less elastic; the estimate in column (ii) is indicative at -0.712. This elasticity is at the upper end of elasticities reported in the literature,[20] but is consistent with more recent estimates from the period before the steep increase in Internet penetration in the U.S. (Yurekli and Zhang, 2000; Keeler et al., 2001). Table 3 illustrates that in 2000, the availability of the Internet increased the price elasticity with respect to tax increases by about 63 percent.

[19] See Lovenheim (2007) for a discussion of the different definitions of consumption and sales elasticities and their relevance for tax policy analysis.
[20] In their review of the literature, Chaloupka and Warner (2000) report price elasticities typically fall within a small neighborhood of -0.4.

That increases in Internet penetration increase the sensitivity of taxed sales to cigarette taxes suggests models that ignore Internet usage will produce elasticity estimates that are biased upward in absolute value. This bias amounts to an omitted variables bias because an omitted variable – Internet smuggling – is correlated with both taxed cigarette sales and cigarette prices. Column (i) in Table 3 presents elasticity estimates from our baseline model that ignores Internet usage. The results are consistent with such a bias; the price elasticity due to a tax change in the baseline model is -1.136, which is much larger than the corresponding price elasticity in column (ii).

The baseline taxable sales elasticity in column (i) is much higher than those from the previous literature as well. This difference reflects a rise in taxable sales elasticity estimates that ignore Internet smuggling. For example, Yurekli and Zhang (2000) find a taxable sales elasticity of -0.72 over the period 1970-1995, and Stehr (2005) finds a taxable sales elasticity of -1.11 over the period 1985-2001. This change is reflected in our data as well; over the period 1980-1995, we estimate a baseline taxable sales elasticity of -0.79, which increases to -1.00 when we extend the sample to 2001. Together, these estimates show that the taxable sales elasticity is rising, but that the price elasticities absent smuggling in Table 3 are quite similar to estimates from the 1980's and early 1990's (before the large rise in Internet use) suggests this increase can be explained largely by an increasing bias from ignoring Internet smuggling in these estimates.

In the last row of Table 3, we present the effect of a 1 percent change in Internet access on taxable sales implied by the parameter estimates in Table 2. In our baseline specification (column (ii)), we estimate, at fiscal year 2000 price levels, a one percent increase in Internet penetration reduced home state sales by -0.04 percent. In 2000, the CPS estimate

of Internet penetration is 41.3 percent in the U.S., which implies Internet smuggling reduced home state cigarette sales by 3.3 percent relative to a counterfactual in which there is no Internet smuggling. While there is variation across columns in Table 3 in the size of the Internet taxable sales elasticity, it is negative in all but two columns, suggesting Internet smuggling has had a negative effect on cigarette sales that has not been translated fully into reduced cigarette consumption.

3. Implied Revenue Effects

Our estimates from Tables 2 and 3 imply that Internet smuggling has changed the relationship between state taxes and state taxed sales, and that the Internet has reduced the revenue gains that would otherwise have been collected from recent cigarette tax increases. From the baseline estimates in column (ii) in Tables 2 and 3, we can estimate the impact of Internet sales on the revenue gained due to tax increases between 2001 and 2005, which was a period of large cigarette tax increases in the United States. Over this period, (unweighted) average real per-pack cigarette taxes increased from 62.0 cents to 99.6 cents nationally, a 61% increase. Holding real wholesale prices constant at their 2001 levels, these tax increases imply a 9% tax-inclusive average price increase. Using the price elasticity from a tax increase in Table 3, column (ii), this implies that average tax revenues increased by 8.2% less than would have been expected without any tax-free Internet sales.[21]

[21] To calculate the estimated effect of Internet smuggling on revenues, we multiply the price increase implied by a given tax increase by the state taxable sales revenue elasticities both including and excluding Internet purchases. The revenue elasticities are given by $(1+\varepsilon_{tax})$, where ε_{tax} is the taxable sales elasticity with respect to the cigarette tax rate. The taxable sales elasticity with respect to the tax rate that includes Internet penetration is found by multiplying the taxable sales elasticity in the first row of column (ii), Table 3 by the share of the full, tax-inclusive price constituted by the tax. The taxable sales elasticity with respect to the tax rate that assumes no Internet purchases is found by multiplying the elasticity in the second row of column (ii), Table 3 by this same share.

These revenue effects are by no means constant across states (or time). Anecdotally, in New York, where the nominal per-pack tax went from 56 cents to 150 cents between 1999 and 2005, the New York Association of Convenience Stores has claimed that the revenues from this tax increase were some 50 percent smaller than forecast at the time of the tax hike. Our estimates imply the revenue gains over this time period were a more modest, but still substantial,11% lower than would have been expected with no Internet smuggling. Using our estimates from New Jersey, where real taxes rose from 110.4 to 278.1 cents per pack[22] and Internet penetration rose from 49.9 to 64.8 percent between 2001 and 2005, revenues should have increased by over 71 percent but actually increased by 61 percent, representing a drop in expected revenues of almost 14 percent. In contrast, in a state such as Louisiana, where Internet usage was only 35.1 percent in 2001, our estimates suggest tax-free Internet sales reduced the revenue effect of tax increases by only 3.4 percent. In short, our findings suggest there is a major shift underway in the ability of states to raise money through tobacco taxes due to Internet smuggling.

VI. Cigarette Taxes and Internet Smuggling

The results discussed to this point suggest the elasticity of taxable cigarette sales has grown, and the growth in the elasticity appears to be associated with differential state-level increases in Internet penetration. These results are consistent with a change in the technology of smuggling. Taxed purchases have become dramatically more elastic with respect to state tax rate changes in states in which Internet penetration has increased the most. It is unlikely

[22] The nominal tax in New Jersey in 2005 included a $2.40 per-pack excise tax and a $0.33 per-pack sales tax. In 2001, the nominal per-pack excise tax was $0.80 and the per-pack sales tax was $0.19.

that Internet use affects smoking consumption absent the price mechanism,[23] which means the increased taxable sales elasticities that are correlated with Internet penetration growth can be attributed to increased Internet smuggling behavior, not changes in consumption patterns.[24]

To investigate the relationship between Internet smuggling and cigarette taxes further, we turn to the BRFSS data on individual cigarette consumption. Using these consumption data, we construct state-level measures of annual packs-per-person smoked. Absent smuggling, the BRFSS annualized per-capita smoking level and per-capita taxable sales should be equal. We therefore create a measure of the amount of smuggled cigarettes by taking the difference of the log state-level estimates of cigarette consumption and log state-level taxable sales (i.e., the log ratio of taxable sales to actual smoking).[25] In Table 4, we present results from regression that relate this difference to variation in home state prices, border state prices, and the interaction between home state prices and Internet penetration. The expectation is that the difference between log consumption and log sales should respond positively to increases in home state prices, and that in the presence of Internet smuggling, increased Internet access should increase the magnitude of this response because taxable sales respond more to price changes than does consumption.

The results in Table 4 are consistent with predictions and with the existence of Internet smuggling. Looking at column (i), the coefficients on the price variables are both positive, although only the coefficient on the tax rate is significant at the 5 percent level. Furthermore,

[23] This is confirmed by our finding that the coefficients on the Internet penetration variable in Table 2 are not statistically different from zero at even the 10 percent level in any specification.
[24] We also ran equation (7) using log per-capita cigarette consumption from the BRFSS as a dependent variable. While we find no evidence that elasticity of consumption is affected by Internet penetration, the standard errors on our estimates are large due to small sample sizes. We thus do not present these results, but they are consistent with the notion that the change in the taxed sales elasticity due to Internet use is due to smuggling behavior and not a consumption response.
[25] Stehr (2005) uses an identical measure to estimate the level of casual smuggling and bootlegging. He does not provide estimates of cigarette smuggling over the Internet.

both of the price-Internet interactions are positive and significant at the 5 or 10 percent level, indicating that the difference between cigarette consumption and cigarette sales responds more positively to price changes the higher is the Internet penetration rate. In the subsequent columns, we add state-specific price interactions and price-specific linear year trends, and while the results hold qualitatively, the standard errors become large and reduce our ability to make meaningful statistical inferences from the results.

VII. Robustness Checks

The baseline specifications in Tables 2 and 3 suggest that as Internet use grew in states, the sensitivity of taxable sales to price changes in those states grew as well. In Table 5, we consider whether this evidence is consistent with alternative explanations rather than being tied to a rise in cigarette smuggling due to the Internet.

In column (i) of Table 5, we show our results are not simply the spurious correlation of high Internet usage late in the sample with the large rise in prices due to the tobacco settlement. We do this by restricting the sample to only the years before fiscal year 1999 (when the settlement raised pre-tax prices substantially in our data).[26] The results are qualitatively similar to those reported in column (ii) of Table 2.[27]

Second, in column (ii), we exclude the four states with the lowest cigarette taxes (VA, KY, NC, SC); because they are frequently the source of the Internet cigarettes, taxable sales in these states might conceivably respond differently to changes in Internet usage. As they

[26] We observe that, in regressions using data for all the years, the estimated coefficients on the year dummy variables often have a sharp upward spike in 2000 and 2001, though this effect does not appear in the coefficients on the covariates of interest.

[27] It is notable that the coefficient on the Internet-log tax rate interaction term as well as the Internet penetration rate is much larger in absolute value than in Table 2. The reason for this is when restricting to pre-1999 years, we are cutting out years of high Internet growth, which means the Internet penetration rate is collinear with the state-specific year trends in the years prior to 1999. This mutlicollinearity limits our ability to identify all of the parameters of the model.

are only a small portion of the sample, the point estimates do not change appreciably when they are excluded.

Column (iii) weights each observation by population in case the results are being driven by a few outlying observations in small states. There is no evidence that this is so.

In columns (iv) and (v) we consider the role of Native American Reservations as an alternative source of smuggling. As detailed in Evans et al. (2002), a loosening of the rules regarding gambling on reservation land in 1989 caused a dramatic increase in the number of Indian casinos in the United States. To the extent more people are going to such casinos and while there are able to purchase cigarettes tax free, this will make taxed sales more sensitive to tax rates due to tax avoidance, but will be only spuriously correlated with the growth of Internet-related tax avoidance over the same time period. Although we have no direct measures of the number of Indian gaming visits by state across time, using data from the National Indian Gaming Association, we have been able to count the number of Indian casinos by state in 2004. We split our sample based on the number of Indian casinos in each state and estimate equation (7) using only states where there were no casinos in 2004 (column (iv)) and only states with more than 5 casinos (i.e., the upper quartile of the casino distribution) in column (v). Results across the two columns are consistent with the baseline estimates in Table 2 in both magnitude and sign.

We next consider the role of changing demographics in each state that are not being accounted for by the state-specific linear time trends and fixed effects. To see why this could be important, consider the following example: if there has been a rise in teen smoking, and teens are both relatively price-sensitive (as documented in Gruber, 2000) and tend to live in

states where the Internet grew relatively quickly, this could cause us to spuriously conclude that rising Internet use makes taxable cigarette sales more tax-sensitive.

We suspect, though, that any measure of the actual change of demographic characteristics in a state, conditional on the state-specific trends and fixed effects, will not be large enough the account for the large estimated effect of the Internet on taxable sales shown in Table 2. The changes and the differences in elasticities across groups are simply too small. To further investigate this possibility, or any other state-specific factor, we allow the baseline elasticities to differ across states by interacting the state fixed effects with the price terms. [28] The specification also includes the Internet interaction term, so it examines whether higher Internet use makes states more price sensitive than they would otherwise have been and accounts for any state-level heterogeneity in price sensitivity. In this specification, the results of which are shown in column (vi), the estimated impact of the Internet on tax sensitivity is statistically significant and large, though smaller than the baseline specification in column (ii) of Table 2. However, the coefficient on the wholesale price-Internet coefficient is positive, though it is small and not statistically significant. The average t-statistic on the state-level price elasticities is almost seven, so the sample is large enough to estimate these parameters separately.

In column (vii), we examine whether the Internet effect can be differentiated from a linear trend in the elasticity that applies to all states. We do this by adding an explanatory variable that interacts the log of each price with a linear year trend. This exercise suggests that, indeed, there is an upward drift in the absolute value of the elasticity, but that this trend can be statistically differentiated from the impact of Internet use on the price elasticity. There is no such effect for the price elasticity due to tax increases. The results in column (vii) are

[28] These coefficients are not reported individually in order to save space.

similar to those in column (vi) in magnitude and sign, though the inclusion of the linear time trend in price sensitivity increases the size of the standard errors such that one can no longer reject the null hypothesis that the Internet-price interaction terms are different from zero.

Finally, in column (viii), we take the robustness check to the full extreme by allowing a linear time trend and state-specific elasticities. Here, the coefficient on the tax rate-Internet variable is negative, significant, and of a similar magnitude to the baseline specification. Again, the wholesale price-Internet coefficient is positive and statistically insignificant. Further, none of the state or year price elasticities are individually significant (average t-statistics of about 0.2). We simply lack the statistical power to estimate all of these effects separately.

Taken together, the sensitivity analyses in Table 5 suggest our main result showing an increased sensitivity of taxed sales to price that is correlated with the growth in Internet penetration is robust to many alternative specifications. Regardless of how flexible we make the model, this result persists.

VIII. Conclusions

Using information on the purchases of cigarettes and the use of the Internet across states and time since 1980, this paper has presented evidence suggesting that the rise of the Internet and the associated increase in the ability of individuals to purchase tax-free cigarettes has significantly increased the tax sensitivity of consumers. Our estimates imply the growth in Internet penetration in the U.S. has led to an increase in the taxable sales elasticity of over 60 percent. The evidence suggests this increased sensitivity is due to smuggling and not due to any greater sensitivity of cigarette consumption. We find no evidence that the increasing

sensitivity is due to the changing demographics of smokers or other spuriously correlated factors. The large estimates imply major reductions in the ability of states to raise revenue by increasing the cigarette tax.

Bibliography

Advertising Age (2002). "Top 10 Cigarette Brands," Advertising Age Online, June 24, 2002, <http://www.adage.com/page.cms?pageId=925>.

Becker, Gary, Michael Grossman, and Kevin Murphy (1994). "An Empirical Analysis of Cigarette Addiction," *American Economic Review*, 84(3), June, 396-418

Behavioral Risk Factor Survey System, Oregon (2004), Tobacco Use Module, http://www.dhs.state.or.us/dhs/ph/chs/brfs/04/tobacco.pdf>, page 28.

Business Review (2003). "New York Begins Ban on Internet Sales, " June 18. <http://albany.bizjournals.com/albany/stories/2003/06/16/daily25.html>, accessed August 15, 2003.

Centers for Disease Control (2003), "Behavioral Risk Factor Surveillance System, " <http://www.cdc.gov/brfss/index.htm>, accessed October 2, 2003.

Chaloupka, Frank J. and Kenneth Warner (2000). "The Economics of Smoking." In J. Newhouse and A. Culyer (eds.), *The Handbook of Health Economics*, v.1B. Amsterdam: Elsevier, pp. 1539-1627.

Coats, Morris (1995). "A Note on Estimating Cross-Border Effects of State Cigarette Taxes." *National Tax Journal,* Vol. 48, No. 4 (December), pp. 573-84.

Consumeraffairs.com (2005). "Credit Card Companies Snuff Online Tobacco Sales," consumeraffairs.com, March 17: http://www.consumeraffairs.com/news04/2005/07/tobacco_ags.html. Last accessed on August 7, 2007.

Evans, William, Jeanne Ringle and Diana Stech (1999), "Tobacco Taxes and Public Policy to Discourage Smoking," *Tax Policy and the Economy*, volume 13, J. Poterba, ed. MIT Press (Cambridge, MA).

Evans, William, Matthew C. Farrelly and Edward Montgomery, (2002). "Do Workplace Bans Reduce Smoking?" *American Economic Review*, Vol. 89, No. 4, September, pp. 728-747.

Farrelly, Matthew, Frank J. Chaloupka, and Terry Pehacek, (2001). "The Impact of Tobacco Control Program Expenditures on Aggregate Sales: 1981-1998," NBER Working Paper 8691, December.

Forrester Research, Inc. (2001). "Online Tobacco Sales Grow, States Lose." April 27.

General Accounting Office (2002). "Internet Cigarette Sales: Giving ATF

Investigative Authority May Improve Reporting and Enforcement ," GAO-02-743, August 9.

General Accounting Office (2003). "Internet Cigarette Sales: Limited Compliance and Enforcement of the Jenkins Act Result in Loss of State Tax Revenue," GAO-03-714T, May 1.

Glasner, Judith (2003). "U.S. Bill Targets Tobacco Sites," June 6, Wired News, < http://www.wired.com/news/business/0,1367,59124,00.html>, accessed August 15, 2003.

Goolsbee, Austan and Jeffrey Brown (2002). "Does the Internet Make Markets More Competitive? Evidence from the Life Insurance Industry," *Journal of Political Economy,* June, Vol. 110, No. 3, pp. 481-507.

Goolsbee, Austan (2000). "In a World Without Borders: The Impact of Taxes on Internet Commerce," *Quarterly Journal of Economics,* Vol. 115(2), (May), pp. 561-576.

Gruber, Jonathan (2000), "Youth Smoking in the U.S.: Prices and Policies," NBER Working Paper 7506.

Gruber, Jonathan and Bötond Koszegi (2001), "Is Addiction Rational? Theory and Evidence" *Quarterly Journal of Economics,* Vol. 116, No. 4, pp. 1261-1305

Gruber, Jonathan, Anindya Sen, and Mark Stabile (2003). "Estimating Price Elasticities When There is Smuggling: The Sensitivity of Smoking to Price in Canada," *Journal of Health Economics* Vol. 22, No. 5, pp. 821-842.

Hu, Teh-Wei, Hai-Yen Sung, and Theodore E. Keeler (1995), "The State Antismoking Campaign and the Industry Response: The Effects of Advertising on Cigarette Consumption in California," *American Economic Review*, Vol. 85, No. 2, May, 85-90.

Keeler, Theodore E., Teh-Wei Hu, P.G. Barnett, W.G. Manning, and Hai-Yen Sung (1996). "Do Cigarette Producers Price-Discriminate by State? An Empirical Analysis of Local Cigarette Pricing and Taxation." *Journal of Health Economics*, Vol. 15, No. 4 (August), pp. 499-512.

Keeler, Theodore E., The-wei Hu, Willard G. Manning and Hai-Yen Sung (2001). "State Tobacco Taxation, Education, and Smoking: Controlling for Effects of Omitted Variables." *National Tax Journal,* Vol. 54 (March), pp. 83-102.

Lewis, Truman (2007). "Bill Targets Online Cigarette Sellers," consumeraffairs.com, July 11: http://www.consumeraffairs.com/news04/2007/07/cigarettes_online.html. Last accessed on August 7, 2007.

Lovenheim, Michael F. (2007). "How Far to the Border?: The Extent and Impact of Cross-Border Casual Cigarette Smuggling." SIEPR Discussion Paper No. 06-040.

Orzechowski and Walker (2006). *The Tax Burden on Tobacco*. *Historical Compilation, Volume 41*.

REA (Ridgewood Economic Associates, Ltd.) (2002). "New Cigarette Tax Revenue Sources for New York State, " mimeo, December 24 2002. http://www.factalliance.org/images/taxstudy.pdf, accessed August 26, 2003

Slemrod, Joel (2007). "The System-Dependent Tax Responsiveness of Cigarette Purchases: Evidence from Michigan." University of Michigan mimeo, May.

Stehr, Mark (2005). "Cigarette Tax Avoidance and Evasion." *Journal of Health Economics*, Vol. 24, pp. 277-297.

Thursby, Jerry and Marie Thursby. (2000). "Interstate Cigarette Bootlegging: Extent, Revenue Losses, and Effects of Federal Intervention." *National Tax Journal*, Vol. 53 (March), pp. 59-78.

Yonish, Steve, with James L. Mcquivey, Gillian Demoulin, Jennifer Gordon, Resa Broadbent (2001). "Why Technographics Works," Forrester Online Report, November, 2001, <http://www.forrester.com/er/research/report/0,1338,11797,00.html>, accessed August 17, 2003.

Yurekli, A. and Ping Zhang (2000). "The Impact of Clean Indoor-Air Laws and Cigarette Smuggling on the Demand for Cigarettes: An Empirical Model," *Health Economics* Vol. 9, No. 2, 159-170.

Data Appendix

1. Cigarette Sales per Capita

Cigarette sales are taken directly from *The Tax Burden on Tobacco* (Orzechowski and Walker, 2006). This compilation contains state tax-paid cigarette sales by state for each fiscal year. The fiscal year is defined as July 1-June 30. Thus, for example, fiscal year 1997 starts on July 1, 1997 and ends on June 30, 1998. We adopt this definition of the fiscal year throughout in order to align the variables with the timing of the sales data.

The Tax Burden on Tobacco lists total tax-paid sales for the fiscal year in millions of packs. To convert to packs per capita, we multiply by 1,000,000 and then divide by the total population in a state in a given calendar year. Population estimates are taken from the Bureau of the Census and can be found at http://www.census.gov/popest/archives/.

2. Cigarette Taxes and Wholesale Prices

Table 6 of *The Tax Burden on Tobacco* lists tax increases by state and the date the tax increase took effect. Using these dates, we calculate the daily weighted average per-pack tax in each state over each fiscal year. We then add in the associated sales tax (if appropriate) listed in Table 15. The nominal per-pack cigarette taxes are converted into real 2005 dollars using the monthly-weighted average CPI over the fiscal year.

Wholesale cigarette prices are also taken from *The Tax Burden on Tobacco*, Tables 13 and 13A. The tables list sales-weighted average excise tax-inclusive prices as of November 1 of each calendar year. To calculate average wholesale prices over the fiscal year, we first subtract the November excise tax from the tax-inclusive price. Assuming constant linear growth in the wholesale price from November to November of each year, the formula for the average price in fiscal year t is $p_t = \frac{10}{144} p_{Nov,t-1} + \frac{106}{144} p_{Nov,t} + \frac{28}{144} p_{Nov,t+1}$. Similar to the tax level, the nominal wholesale price is then adjusted to real 2005 dollars using the average CPI over the fiscal year.

3. Neighbors' Average Tax-Inclusive Price and Cigarette Tax

We calculate the population-weighted average tax-inclusive price of all border states for each state by adding the fiscal year average real wholesale price and the tax levels together and then calculating a population weighted average across all border states for each state. We define a state as a border state if they share a border of any length. The population estimates used for the weights are the same population as those used to calculate per-capita cigarette sales from the U.S. Census Bureau. We apply the same methodology to the tax level to find each state's population weighted average neighbors' tax rate.

4. CPS Internet Penetration Measure

We use the 1989, 1993, 1997, 1998, 2000, 2001, and 2003 CPS Computer supplements to calculate the proportion of each state's population in a given fiscal year that has Internet access. The survey questions we utilize ask whether respondents use the Internet, but the wording changes from year to year. The 2001 and 2003 surveys inquire about Internet use from any location, whereas the CPS asks about Internet usage in the home and outside the home separately in 1998 and 2000. In 1997, the CPS survey asks for Internet usage at home, work, and school separately, whereas prior to 1997, the survey questions concern only whether the respondent uses a modem and has email. We define an Internet variable equal to 1 if a respondent answered "yes" to any of the Internet usage questions in 1997-2003 surveys and if they have email or a computer with a modem in the 1989 and 1993 surveys. We then take the average value of this variable by state and year, weighted by the non-response weights in the CPS. These state-year averages constitute the Internet penetration measure we utilize throughout the analysis. Because the CPS Internet supplements occur late in the calendar year, we apply each year's average to the next fiscal year (so, for example, the 1997 rates will be applied to the 1998 fiscal year data).

Note there is a 1994 CPS survey that asks only whether the respondent has a computer with a modem. We exclude this survey because the Internet penetration rate is much lower and is "off trend" when these date are utilized.

To be able to construct a continuous state-level panel from 1980-2005, we linearly interpolate the state-level Internet penetration rate between survey years. Prior to fiscal year 1990, we assume Internet penetration is zero, though we also perform a specification in which we linearly interpolate the CPS Internet measure between the 1990 level and zero in 1980 in each state.

5. Forrester Internet Penetration Measure

We use data from a large consumer survey conducted by Forrester Research, Inc. as part of the Technographics 2002 program to measure Internet penetration as well. The survey collected demographic information from a nationally-representative sample of about 80,000 people, including whether they smoke and posed questions about whether they use the Internet at all, whether they have ever bought something online, and their past history of Internet usage. More details on the Forrester data can be found in Yonish et al. (2001) and Goolsbee (2000). Using the responses to a question about how long each person has been online, we create a measure of the share of each state's population that was online in a given year from 1995 to the present, following the method of Goolsbee and Brown (2002). For years before 1995, we set all the Internet use measures to zero.

6. Real Income per Capita

We measure real income per capita using the state-level quarterly income estimates published by the Bureau of Economic Analysis (BEA), which can be found at: http://www.bea.gov/regional/sqpi/default.cfm?sqtable=SQ1. Using the quarterly data, we calculate average income for each state and fiscal year and then adjust to real 2005 dollars using the CPI. We convert to income per capita by dividing by the total population estimates discussed in Section 1 of this appendix.

Table 1. Means of Selected Variables by Year

Variable	Mean (S.D.) FY 1980		Mean (S.D.) FY 1990		Mean (S.D.) FY 2000	
Sales/capita (packs)	131.66	25.69	104.09	21.56	84.16	25.31
ln(Sales/capita)	4.86	0.18	4.63	0.20	4.39	0.31
Consumption/capita (packs)	n.a.	n.a.	82.19	14.05	75.47	14.08
ln(consumption/capita)	n.a.	n.a.	4.39	0.17	4.31	0.19
ln(consumption)-ln(sales)	n.a.	n.a.	-0.23	0.14	-0.08	0.18
Real State Tax (2005 cents)	36.16	11.32	43.92	17.80	61.97	31.57
Real Wholesale Price (2005 cents)	128.02	6.78	215.24	11.22	336.47	11.43
Real Tax-inclusive Price (2005 cents)	164.18	14.91	259.15	25.43	398.45	39.21
m	0.28	0.09	0.20	0.08	0.18	0.09
ln(1+m)	0.25	0.07	0.18	0.06	0.18	0.09
ln(income/capita)	10.97	0.14	10.65	0.16	10.50	0.16
CPS Internet Penetration Rate	0.00	0.00	0.05	0.02	0.41	0.06
Forrester Internet Penetration Rate	0.00	0.00	0.00	0.00	0.49	0.06

[1] Source: authors' calculations as described in the text. All means are at the state-level for the specified fiscal year.

[2] n.a means data for the given fiscal year were not available. The variable m refers to the ratio of the state tax to the state wholesale price.

Table 2. IV Estimates of the Effect of Prices and Internet Penetration on Cigarette Sales, 1980-2005

	Dependent Variable: ln(Sales/capita)						
	Baseline	CPS	Extrapolated CPS	Forrester	1st Difference	Years>1989	CPS Years Only
Variable	**(i)**	**(ii)**	**(iii)**	**(iv)**	**(v)**	**(vi)**	**(vii)**
ln(p)	-0.151	-0.187**	-0.177**	-0.210**	-0.142**	-0.046	0.177
	(0.092)	(0.074)	(0.078)	(0.083)	(0.107)	(0.107)	(0.215)
ln(1+m)	-1.136**	-0.712**	-0.710**	-0.893**	-0.666**	-0.975**	-1.105**
	(0.105)	(0.111)	(0.113)	(0.094)	(0.128)	(0.126)	(0.228)
ln(p)*Internet		-0.360	-0.399	-0.307	-0.062	-0.159	-0.250*
		(0.276)	(0.297)	(0.329)	(0.260)	(0.305)	(0.464)
ln(1+m)*Internet		-1.074**	-1.063**	-1.324**	-1.581**	-0.975**	-0.251
		(0.281)	(0.286)	(0.280)	(0.688)	(0.126)	(0.449)
Neighbors' ln(p(1+m))	0.295	0.402*	0.406*	0.044	0.217*	0.399*	0.370
	(0.218)	(0.205)	(0.204)	(0.125)	(0.173)	(0.184)	(0.242)
Internet		2.191	2.463	2.137	0.616	0.888	1.510
		(1.560)	(1.689)	(1.969)	(1.591)	(1.714)	(2.605)
ln(income/capita)	0.386**	0.439**	0.432**	0.359**	0.173**	0.116	-0.034
	(0.119)	(0.122)	(0.124)	(0.121)	(0.080)	(0.232)	(0.349)
Observations	1274	1274	1274	1078	1225	784	343
R^2	0.98	0.98	0.98	0.98	0.36	0.98	0.98

[1] Source: authors' calculations as described in the text. Standard errors clustered at the state level are in parentheses: * indicates significance at the 10% level and ** indicates significance at the 5% level. All specifications include state and year fixed effects and state-specific linear time trends.

[2] The Variable p refers to the state average wholesale price and m refers to the state average per-pack cigarette tax divided by the state average wholesale price.

[3] The specification using the Forrester Internet penetration data includes years 1980-2001.

[4] CPS years refer to the fiscal years in which Internet penetration questions were asked in the survey: 1990, 1994, 1998, 1999, 2001, 2002, and 2004.

Table 3. Average Price Elasticities from Parameter Estimates in Table 2, FY 2000

	Dependent Variable: ln(Sales/capita)						
	No Internet	CPS	Extrapolated CPS	Forrester	1st Difference	Years>1989	CPS Years Only
Price Elasticity Due to Tax Change	**(i)**	**(ii)**	**(iii)**	**(iv)**	**(v)**	**(vi)**	**(vii)**
ε^{t}_{price} - With Internet	-1.136	-1.157	-1.150	-1.153	-1.320	-1.142	-1.224
ε^{t}_{price} - No Internet		-0.712	-0.710	-0.893	-0.666	-0.975	-1.105
Elasticity of Taxable Sales with respect to Internet Growth		-0.035	-0.016	0.063	-0.004	-0.043	0.001

[1] Source: authors' calculations from equations (8) and (9) as described in the text.
[2] The specification using the Forrester Internet penetration data are for the years 1980-2001.
[3] CPS years refer to the fiscal years in which Internet penetration questions were asked in the survey: 1990, 1994, 1998, 1999, 2001, 2002, and 2004. The elasticities for the CPS years are for FY 2001.

Table 4. IV Estimates of the Effect of Prices and Internet Penetration on Cigarette Smuggling Using the CPS Internet Penetration Measure, 1991-2000

	Dependent Variable: ln(consumption)-ln(sales)		
Variable	**(i)**	**(ii)**	**(ii)**
ln(p)	0.214		
	(0.196)		
ln(1+m)	0.749**		
	(0.239)		
ln(p)*Internet	1.515**	0.935	-0.020
	(0.840)	(1.713)	(1.698)
ln(1+m)*Internet	1.776**	5.954**	3.614
	(0.846)	(2.407)	(2.863)
Neighbors' ln(p(1+m))	-0.245	-0.478	-0.528
	(0.303)	(0.411)	(0.400)
Internet	-9.283*	-6.578	-0.851
	(4.922)	(9.483)	(9.401)
ln(income/capita)	-0.309	-0.775	-0.602
	(0.656)	(0.598)	(0.606)
ln(p)*year			0.099
			(0.085)
ln(1+m)*year			0.068
			(0.072)
State-specific Elasticities	No	Yes	Yes
Observations	526	526	526
R^2	0.75	0.84	0.84

[1] Source: authors' calculations as described in the text. Consumption data come from the BRFSS survey and are aggregated to the state level. The BRFSS data are only available from 1991-2000. All specifications include state and year fixed effects but not state-specific linear time trends.

[2] Standard errors are in parentheses clustered at the state level: * indicates significance at the 10% level and ** indicates significance at the 5% level.

[3] State-specific elasticities refer to state fixed effects interacted with both ln(p) and ln(1+m).

Table 5. Sensitivity Analysis of IV Estimates of the Effect of Prices and Internet Penetration on Cigarette Sales Using the CPS Internet Variable, 1980-2005

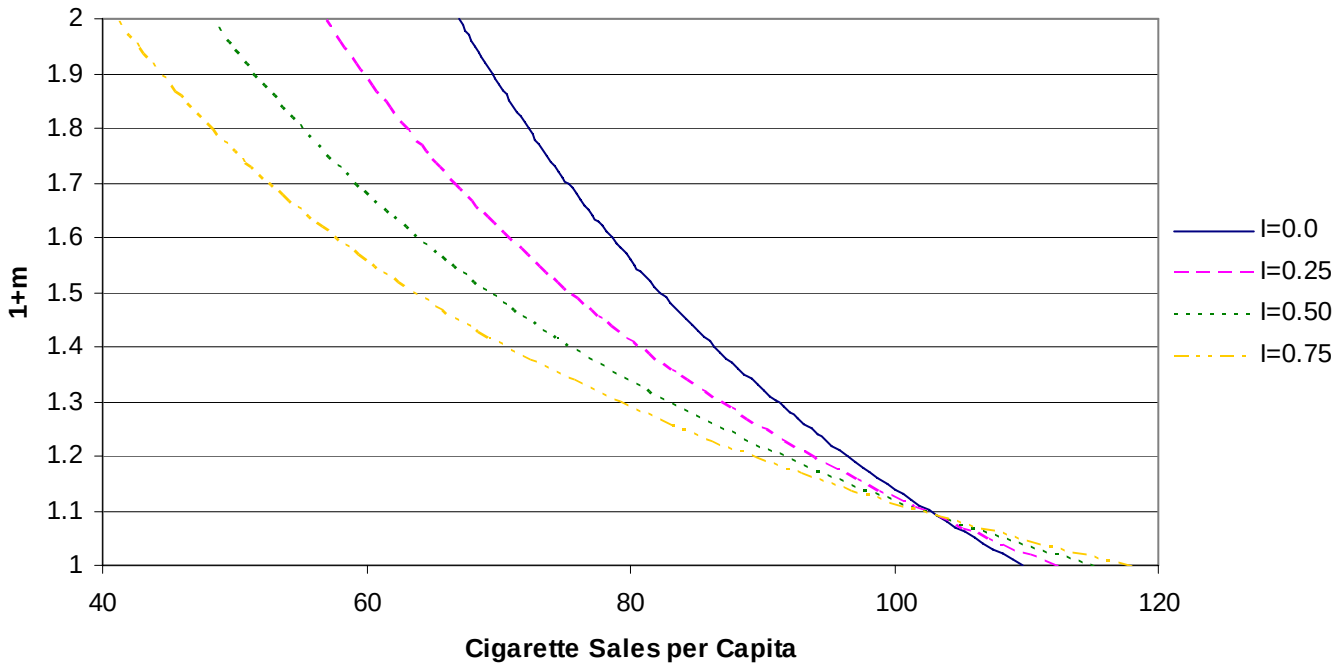
	Dependent Variable: ln(Sales/capita)							
	Pre-Settlement	No Havens	Population Weights	No Casinos	More than 5 Casinos	Controls	Controls	Controls
Variable	**(i)**	**(ii)**	**(iii)**	**(iv)**	**(v)**	**(vi)**	**(vii)**	**(viii)**
ln(p)	-0.132	-0.173**	-0.035	-0.074	-0.003		0.917**	
	(0.080)	(0.079)	(0.076)	(0.409)	(0.093)		(0.377)	
ln(1+m)	-0.516**	-0.728**	-0.614**	-1.362**	-0.802**		-1.055**	
	(0.111)	(0.120)	(0.145)	(0.302)	(0.190)		(0.293)	
ln(p)*Internet	-1.209	-0.457	-0.733**	-1.204*	-0.696	0.150	0.154	0.628
	(1.003)	(0.286)	(0.317)	(0.634)	(0.400)	(0.244)	(0.414)	(0.384)
ln(1+m)*Internet	-4.387**	-0.996**	-0.614**	-1.362**	-0.911*	-1.140**	-1.240	-0.922*
	(1.099)	(0.358)	(0.145)	(0.302)	(0.490)	(0.328)	(0.566)	(0.526)
Neighbors' ln(p(1+m))	0.034	0.403*	0.098	1.009**	-0.125	0.178	0.385	0.177
	(0.155)	(0.212)	(0.148)	(0.309)	(0.125)	(0.167)	(0.254)	(0.160)
Internet	7.432	2.733*	4.532**	6.223	3.749	-0.918	-1.255	-3.596*
	(5.422)	(1.615)	(1.878)	(3.679)	(2.302)	(1.379)	(2.307)	(2.087)
ln(income/capita)	0.360**	0.436**	0.526**	-1.140**	0.613**	0.527**	0.107	0.513**
	(0.110)	(0.129)	(0.106)	(0.519)	(0.221)	(0.129)	(0.218)	(0.135)
ln(p)*year							-0.098**	-0.035**
							(0.021)	(0.016)
ln(1+m)*year							-0.005	-0.019
							(0.017)	(0.016)
State-specific Elasticities	No	No	No	No	No	Yes	No	Yes
Observations	931	1170	1274	546	416	1274	1274	1274
R^2	0.98	0.98	0.99	0.96	0.98	0.95	0.95	0.98

[1] Source: authors' calculations as described in the text. Standard errors are clustered at the state level in parentheses: * indicates significance at the 10% level and ** indicates significance at the 5% level. All specifications include state and year fixed effects. State-specific linear time trends are included in columns (i)-(v) only due to multicollinearity of the state-year trends and the state-specific elasticities.

[2] Pre-settlement refers to years prior to 1999. "Haven" states are Virginia, Kentucky, North Carolina, and South Carolina.

[3] State-specific elasticities refer to state fixed effects interacted with both ln(p) and ln(1+m).

Figure 1. Simulated Cigarette Sales per Capita vs. Cigarette Tax Rates by Internet Penetration, FY 2000



Source: simulations based on parameter estimates from Table 2, column (ii). All variables are at the mean 2000 level except for the tax rate and Internet penetration rate. The term *I* refers to the Internet penetration rate. The *m* term is the tax divided by the wholesale price—the *ad valorem* tax rate.