Cigarette Tax Evasion in Minnesota

A report
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In a challenged fiscal environment, preserving the integrity of a state's revenue sources becomes an especially important objective. While taxing an addictive good like tobacco might seem to insulate the associated revenues from cyclical economic conditions, several influences may jeopardize those revenues. One is the lure of making nominally tax-free purchases on the Internet. A second is the possibility of buying cigarettes that are taxed at a lower rate in a neighboring state. Cigarette sellers also may contribute to the problem by engaging in bootlegging. Devising tax administration policies to reduce the impact of these influences is complicated by the fact that little is known about the magnitude of these "foregone" revenues. Estimating the size of this "tax gap," the difference between the revenues legally due to the state and the revenues actually collected, is the purpose of the study reported here.

Measuring any tax gap requires distinguishing between legal avoidance behavior and illegal evasion. Under Minnesota law, a person may acquire title to or possess fewer than 200 untaxed cigarettes in a month, provided that she/he carries the cigarettes into the state.[1] That is, a Minnesota resident may legally purchase up to 200 cigarettes (one carton) in a lower-tax state if she/he then personally carries them into Minnesota. Possession of one carton of untaxed cigarettes therefore exemplifies legal avoidance, not evasion. Because it is not possible to separate revenues foregone due to this *de minimus* provision from revenues lost due to illegal evasion, the estimates presented below include legal avoidance along with evasion. For that reason, they likely overstate, to an unknown extent, Minnesota's true cigarette tax gap.

In designing the methodology used in this study, the academic and administrative literature regarding cigarette taxation was carefully reviewed. A document summarizing that review and describing an estimation strategy was previously transmitted to the Minnesota Department of Revenue. The basic plan was, first, to construct a direct estimate of Minnesota cigarette tax evasion as the difference between the quantities of cigarettes consumed and the quantities sold with the cigarette tax paid, and, second, to explore the geographic and demographic characteristics of its distribution across the state. Consumption was to be measured by responses to the Minnesota Adult Tobacco Survey (MATS) and the Minnesota Student Survey (MSS). Sales for the state as a whole were to be taken from the data published by Orzechowski and Walker, 2007; sales for each county in the state were to be newly collected by the Department of Revenue. As is explained below, several modifications of that plan proved necessary in order to paint a more nuanced picture of both the magnitude of evasion and its geographic and demographic characteristics.

The report is organized into six main sections, denoted by roman numerals. The first section constructs three different point estimates of cigarette tax evasion in Minnesota. The second section explores the characteristics of evasion. Sections 3

[1] 2009 Minnesota Statutes, Section 297F.25: Cigarette Sales Tax

and 4 plumb the determinants of taxed sales and consumption, respectively. Consumption and taxed sales are compared in the fifth section. The sixth section concludes.

I. POINT ESTIMATES OF EVASION

This section begins with historical estimates of Minnesota cigarette consumption, first using micro survey data (subsection 1) and then macro data (subsection 2). Subsection 3 contains historical measures of state tax-paid sales of cigarettes. Three point estimates of evasion are constructed in subsections 4, 5 and 6.

1. Cigarette Consumption Using Micro Survey Data.

Minnesota Adult Tobacco Survey (MATS)

This survey of Minnesota adults has been conducted three times, in 1999, 2003, and 2007. Using the criteria developed by the Center for Disease Control's Behavior Risk Factor Surveillance System (BRFSS), MATS estimates the **prevalence** of smoking by classifying each respondent either as a current smoker, a former smoker or a non-smoker. [2] It estimates the **frequency** of smoking by further dividing smokers into those who smoke everyday and those who smoke only on some days. Everyday smokers are asked: "On average, about how many cigarettes per day do you smoke?" Some day smokers are asked: "During the past 30 days, on how many days did you smoke cigarettes?" and "During the past 30 days, on the days when you smoked, about how many cigarettes did you smoke on average?" Since a number of "former smoker' respondents and a few "never-smokers" report positive amounts to the frequency questions, the classification is not entirely accurate. In Table 1, I include all reported consumption, weighted to the adult population of Minnesota.

Minnesota Student Survey (MSS)

The Minnesota departments of Education, Health, Human Services and Public Safety jointly administer a survey of public school students in grades 6, 9 and 12 every three years (most recently, 2001, 2004, and 2007). I used responses to the following question to construct estimates of cigarette consumption by underage Minnesota smokers, recorded in Table 1:

"During the last 30 days, how frequently have you smoked cigarettes?

Never

[2] A current smoker is one who has smoked at least 100 cigarettes over her lifetime and now smokes everyday or some days; a former smoker has smoked at least 100 cigarettes in her life but now does not smoke; a non-smoker has smoked fewer than 100 cigarettes over her life.

Less than 1 cigarette per day
1 to 5 cigarettes per day
About ½ pack per day
About 1 pack per day
About 1 12 packs per day
2 packs or more per day"

National Health Information Survey (NHIS)

For 2007, I used public use data from this national survey to estimate daily cigarette consumption among current and former smokers as a function of several demographic characteristics common to both the public-use NHIS and MATS (age, region, marital status, and race) datasets. Next, I use that function to impute average daily consumption for all respondents included in the 2007 MATS estimate, weighting and summing them to yield an alternative consumption estimate. It is recorded in Table 1.

2. Cigarette Consumption Using USDA Macro Data.

Until recently, the U.S. Department of Agriculture collected and published annual data for cigarettes, estimating per capita U.S. consumption as taxed removals + imports + miscellaneous shipments – inventory changes.[3] For 2006 (the last full year for which a USDA estimate is available) per capita consumption among all Americans 18 years of age and older was 1691 cigarettes. In Table 1, for Minnesota's adult population, this corresponds to an estimated total consumption of 6584 million cigarettes (1691 x 3,893,569). However, since the prevalence of smoking among Minnesotans is less than for the U.S. as a whole, this calculation may overstate Minnesota consumption. A more nuanced calculation that accounts for Minnesota's lower prevalence (labeled USDA-2) is also recorded in Table 1. [4]

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[3] The Alcohol and Tobacco Tax and Trade Bureau, an agency of the U.S. Department of the Treasury, collects and publishes cigarette data that are more current but less detailed. While taxed removals and imports are reported, neither miscellaneous shipments nor inventory changes are included, so that calculating cigarette consumption in a consistent manner after 2006 is not possible. See http://www.ttb.gov.

[4] See http://www.cdc.gov/nchis/earlyrelease/200812_08.pdf for U.S. prevalence and http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5809a1.htm) for state-specific prevalence. The CDC's estimate for MN's prevalence rise from 1998 to 2001 and then decline. Hence, the 1999 prevalence estimate (19.5%) is lower than over the period 2000-2005. In contrast, the U.S. prevalence estimates decline monotonically 1998-2007.
The calculation, for the 18+ population, is as follows:

- US consumption per smoker = US TOTAL Consump/(US pop*US prevalence)
- MN TOTAL Consump = US Consump per smoker * (MN pop * MN prevalence)

Table 1 **Minnesota Cigarette Consumption** Millions of cigarettes							
	1999	**2001**	**2003**	**2004**	**2005**	**2006**	**2007**
Micro Survey Data Weighted. Sample sizes in parentheses Survey-years in **bold**; other years interpolated							
MATS	**4000** (1234)	3774	**3547** (1585)	3432	3318	3203	**3088** (1701)
MSS	----------	**88.9** (133,629)	72.7	**64.6** (131.862)	57.9	51.2	**44.5** (136,549)
MATS + MSS	----------	3863	3620	3497	3375	3254	**3133**
NHIS	----------	----------	----------	----------	-------	--------	**3740** (1701)
Macro Data							
USDA	7543	7581	7180	6925	6609	6584	--------
USDA-2	6259	7413	6977	6858	6324	5793	----------

3. Taxed Sales of Cigarettes.

Table 2 contains Minnesota Department of Revenue data, 1999-2007.

Table 2 **Minnesota Taxed Sales** Minnesota Department of Revenue[5] Millions of Cigarettes (calendar yea)							
	1999	**2001**	**2003**	**2004**	**2005**	**2006**	**2007**
Taxed sales	7294	7094	6746	6595	6020	5370	5336

4. Estimating Evasion as (Consumption – Taxed Sales).

If evasion is to be measured by how much consumption exceeds taxed sales, the micro survey data in Tables 1 and 2 reveal an immediate problem: underreporting. Note that these survey data account for only 53%-61% of taxed sales during this period. Underreporting could be present in at least two ways: smokers who self-identify as non-smokers, denying any consumption, or smokers who self-identify as smokers but report fewer cigarettes than they actually consume. These data do not permit either disentangling these types of underreporting or estimating their magnitudes. In the literature, underreporting of cigarette consumption was recognized after the 1964 Surgeon General's warning (Warner, 1978). A few researchers have attempted to verify respondents' reports using bioassays of

[5] Personal communication, Randy Sanford, August 3, 2009

nicotine markers in blood or saliva. Some conclude that while self-reports of smoking status are pretty reliable, self-reports of smoking frequency are subject to various forms of bias (Klesges et al.1995, Caraballo 2001). Respondents may engage in "digit preference bias" by tending to report consumption in multiples of 10. "Social desirability bias" occurs when respondents obscure their participation in behaviors with adverse consequences (Perez-Stable et al , 2001). Interestingly, for the period between 1974 and 1985, Hatziandreu et al (1989) found that the ratio of self-reported cigarette consumption to the USDA estimate of consumption remained statistically fairly constant, suggesting that cross-sectional surveys could be a reliable surveillance tool for monitoring changes in population smoking behavior.

The macro data are less plagued by underreporting, as the first set of USDA-based Minnesota consumption estimates exceed Minnesota Department of Revenue's taxed sales in each of the years in Tables 1 and 2.[6] For these years and for both sets of consumption estimates, Table 3 summarizes the range in the level of estimated evasion in terms of the number of untaxed sticks, dollars of unpaid tax and the percent of taxes collected. As noted earlier, some unknown fraction of these estimates represents legal avoidance behavior, since state law permits possession of one carton of untaxed cigarettes per person.

[6] The estimate for 2007 is based on preliminary data (see footnote 3 above).

Table 3
Estimated Evasion: (USDA Consumption – MNDOR Taxed Sales)*

	1999		2001		2003		2004		2005		2006	
	USDA	USDA-2	USDA	USDA-2	USDA	USDA-2	USDA	USDA-2	USDA	USDA-2	USDA	USDA-2
Millions of sticks	249	0	487	319	434	231	330	263	589	304	874	423
Millions of packs	12.45	0	24.35	15.95	21.7	11.55	16.5	13.15	29.45	15.2	43.7	21.15
Average tax rate per pack[7]	$0.67	$0.67	$0.70	$0.70	$0.71	$0.71	$0.71	$0.71	$1.0225	$1.0225	$1.49	$1.49
Dollars unpaid tax (millions)	$8.34	$0	$17.05	$11.17	$15.41	$8.20	$11.72	$9.34	$30.11	$15.54	$65.11	$31.51
% of taxes collected[8]	3.60%	0%	7.0%	4.59%	6.32%	3.36%	4.90%	3.91%	8.68%	4.48%	16.29%	7.88%

* The USDA-2 columns reflect adjustments for Minnesota's lower smoking prevalence, relative to average U.S. prevalence.

[7] For a calendar year during which Minnesota's tax rate changed (e.g., 2005 and 2006), the entry is a weighted average. The entries include the cigarette excise tax, the sales tax collected on cigarettes and, in 2005 and 2006, the Health Impact Fee. (Orzechowski and Walker).

[8] Reflects estimated unpaid sales and excise taxes as a percent of sales and excise tax collections (MNDOR and Orzechowski and Walker).

5. Estimating Evasion with Micro Survey Data Regarding Source of Purchase

While Minnesotans are obliged to pay the cigarette tax regardless of the source of purchase, in practice they pay only when purchasing from sources within the state.[9] Therefore, it is possible to infer evasion from self-reports of purchases from sources outside of Minnesota. Both the 2007 MATS and all three waves of the MSS pose a question about sources. The 2007 MATS asks:

"Do you usually buy your cigarettes

In Minnesota?
Out of state?
Over the Internet?
Through Mail Order?
An 800 number?"

The MSS poses a somewhat different source question:

"If you used tobacco, how did you get it in the last 30 days? (Mark all that apply)

Bought it at gas stations or convenience stores
Bought it at bars or restaurants
Bought it at grocery, discount, or drug stores
Bought it at places like bowling alleys, video arcades, or pool halls
Bought it from vending machines
Bought it on the Internet
Got it from friends
Got it from my parents
Got it from other family members
Got it by getting someone else to buy it for me
Took it from my home
Took it from a friend's home
Took it from stores."

For adult MATS respondents, I considered the consumption of anyone who reported usually buying out of state, on the Internet, by mail order or by an 800 number as untaxed. That is, I counted all of such respondents' reported cigarette consumption as evasion. For teen MSS respondents, since it was not possible to determine how many cigarettes (or other forms of tobacco) were obtained from each when multiple sources were checked, I counted all of the consumption reported by anyone who checked "bought it on the Internet" as evasion. Of course, the resulting estimates are subject to bias in both directions: biased upward in the case of an underage smoker who checks "Internet" and some other purchased source(s), and biased downward for both market segments, due to underreporting. Note that a third opportunity for underreporting is present here: to deny purchasing cigarettes anywhere but within Minnesota. Given that underage consumption is a relatively smaller part of total cigarette consumption, these resulting point estimates of evasion are likely to represent lower bounds on total annual evasion (Table 4).

[9] Only a small number of state residents file the necessary return and pay the cigarette tax owed on out-of-state purchases.

Table 4 **Source of Purchase as Measure of Evasion** Millions of cigarettes Sample size in parentheses	
	2007
MATS: outside MN	260.8 M (94)[10]
MSS: Internet	2.33 M (247)
TOTAL cigarettes	263.13 M
Total packs	13.16 M
Average tax rate per pack	$1.49175
Dollars of unpaid tax	$19.63 Million
% of taxes collected	4.9%

At an average 2007 tax rate of $1.49175, these data support an estimate of (at least) $19.63 million in unpaid tax..

6. Estimating Evasion From Different Rates of Decline in Reported Consumption and Taxed Sales Over Time

Suppose that survey respondents systematically underreport their cigarette consumption by some constant rate. That is,

$R = C - k*C,$

where

R = reported consumption

C = actual consumption and

$0<k<1$ is the rate of underreporting.

When we estimate evasion as R – sales, we will get

$Evasion = C\text{-}sales - k*C,$

obviously biased downward by the unobservable amount k*C.

Instead, suppose we estimate evasion using the difference between the proportional changes in R and in S. For a 2-period case, the proportional change in R is:

$(R1 - R2)/R1 = ((C1-kC1) - (C2-kC2))/ (C1-kC1).$

This reduces to

$(R1-R2)/R1 = (C1-C2)/C1.$

That is, the proportional change in reported consumption is the same as the proportional change in actual consumption, underreporting having been "differenced out." Next, if the proportional decline in taxed sales exceeds the proportional decline in consumption, we can infer that the difference represents untaxed purchases, and we can estimate its magnitude.

[10] Sample restricted to current and former smokers. Including never smokers raises the estimate to 337 M sticks (n=???).

For Minnesota and the period between 2001 and 2007, Table 5 uses the entries from Tables 1 and 2 in order to document that while the relationship runs the other way between 2001 and 2003, consumption did indeed decline at a slower rate than taxed sales between 2004 and 2006 and, using USDA-2 data, between 2003 and 2004 as well. It also shows that the proportional decline in consumption estimated by micro survey data (MATS + MSS) is about the same as that estimated by macro USDA data, for 2001-2005.[11] This finding provides some support for the assumption that underreporting is a constant fraction of actual consumption.

Table 5
Proportional Declines in Consumption vs Taxed Sales

	2001 to 2003	**2003 to 2004**	**2004 to 2005**	**2005 to 2006**
Consumption				
• MATS + MSS	.063	.034	.035	.036
• USDA	.053	.036	.046	.004
• USDA-2	.058	.036	.078	.084
Taxed Sales	.049	.022	.087	.108
Dollars of unpaid tax				
• USDA	-$1.88 million	-$3.69 million	$13.24 million	$35.90 million
• USDA-2	-$3.12 million	$1.14 million	$2.10 million	$8.86 million
% of taxes collected				
• USDA	-0.7%	-1.5%	3.8%	9.0%
• USDA-2	-1.28%	0.5%	0.6%	2.2%

Between 2004 and 2005, using USDA-2 data, the 7.8% decline in consumption amounts to 534 million sticks, as compared with a 575 million-stick decline in taxed sales sticks (8.7%). The difference, 41 million sticks, represents cigarettes that were smoked but for which no Minnesota tax was collected. Assuming 20 cigarettes per pack and using the average Minnesota sales and excise cigarette tax rate for 2005 ($1.0225), I calculate the foregone revenue estimate as $2.10 million. A similar calculation for between 2005 and 2006 yields an estimated $28.03 million in foregone revenue. MNDOR collections were $270.541 million and $399.626 million respectively in 2005 and 2006. Hence, foregone revenue as a percent of collected revenues was 0.8% and 2.2%, respectively.

II. CHARACTERISTICS OF EVASION
Responses to Source of Purchase Question in the 2007 MATS

[11] This is also true using USDA-2 data, for 2001-2004.

I use the 2007 MATS data to explore differences in the characteristics of individual respondents who report purchasing cigarettes within Minnesota versus those who do not.

First, for respondents who smoke and self-identify as evaders (purchasing outside the state, on the Internet, via mail-order or an 800 telephone number), I use multiple regression to estimate their reported cigarette consumption as a function of age, employment status, marital status, gender and their residence in a border county (North Dakota, South Dakota, Iowa or Wisconsin). Table 6 contains the results of that regression. Note that the consumption reported by evaders increases significantly with age (65 additional sticks per year for each additional year of age), and being male (an additional 2570 sticks per year for males, relative to females) but is not affected by being employed or married, or by residence in a border county. That is, with respect to county of residence, evaders who live in border counties do not consume either more or fewer cigarettes than evaders living in the interior of the state.

Table 6
Cigarette Consumption of Evaders
Dependent Variable: Annual Consumption (sticks)

Independent Variable	Coefficient Estimate	Standard error
Age	64.6690 **	25.1262
Married	480.7436	696.721
Employed	-586.338	808.9388
Male	2569.676**	706.4439
ND Border	-121.1615	1107.651
SD Border	3320.105	2452.321
IA Border	-156.7767	1374.85
WI Border	-731.8159	792.206
constant	1764.928	1696.391
N= 95 R^2= 0.2340	** statistically significant at the 5% level	

Second, for all smokers, I ran a probit regression to estimate how smokers' propensity to evade is impacted by their demographic characteristics and their level of cigarette consumption. Here, the dependent variable is categorical, set to 1 if the respondent self-identified as an evader, and 0 otherwise. Table 7 contains the results. The propensity to evade is positively associated with age, higher cigarette consumption and residence in counties that border North Dakota. On the other hand, the propensity to evade is negatively associated with residence in one of the 7 metro counties. An interaction term, Metro x WI, testing whether the influence of the Wisconsin border is different in the metro area, is not statistically significant.

Table 7
The Decision to Evade

Dependent Variable: Evade (0/1)

Independent Variable	Coefficient	Standard error
Age	0.0143**	0.0038
Employed	0.2073	0.1297
Married	-0.0184	0.1092
Male	-0.0471	0.1121
ND Border	1.6168**	0.2940
SD Border	0.0382	0.4186
IA Border	0.2213	0.2277
WI Border	0.2487	0.1535
Metro	-0.6073**	0.1442
Annual consumption	0.00005**	0.00001
Metro x WI	0.2519	0.2694
Constant	-2.5310	0.2556
N = 1696	** statistically significant at the 5% level	

That annual consumption is positively related to the decision to evade is intuitively sensible since heavy smokers would have a greater incentive to economize by purchasing cigarettes from sources offering lower tax rates. For example, in 2007, the Minnesota tax per pack was $1.49175 compared with $0.77 in Wisconsin, $0.48 in North Dakota and possibly zero on the Internet. The significant North Dakota and almost-significant Wisconsin coefficients[12] tend to suggest that much evasion is casual, cross-border smuggling since, if Internet purchases dominated evasion then it would be just as easy to evade if you lived in an interior county as in a border county and the border county coefficients might not be significant. However, to put these results in perspective, there were only 96 respondents who self-identified as evaders in the 2007 MATS. Almost all of them (90) simply acknowledged purchasing most of their cigarettes outside Minnesota. Just two reported usual purchases on the Internet; three cited mail order outlets; and 1 reported using an 800 number source.

III. Determinants of Taxed Sales

1. The data

On April 1, 2009, MNDOR sent a letter to a random sample of Minnesota cigarette retailers, requesting tabulations of the quantity of cigarettes received and/or sold each year from 2003 through 2008, separately for each distributor. The data received from responding retailers accounted for approximately 25% of total taxed sales (as reported by Orzechowski and Walker) in 2007. Responding retailers were

[12] As Table 7 indicates, the North Dakota coefficient is significant at the 5% level. The Wisconsin coefficient is just short of significance at the 10% level.

located in 81 of Minnesota's 87 counties.[13] Geographic coverage was most complete for the years from 2004 through 2007. MNDOR tabulated seizures of unstamped cigarette products, by county, for 2005-2007, provided counts of inspections, by zip code for 2005-2007 and MN cigarette tax rates from 1999 to the present, by fiscal year.

The author obtained the following data, by county in Minnesota for 2004-2007: per capita income, proportions of the population ages 13-18 (TEEN) and 18 and over, and proportion of population with Internet access. Annual adult populations estimates (18 years of age and older) were collected for the U.S. and for Minnesota, 1999-2007. Cigarette tax rates for North Dakota, South Dakota, Iowa and Wisconsin were taken from Orzechowski and Walker. For calendar years in which a state tax rate changed, the author calculated an average or weighted tax rate. A table of the state tax rates used here may be found in the appendix. Dummy variables for counties bordering these states and for metropolitan/micropolitan/rural counties were constructed. Where necessary, tax rates were converted from a fiscal year basis to a calendar year basis. Smoking prevalence rates for the U.S. and for Minnesota were gathered from the Centers for Disease Control (CDC). Source citations for all of the variables may be found in an appendix.

2. Methodology

All of the data was organized as a panel, containing 243 observations (81 counties over 3 years: 2005, 2006 and 2007).[14] The regression model explores the impact on per capita taxed sales in a county of the share of the population ages 13-18 (TEEN), the share with Internet access, state tax rates, MNDOR's enforcement activities (seizures and inspections), and border location dummies:

$$SALES = \beta_0 + \beta_1 TEEN + \beta_2 INTERNET + \beta_3 TAXES + \beta_4 SEIZURES + \beta_5 INSPECTIONS + \beta_6 BORDERS$$

I expected per capita sales to decline in counties with a greater proportion of teens, as Internet access increases, as Minnesota's cigarette tax rate rose (also, relative to other states' rates) and as there were more seizures or inspections. The BORDERS variables would test whether the opportunity to purchase cigarettes by crossing a nearby state line affected per capita sales, relative to counties in the state's interior.

The basic model was estimated using two different statistical methodologies, Fixed Effects and Ordinary Least Squares. Fixed effects regression permits controlling for any unobservable differences between cross-sectional entities, here between

[13] Counties not represented were: Big Stone, Lac Qui Parle, Lincoln, and Pipestone(along border with S.D.) and Murray and Stevens (in the state's interior).
[14] 2004 data were eliminated since no information regarding seizures in that year was available.

counties. It utilizes the within-county variation (across time) in the variables to estimate the separate impacts of the independent variables. Since whether a county shares a border with another state does not vary across time, the BORDERS variables cannot be estimated by a Fixed Effects regression. Ordinary Least Squares, in contrast, does not control for any unobservable cross-county differences but does permit estimation of the BORDERS variables. Selection of a methodology rests on whether unobserved differences in county characteristics significantly affect estimation of the impacts of the independent variables. A standard statistical test (an F-test) of whether controlling for unobserved county characteristics matters was performed. As it suggested that the unobserved characteristics were not significantly related to per capita taxed sales, I used Ordinary Least Squares to estimate the model. Since one important way in which counties differ is whether they share a border with another state, including the BORDERS variables provides a rough proxy for Fixed Effects. It is, of course, also of interest here in its own right. Preliminary results found no statistically significant relationship between SALES and INTERNET, probably because the INTERNET variable was not precisely measured. I substituted two dummy variables, METRO (11 county Minneapolis-St. Paul) and MICROPOLITAN[15] to proxy for Internet access, expecting per capita sales to be lower in METRO and MICROPOLITAN counties (relative to rural counties), with a somewhat larger METRO effect.

3. Results

The results are in Tables 8 and 9. Table 8 contains single-year cross-section regressions. For both metropolitan and micropolitan counties, per capita taxed sales are about the same as in rural counties, holding all other determinants constant. To the extent that these two variables accurately represent access to the Internet, there does not appear to be a significant link between access and taxed sales. Neither the proportion of a county's population between 13 and 18 (TEEN) nor its per capita income is significantly associated with its per capita taxed sales. Minnesota DOR's enforcement activities, seizures and inspections, measured contemporaneously, also appear unrelated to per capita sales.[16] While several of the border county coefficients are significant, some have opposite signs than one would expect in the light of state tax rate differentials. An appendix contains a table summarizing Minnesota and border state cigarette tax rates. Note that over the 2005-2007 period, cigarette excise and sales tax rates were lower in North Dakota, Iowa, and Wisconsin than in Minnesota. South Dakota's rate was lower in 2005 and 2006 but higher in 2007. The regression results in Table 8 show that in all three

[15] As defined by the Census Bureau and the Office of Management and Budget, a micropolitan area is an urban area surrounding a core city or town with a population of 10,000 to 49,999. Minnesota micropolitan areas are in the following counties: Beltrami, Brown, Blue Earth, Cass, Crow Wing, Douglas, Freeborn, Goodhue, Kandiyohi, Lyon, Martin, McLeod, Mower, Nicollet, Nobles, Otter Tail, Rice, Steele, Wilkin and Winona.

[16] Lagging seizures and inspections produced similarly insignificant results.

years, per capita sales in counties bordering North Dakota are significantly lower than in Minnesota's interior, consistent with those Minnesotans purchasing cigarettes in lower-tax North Dakota. For example, in 2006, taxed sales in Minnesota counties bordering North Dakota were about 228 sticks lower, per capita, than in interior counties. On the other hand, South Dakota-bordering counties had 395 fewer tax paid sticks per capita in 2007 in spite of Minnesota's relatively lower tax rate. For Iowa-bordering counties, this regression estimates higher per capita sales in 2005 and 2007, relative to interior counties (211 and 171 more sticks per capita, respectively), in spite of Minnesota tax rates that were higher than Iowa's. Sales in counties bordering Wisconsin are significantly higher than in Minnesota's interior in each of these three years (798, 524 and 410 more sticks per capita, in 2005, 2006 and 2007, respectively), though Minnesota's tax rate exceeded Wisconsin's. However, this is mostly a non-metro phenomenon, since the statistically significant coefficient on a metro-Wisconsin interaction term (METRO X WI) is opposite in sign and nearly as large in magnitude, significant for 2005 and 2006.[17] In sum, per capita taxed sales were significantly lower for all three years in counties along the North Dakota border and significantly higher in non-metro counties along the Wisconsin border, relative to interior counties.

Table 8
Determinants of Per Capita Taxed Sales
Single-Year Cross-Sections, 2005-2007
Dependent variable: per capita taxed sales (sticks)

Independent variable	**2005** Estimated coefficient (standard error)	**2006** Estimated coefficient (standard error)	**2007** Estimated coefficient (standard error)
METRO	-107.63(148.05)	-25.08 (150.10)	-41.99 (141.08)
MICROPOLITAN	-30.45 (88.98)	33.83 (79.49)	16.47 (77.74)
TEEN	-63.61 (63.10)	-89.83 (59.99)	-66.79 (57.10)
Per capita income	-0.003 (0.009)	-0.00 (0.01)	-0.002 (0.01)
SEIZURES	4.83 (6.34)	-3.37 (5.53)	-13.99 (10.50)
INSPECTIONS	3.43 (6.16)	1.28 (3.70)	5.90 (4.28)
ND BORDER	-239.09(129.97)*	-227.93 (123.82)*	-217.84 (119.48)*
SD BORDER	-391.02 (296.75)	-356.72 (284.48)	-394.89 (199.95)**
IA BORDER	210.61 (114.91)*	63.06 (109.89)	170.83 (101.98)*
WI BORDER	798.02 (110.36)**	524.09 (106.43)**	409.90 (103.58)**
METRO X WI	-716.46 (237.46)**	-485.97 (227.86)**	-356.74 (220.32)
Constant	1069.63 (643.34)	1158.78 (577.86)	962.41 (528.54)
N, R^2	75, 0.567	77, 0.411	79, 0.396
	* statistically	**statistically	

[17] Non-metro, Wisconsin-bordering counties are: Carlton, Cook, Goodhue, Houston, Lake, Pine, St. Louis, Wabasha and Winona. Those in the metro area are Chisago, Dakota and Washington.

	significant at the 10% level	significant at the 5% level	

Table 9 contains the Ordinary Least Squares panel regressions. In the second column of Table 9, taxed sales per capita are lower in counties with larger proportions of teens (ages 13-18), controlling for all of the other independent variables. As the Minnesota tax rate rose over this period, per capita sales declined.[18] As in the single-year regressions, ND border and SD border counties had lower per capita sales while Iowa border and Wisconsin border counties had higher per capita sales, all relative to sales in interior counties. However, because the metro-Wisconsin interaction term (METRO X WI) is opposite in sign and similar in magnitude to the Wisconsin border coefficient, per capita sales are significantly higher mostly in non-metro border counties.[19] Neither the seizure variable nor the interactions variable was significant, either contemporaneously, as here, or when lagged. Per capita income was also not significantly associated with per capita sales.

The third column displays the results when Minnesota's tax rate is measured relative to that of North Dakota's.[20] As expected, an average county's per capita sales decline as Minnesota's tax rate rises relative to North Dakota's; all the other coefficients are comparable in magnitude and significance to those in the second column. Substituting Minnesota's tax rate relative to Wisconsin's (rather than relative to North Dakota's) yields qualitatively similar results.

In the final column, a variable interacting the Minnesota tax rate with the Wisconsin border variable is substituted for the METRO X WI interaction term. Per capita taxed sales in this regression decline as the Minnesota tax rate increases and in counties bordering North Dakota and South Dakota and rise in counties bordering Iowa and Wisconsin. However, the higher sales along the Wisconsin border decline a bit as the Minnesota tax rate increases.

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[18] In a personal communication, Randy Sanford related the observations of a cigarette distributor, comparing sales for a 9-week period ending 10/1/05 (immediately after a substantial increase in Minnesota's tax rate) with the same period in 2004. The distributor's sales were about 100% higher in Hudson and Superior, WI, 89% higher in Sibley, IA and about 30% higher in Fargo, ND and Brookings, SD. In contrast, his Minnesota sales, fell between 33% (Duluth) and 55% (Moorhead).

[19] Dropping the interaction term, the metro coefficient increases in absolute value, remaining negative and significant at the 5% level while the Wisconsin border coefficient falls but is also still significant.

[20] Substantial collinearity among the variables measuring the region's tax rates made it impossible to separately estimate each of them. The MN-ND relative tax rate variable was significant when entered alone, as was the MN tax rate itself. Indeed, most of the variation in tax rates over this period is in the MN rate. Its divergence is persistently large with respect to the ND rate.

In sum, this evidence suggests that per capita taxed sales are negatively related to Minnesota's tax rate, whether measured absolutely or relative to a border state's rate. A ten-cent increase in Minnesota's tax rate is associated with a taxed sales decline of 18-24 sticks per capita. Consistent with casual, cross-border smuggling, per capita sales in this period were lower in counties bordering lower-tax North and South Dakota. The higher per capita sales in counties bordering lower-tax Iowa and non-metro Wisconsin are not consistent with cross-border smuggling. Finally, in Wisconsin-bordering counties, the increase in taxed sales does respond negatively to an increase in Minnesota's tax rate.

Table 9
Determinants of Per Capita Taxed Sales
Panel Data, 2004-2007[21]

Dependent variable: per capita taxed sales (sticks)

Independent variable	Estimated coefficient (standard error)	Estimated coefficient (standard error)	Estimated coefficient (standard error)
METRO	-46.77 (80.70)	-45.78 (80.73)	-187.20 (76.11)
MICROPOLITAN	25.59 (44.69)	25.79 (44.72)	14.09 (46.00)
TEEN	-63.67 (32.84)*	-62.49 (32.79)*	-83.99 (33.42)
Per capita income	-0.003 (0.005)	-0.003 (0.005)	-0.005 (0.005)
SEIZURES	-0.22 (3.54)	-0.19 (3.54)	1.31 (3.62)
INSPECTIONS	1.25 (2.06)	1.24 (2.07)	2.63 (2.16)
MN cigarette tax rate	-2.43 (0.87)**		-1.78 (0.97)*
MN/ND cig. tax rate		-148.59 (54.25)**	
ND BORDER	-233.94 (69.74)**	-234.25 (69.78)**	-243.75 (71.80)**
SD BORDER	-388.59 (139.53)**	-389.45 (139.62)**	-406.36 (143.68)**
IA BORDER	142.22 (60.86)**	142.16 (60.90)**	149.60 (62.67)**
WI BORDER	596.20 (58.44)**	596.73 (58.47)**	1180.89 (318.42)**
METRO X WI	-544.36 (125.90)**	-545.10 (125.97)**	
MN tax X WI			-5.30 (2.36)**
Constant	1342.22 (360.08)	1334.98 (360.50)	1495.78 (368.88)
**/* statistically significant at the 5%/10% level	N=231 R^2 = 0.4472	N=231 R^2= 0 .4465	N=231 R^2=0.4134

[21] Enforcement variables (seizures and inspections) only run from 2005 to 2007.

IV. Determinants of Consumption

The taxed sales data suggest that sales are lower along Minnesota's border with North Dakota and higher along the portion of its border with Wisconsin outside the 11-county metro area. I next explore the 2007 MATS consumption data, toward establishing whether a similar geographic pattern exists in the cigarette consumption reported by individual Minnesotans who smoke. Recall from Tables 6 and 7 that while the decision to evade the cigarette tax exhibits a geographic pattern (greater likelihood of evasion among residents of counties bordering North Dakota and Wisconsin; lower likelihood among 7-county metro residents), the magnitude of annual cigarette consumption among evaders does not vary systematically across border, interior and metro counties. Here we look at the consumption behavior of all smokers, both those who evade and those who do not. The regression results are in Table 10.

Table 10
Determinants of Reported Consumption
MATS, 2007

Dependent variable: Annual consumption of smokers (sticks)

Independent variable	Estimated coefficient	Standard error
METRO	-297.85*	170.24
AGE	57.16**	5.07
MALE	886.52**	165.63
ND BORDER	823.74	732.98
SD BORDER	1467.10*	767.60
IA BORDER	74.51	442.05
WI BORDER	114.03	212.90
*/**statistically significant at the 10%/5% level	N=1696 R^2=0.0837	

Holding all other determinants constant, consumption increases significantly with age and is higher for male smokers. It is lower among 7-county metro residents, and higher for residents of counties bordering South Dakota, both being relative to residents of interior counties. Substituting an 11-county metro term and adding a metro-Wisconsin border interaction term, neither coefficient is statistically significant. Evidently, then, reported consumption is lower only among 7-county metro residents.

V. Comparing the Determinants of Sales and Consumption

Comparing the 2007 column of Table 8 with Table 10, note that while 2007 taxed sales were lower in counties bordering North and South Dakota (relative to the state's interior), the per capita consumption of smokers was about the same in

North Dakota border counties and higher in South Dakota border counties, relative to the interior. If consumption underreporting is spread evenly across the state (i.e., respondents from border counties underreport their consumption at about the same rate as respondents from interior counties), then it is possible that these differences in the geographic patterns of sales and consumption represent evidence of evasion. Certainly the result with respect to North Dakota counties is consistent with the findings regarding the decision to evade, presented in Table 7.

On the other hand, 2007 taxed sales were higher in (non-metro) counties bordering Wisconsin, relative to the interior, while smokers' per capita consumption was about the same as in the interior along the entire Minnesota-Wisconsin border. The former result is puzzling; its confluence with the latter is even more puzzling. Because neither seizures nor inspections were significantly associated with per capita taxed sales (see Table 9), it seems unlikely that the Minnesota Department of Revenue's enforcement activities are at work here. At least three explanations may be at work. First, perhaps cigarette retailers along the non-metro portion of the border were simply more compliant than their interior competitors. Alternatively, perhaps in spite of the substantially higher Minnesota tax, many Wisconsin residents had some other credible reason for purchasing cigarettes across the border. Finally, it may be that the data collection process in that part of the state differed in some way that could account for the anomaly.

VI. Conclusion

Three significant findings emerge from this research. First, the *reported* consumption of Minnesotans who *acknowledge* purchasing most of their cigarettes outside the state suggests a tax gap for 2007 approaching $20 million, almost 5% of cigarette tax revenue. This is likely to be biased downward, due to underreporting. Second, for 2006, the (consumption – taxed sales) estimate (from Table 3, using USDA data, adjusted for Minnesota's smoking prevalence) and the proportional changes estimate (from Table 5, also using adjusted USDA data) bracket that $20 million amount. The former estimate is a much larger $31.51 million (almost 8% of revenue). The latter estimate is a considerably smaller $8.86 million, just over 2% of tax revenue. Third, there is evidence indicating that the geographic distribution of the tax gap is related to differences in state cigarette tax rates. Minnesotans who reside in counties bordering North and South Dakota, where the 2007 tax was lower than in Minnesota, were more likely to report out-of-state purchases (MATS, 2007). And, taxed sales (MNDOR retail survey data) in counties bordering North and South Dakota were depressed relative to the state's interior, while consumption (MATS, 2007) was not.

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Appendix

Minnesota and Border State Cigarette Tax Rates, 2004-2007

cents per pack: sum of excise & sales taxes
calendar year rates (author's calculation)

	2004	**2005**	**2006**	**2007**
Minnesota	48+23=71	102.25 (75 health impact fee, in lieu wholesale 8/1/05)	148.83 (in lieu 8/1/06)	149.175 (in lieu 8/1/07)
North Dakota	44+17=61	44+17=61	44+17=61	44+18=62
South Dakota	53+14=67	53+14=67	53+14=67	153+18=171 (153 excise 1/1/07)
Iowa	36+16=52	36+17=53	36+17=53	111+23=134 (136 excise 4/1/07)
Wisconsin	77+19=96	77+19=96	77+19=96	77+21=98