The Impact of Wyoming's 2003 Cigarette Excise Tax Increase: Second Biannual Report FY 2007

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The Impact of Wyoming's 2003 Cigarette Excise Tax Increase: Second Biannual Report FY 2007

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1. Executive Summary

The Wyoming cigarette excise tax increased from $0.12 to $0.60 per pack in July 2003. This report compares the Wyoming tax increase to national and state tobacco taxation trends; discusses the relationship between taxes, prices, consumption, and tax revenue; evaluates the economic justifications for further tax increases; examines the impact of the $0.48 Wyoming tax increase on tax revenue and cigarette consumption in Wyoming through July 2007; and gives predictions for further tax increases.

The Wyoming Survey & Analysis Center's main conclusions are as follows:

- Consistent with *every* state that has implemented a significant tax increase, Wyoming experienced a significant increase in cigarette tax revenue. The $0.48 tax increase generated about $2.1 million per month in additional tax revenue, quadrupling total tax revenue.
- The $0.48 tax increase reduced total Wyoming consumption by about 0.44 packs per capita per month, or by 229,000 packs per month.
- Analyses of Wyoming regions and counties give results consistent with the statewide analysis.
- Interstate tax differentials influence cigarette sales in counties on the Wyoming border.
- The Wyoming cigarette excise tax has consistently been below the national average. The current Wyoming tax is $0.60 whereas the national state average tax is $1.073. The highest state tax is $2.575 (in New Jersey), and the highest combined state and local tax is $3.66 (in Chicago).
- Because of the relatively low excise tax, Wyoming is likely a net exporter of cigarettes to bordering states. Cigarette exports increase Wyoming cigarette tax revenue.
- We predict that an additional $0.48 tax increase would generate another $3.6 million per month in tax revenue and would reduce Wyoming consumption by another 0.33 packs per capita per month, or 172,000 packs per month.
- The substantial social costs generated by smoking provide strong economic justification for increasing Wyoming's cigarette excise tax. Social costs arise from negative health, productivity, and environmental impacts.Wyoming Department of Health expenditures on tobacco prevention and control reduce cigarette consumption, and hence, cigarette tax revenue.

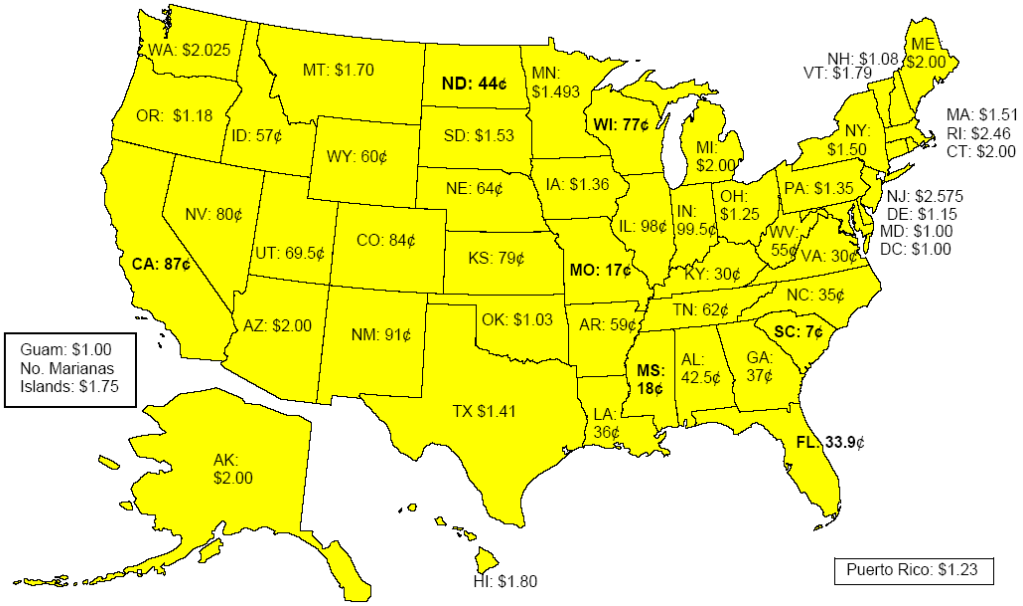
2. Trends in Tobacco Taxation

Governments tax tobacco products using both excise and general sales taxes. Excise taxes are levied on each unit of a specific good (e.g., $0.60 on each pack of cigarettes), whereas sales taxes are levied on the price of a good (e.g., 4% of each dollar spent). Federal, state, and local governments levy cigarette excise taxes, but only state and local governments levy cigarette sales taxes. The analysis in this report focuses on cigarette excise taxes with an emphasis on state taxes, particularly Wyoming's. This report does not address tax impacts for other tobacco products (e.g., spit tobacco, cigars, and cigarillos).

In a 2000 study, Chaloupka, Teh-wei, Warner, Jacobs, and Yurekli showed that the U.S. has one of the lowest total (federal plus state) cigarette excise tax rates in the world. Of the 22 high-income countries studied, only the Republic of Korea had a lower excise tax (measured in U.S. dollars), and the U.S. had the lowest excise tax rate. The federal cigarette excise tax is $0.39 per pack (Campaign for Tobacco-Free Kids, 2007c), and this rate is one of the lowest in the world (Chaloupka et al., 2000). Most cities and counties in the U.S. do not levy a cigarette excise tax, but more than 460 do (Campaign for Tobacco-Free Kids, 2007e). For example, the cigarette excise tax in Chicago includes a $2.00 Cook County tax and a $0.68 Chicago city tax in addition to the $0.98 Illinois state tax (Campaign for Tobacco-Free Kids, 2007e). No cities or counties in Wyoming levy a cigarette excise tax.

All states levy a cigarette excise tax, as Figure 1 shows (states that have not increased their cigarette tax rate since 2001 or earlier are marked in bold). State tax rates vary considerably, with a minimum of $0.07 per pack in South Carolina and a maximum of $2.575 per pack in New Jersey. The lowest tax rates tend to occur in the major tobacco-producing states, which have an average tax of $0.335 per pack (Campaign for Tobacco-Free Kids, 2007b).

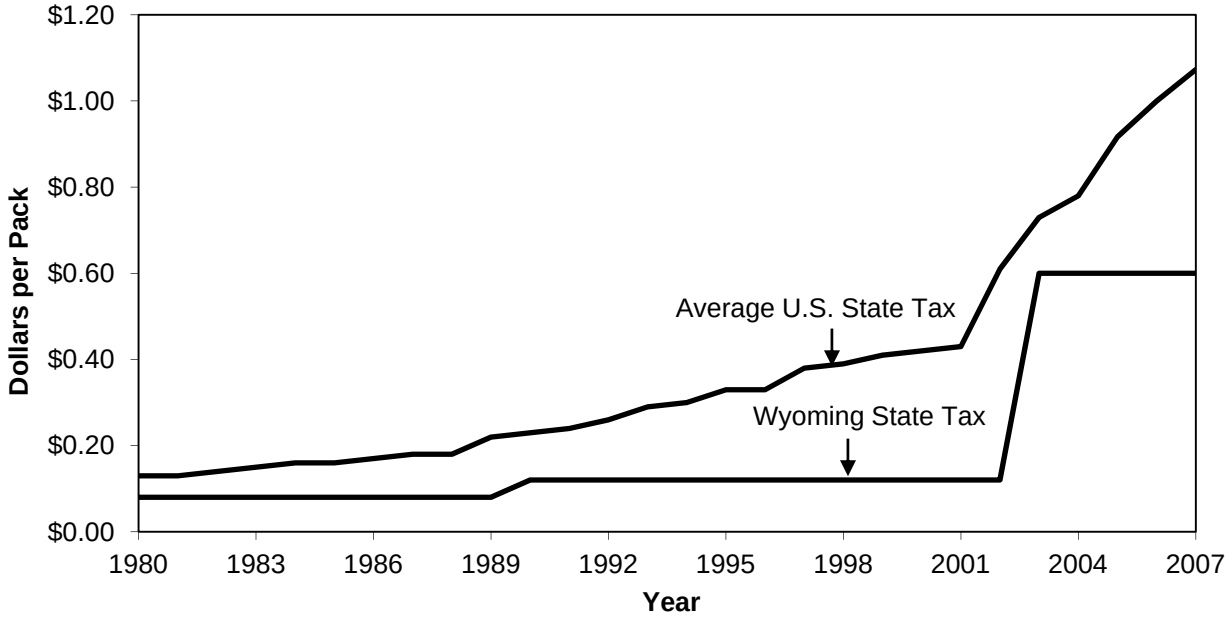
Figure 1. State Cigarette Tax Rates (in Cents per Pack), as of July 1, 2007



Source: Campaign for Tobacco-Free Kids, 2007b

Wyoming has levied its cigarette excise tax in three increments: $0.08 prior to 1989, $0.12 from 1989 to June 2003, and $0.60 from July 2003 to the present. The 2003 tax increase moved Wyoming's tax rate from fifth lowest (in June 2003) to sixteenth lowest (for the 2007 calendar year) in the nation (WYSAC, 2003; Campaign for Tobacco-Free Kids, 2007d). The Wyoming tax has always been below the U.S. state average, which has increased from $0.13 in 1980 to $1.073 in 2007 (Campaign for Tobacco-Free Kids, 2005b, 2007b). Figure 2 illustrates this difference.

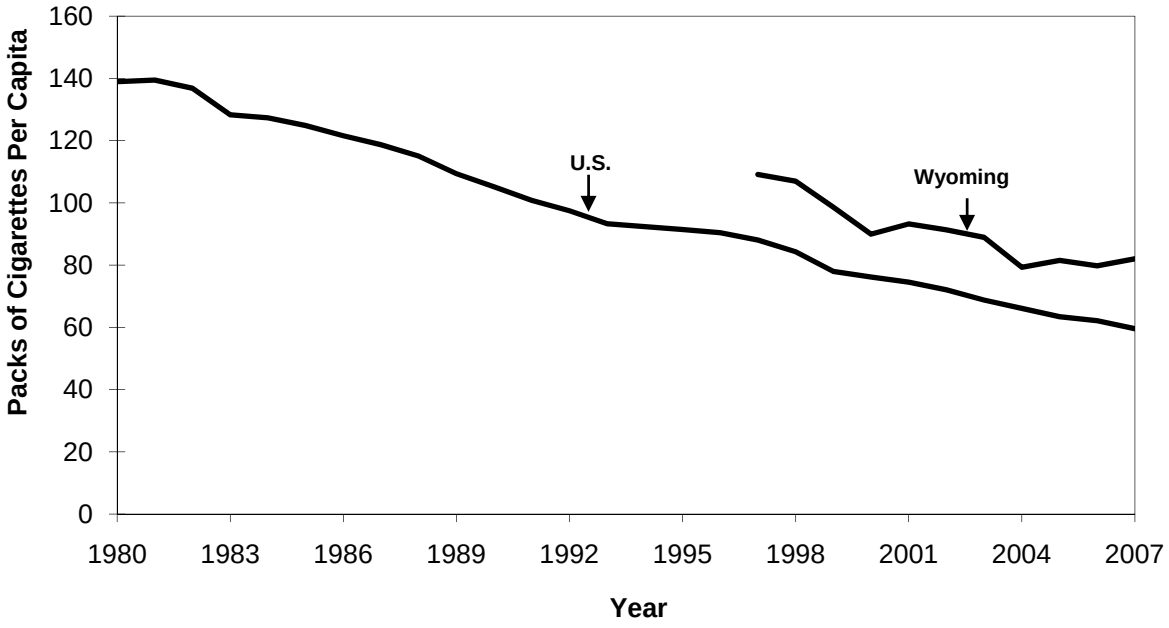
Figure 2. Average U.S. and Wyoming State Cigarette Taxes, 1980–2007



Sources: Campaign for Tobacco-Free Kids, 2005b, 2006, 2007c

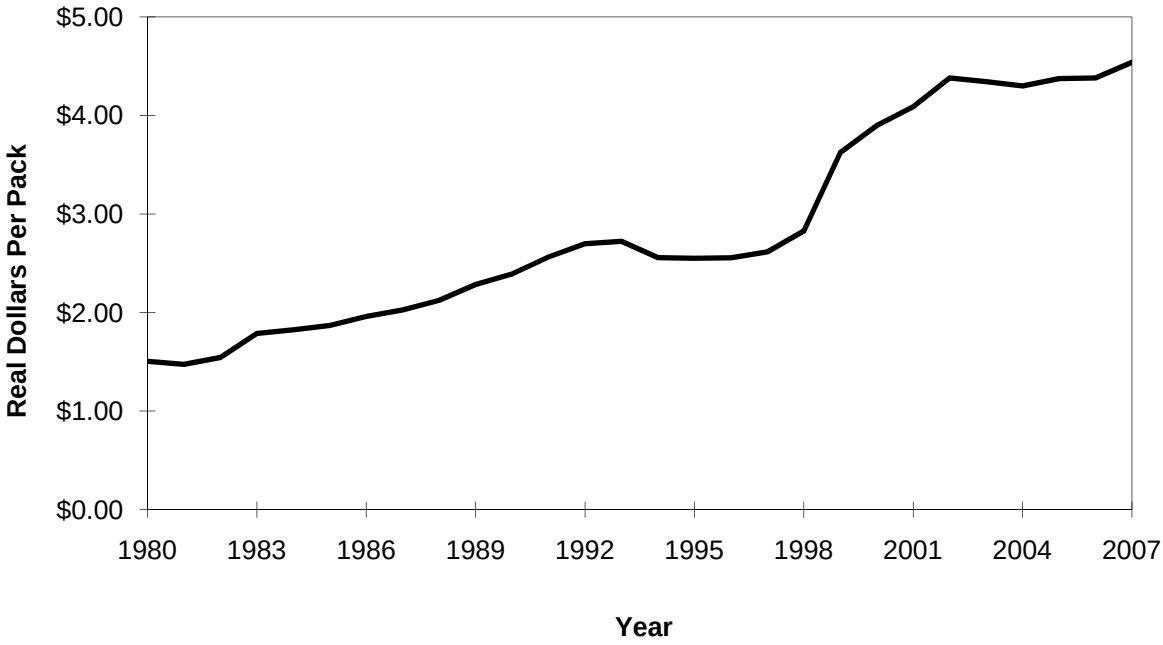
Figures 3 and 4 illustrate trends in U.S. and Wyoming per capita cigarette consumption and real (inflation-adjusted to current dollars) U.S. cigarette price from 1980 to 2007. Figures 3 and 4 paint a picture of steadily increasing prices and steadily decreasing consumption. Real U.S. cigarette price (including taxes) rose from a national average of $1.50 per pack in 1980 to a national average of $4.54 in 2007. Increasing taxes and wholesale prices account for the price increases observed since 1998. The largest single increase in wholesale price ($0.45) occurred in November 1998 when cigarette manufacturers and States' attorneys general signed the Master Settlement Agreement. Annual Wyoming per capita consumption has been about 20 packs higher than the national average in all years since 1996 (when Wyoming data first became available). National and Wyoming consumption have experienced parallel rates of decrease in recent years. The steady decline in consumption may be attributed to price increases, smokefree ordinances, and increased public awareness of the health risks associated with smoking (U.S. Department of Agriculture, 2001).

Figure 3. U.S. and Wyoming Cigarette Consumption, 1980–2007



Sources: U.S. Census Bureau, 2002, 2005, 2006, 2007; U.S. Department of Agriculture, 2007a, 2007b; Wyoming Department of Revenue. (n.d.)

Figure 4. U.S. Cigarette Price, 1980–2007



Sources: U.S. Department of Labor, n.d.a., n.d.b., n.d.c.

3. The Economics of Tobacco Taxation

Zimring and Nelson (1995) note that the three common objectives for taxation are *revenue, deterrence,* and *efficiency*. This section will discuss the relationship between these objectives and taxation.

3.1. Revenue

When an excise tax is increased, economic theory predicts the following:

- Price will rise.
- Consumption will fall.
- Tax revenue may either rise or fall.

The theoretical result of an increase in an excise tax (increased price and reduced consumption) is unambiguous. The nature of the particular product being taxed determines the magnitude of the price increase and consumption decrease. For tobacco products, the characteristics of the market are such that suppliers often pass the entire tax directly to consumers so the price increase equals the amount of the tax (Chaloupka et al., 2000). The magnitude of the consumption decrease depends on how responsive the consumption side of the market is to price changes.

Unlike price and consumption, the impact of increased excise taxes on tax revenue is ambiguous. The two components of revenue, tax and consumption, move in opposite directions: if taxes go up, consumption will go down. For tax revenue to rise, *the tax increase must be larger than the consumption decrease*. Tax revenue will rise if demand is relatively unresponsive to price changes (i.e., price increases are larger than consumption decreases), in which case demand is said to be *inelastic*. Numerous studies have demonstrated that the demand for cigarettes is inelastic. These studies concur that a 10% price increase tends to reduce overall consumption by 3% to 5% and youth consumption by 7% (see, for example, Centers for Disease Control [CDC], 1999; Campaign for Tobacco-Fee Kids, 2005a).

In addition to reducing their consumption, smokers may also respond to state tax increases by evading taxes. Two common methods of tax evasion are (1) smuggling from low-tax states to high-tax states and (2) purchasing cigarettes over the Internet. These methods of tax evasion reduce state sales and affect state tax revenue in the same way as reduced consumption. In 2000, Yurekli and Zhang found that cigarette smuggling and cross-border cigarette purchases accounted for no more than approximately 5% of national cigarette sales. Unfortunately, we do not know the impact of Internet transactions on tax revenues because Internet sales are not reported and accurate records are unavailable.

Regardless of whether smokers respond to excise tax increases by reducing consumption or by evading taxes, the empirical evidence shows that *every* state that has implemented a significant tax increase has also realized a significant increase in cigarette tax revenue (Farrelly, Nimsch, & James, 2003; Campaign for Tobacco-Free Kids, 2005a.)

3.2. Deterrence

The governmental policy of smoking deterrence is largely motivated by the significant health impacts associated with smoking. In Wyoming, $106 million was spent in 1998 on health care costs

directly related to smoking (WYSAC, 2003). The CDC (2001) notes the following human and economic costs for Wyoming in 1999:

- 807 premature deaths, including 258 cardiovascular disease-related deaths, 287 respiratory deaths, 256 cancer deaths, and six other smoking-related deaths;
- 10,454 years of potential life lost for the 807 smoking-attributable deaths; and
- A loss of future earnings of $65 million from smoking-attributable premature mortality.

Because excise taxes result in price increases and price increases reduce consumption, states can use taxation as a policy tool to achieve smoking deterrence. An increase in taxes can boost progress toward achieving some of Wyoming's and the CDC's goals: preventing initiation of tobacco use, promoting quitting, and reducing tobacco use. Taxation as a policy tool is even more effective among young people, who are more responsive to price changes than adults (see Section 3.1).

3.3. Efficiency

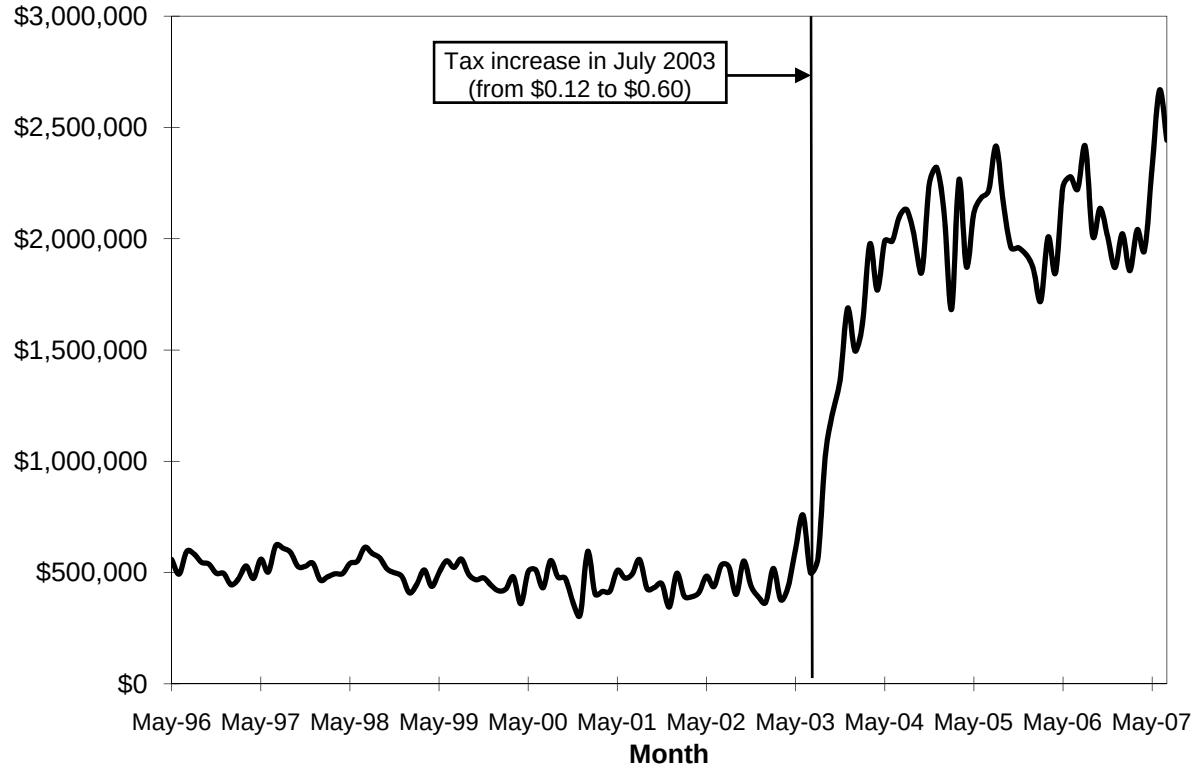
A policy of deterrence through taxation also promotes economic efficiency in the cigarette market. Economic efficiency is achieved in a market when the price of the good being exchanged equals all social costs generated by the consumption of that good (van der Merwe, 1998). The social costs arising from the health impacts and lost productivity associated with cigarette consumption are estimated to be $10.28 per pack (Campaign for Tobacco-Free Kids, 2007d). Total social costs are likely even higher because of other social impacts, such as reduced environmental quality. Because the social costs of smoking exceed current taxes (the highest total excise tax is $3.66 in Chicago), further increases in excise taxes will increase economic efficiency.

4. Wyoming Tax Revenue and Consumption

Wyoming's cigarette excise tax increased by $0.48 per pack in July 2003. This section describes the impact of the tax increase on Wyoming tax revenue and consumption. Direct measures of Wyoming cigarette consumption do not exist. However, we can infer an indirect measure from tax revenue data. Cigarette tax revenue is generated when wholesalers buy cigarette stamps. The wholesalers affix these stamps to cigarette packs (one per pack) before distributing them to retailers. The Wyoming Department of Revenue (n.d.) precisely measures tax revenue, and Figure 5 plots the revenue generated from cigarette taxes. Cigarette tax revenue averaged about $460,000 per month prior to the July 2003 increase in excise tax. After the tax increase, revenue rose steadily for about a year and then appeared to stabilize. The average monthly revenue over the last 22 months of the data (October 2005 to July 2007) was $2,080,922, so tax revenue more than quadrupled because of the increased excise tax.

Cigarette stamp sales are an indirect measure of consumption. The number of cigarette stamps sold in a given month does not exactly equal the number of cigarette packs consumed: it takes time for a pack of cigarettes to move through the marketing chain, and wholesalers, retailers, and consumers all hold inventories. However, these timing and inventory effects become negligible when one averages the data over numerous periods, as most statistical analyses do.

Figure 5. Monthly Wyoming Cigarette Excise Tax Revenue, May 1996–July 2007



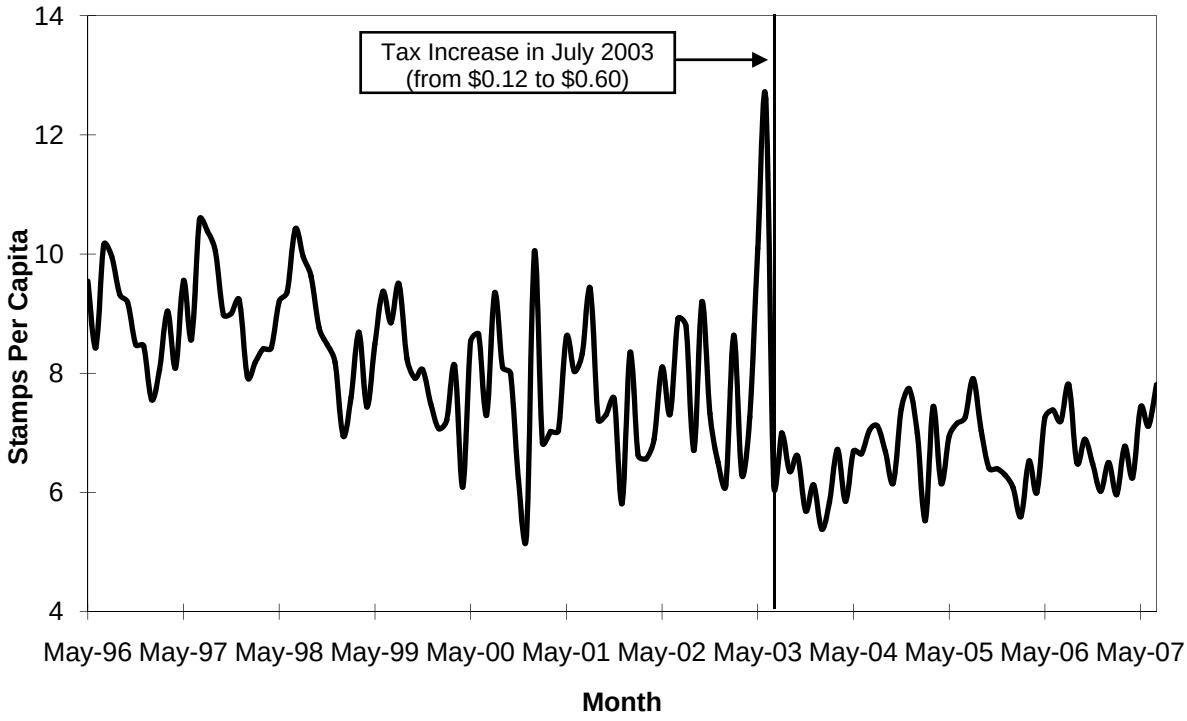
Source: Wyoming Department of Revenue, n.d.

We use tax revenue and excise tax data to compute stamp sales using the following equation:

$$\text{Stamps} = \text{Tax Revenue}/\text{Excise Tax}$$

Figure 6 plots monthly Wyoming per capita cigarette stamp sales. Sales averaged about 7.7 stamps per capita per month prior to the July 2003 tax increase and 6.7 stamps per capita per month in the last 22 months of the data (October 2005 to July 2007), a decrease of 13%. The periods immediately preceding and following the tax increase exhibit anomalous behavior. A large spike in sales appears in the two months immediately preceding the tax. This spike probably occurs because of inventory accumulations in anticipation of the pending price increase. We do not know whether these inventory accumulations occur at the wholesale, retail, or consumer level, or on multiple levels. Sales fall for several months immediately following the tax increase. This sales depression probably reflects consumption of the accumulated inventories and other tax-avoidance behavior such as quitting, cutting back on smoking, and purchasing from alternative low-price sources (e.g., the Internet). This pattern is similar to the pattern observed in other states that have enacted large tax increases: increased sales prior to the tax increase, a sharp decline in sales immediately after the tax increase, and a slow rise to a sales level lower than the pre-increase level (Farrelly, Nimsch, & James, 2003).

Figure 6. Monthly Wyoming per Capita Cigarette Stamp Sales, May 1996–July 2007



Sources: U.S. Census Bureau, 2002, 2005, 2007; Wyoming Department of Revenue, n.d.

5. Analysis of the 2003 Wyoming Excise Tax Increase

The complicated market reaction shown in Figure 6 necessitates the use of regression analysis to estimate the impact of tax increases on cigarette consumption. Simple statistical or graphical methods are unreliable because they cannot take into account this complex tax-avoidance behavior. Regression analysis helps clarify the relationship between a response variable (e.g., cigarette consumption) and multiple explanatory variables, each of which has a causal relationship with the response variable. Regression simultaneously estimates the effects of the explanatory variables on the response variable. The goal of the analysis is to estimate how responsive cigarette consumption is to changes in cigarette price (i.e., to estimate the price elasticity of cigarettes). We can then use this estimate of price elasticity to estimate the tax-related reduction in consumption and to predict the impact of future tax increases on consumption and revenue impacts. We present price elasticity estimates for Wyoming in Section 5.1 and for regions and counties within Wyoming in Section 5.2. In Section 5.3, we analyze the effect of cigarette tax rates in the bordering states of Colorado, Nebraska, Montana, South Dakota, and Utah on Wyoming cigarette consumption.

5.1 Wyoming Results

In this section, we summarize the results of the regression analysis of cigarette consumption in Wyoming. The response variable in the analysis is monthly Wyoming cigarette stamp sales per capita, a proxy for per-capita cigarette consumption. In addition to cigarette price, the regression

model accounts for the effects of inventories, population, inflation, seasonality, and the calendar. The analysis used monthly data from May 1996 to July 2007 (135 observations). Details of the regression analysis appear in Appendix A.

The estimated cigarette price elasticity is -0.41. This implies that for an arbitrary 10% increase in cigarette price, stamp sales will fall by 4.1%. This estimate of responsiveness is consistent with the estimates reported by others (discussed in Section 3.1) that range from 3% to 5%. A price elasticity of -0.41 implies that Wyoming cigarette demand is inelastic. Therefore, tax increases result in increased tax revenue, as has been the case in all other states implementing significant excise tax increases (Farrelly, Nimsch, & James, 2003; Campaign for Tobacco-Free Kids, 2005a).

Wyoming retail cigarette price data are not available, so we construct a price measure based upon wholesale costs, retailer markup, and federal and state taxes. Our constructed measure of price is $3.56 just before the July 2003 tax increase and $4.06 after, a price increase of about 14%. Using the estimated cigarette price elasticity of -0.41, the decrease in consumption that can be attributed to the 2003 tax increase is estimated to be 5.7% (= 0.41 * 14%). The estimated 5.7% decrease in consumption is substantially less than the ad hoc estimate of 13% presented in Section 4 (see page 10), and illustrates the importance of using regression analysis to account for multiple variables that simultaneously affect consumption. A 5.7% decrease in consumption equals about 0.44 stamps per capita per month (5.7% of the average pre-tax sales of 7.7 stamps per capita per month), or approximately 229,000 stamps per month (based on the current Wyoming population of about 521,210; U.S. Census Bureau, 2007).

The regression model does a good job of explaining Wyoming cigarette stamp sales, explaining 81% of the variability in the response variable (see Appendix A). Consequently, the model predictions of future stamp sales should be quite accurate. Only two of the explanatory variables are likely to change in the near future. The real cost of cigarettes will fall with any future inflation (which will encourage additional consumption) and the variable accounting for inventory depletion will continue to decrease (as the inventory build-up is exhausted). Both of these changes, plus the steadily increasing Wyoming population, would have an upward impact on predicted stamp sales. Consequently, predicted stamp sales should increase, and state tax revenues should remain above pre-tax levels.

We can also use the model results to predict the consequences of further tax increases. To facilitate the comparison of consumption and revenue impacts, we consider a tax increase equal to the July 2003 increase of $0.48. An additional $0.48 tax (for a total excise tax of $1.08) would increase the price of a pack of cigarettes by 12%, giving a predicted decrease in consumption of about 4.9% (= 0.41 * 12%) or 0.33 stamps per capita per month (4.9% of the average 6.7 stamps per capita per month currently sold). This decrease in consumption would leave Wyoming with about 6.4 stamps sold per capita per month (= 6.7 – 0.33), or about 3.3 million stamps per month (= 6.4 * 521,210). The total revenue generated by 3.3 million stamps at a tax rate of $1.08 would be $3.6 million per month.

5.2 Region and County Results

In this section, we summarize the results of regression analyses of cigarette consumption in all five Wyoming regions (defined in Table 1) and all twenty-three Wyoming counties (a Wyoming county map is given in Figure 7). The Mental Health and Substance Abuse Services Division (MHSASD) of

the Wyoming Department of Health (WDH) has historically used the regions given in Table 1 for analysis. We fit the same regression model described in Appendix A to each region and to each county with the response variable being monthly cigarette stamp sales per capita in the region or county of interest. Rather than report all regression results for all twenty-eight models, we only report the estimated cigarette price elasticities for each model (see Tables 2 and 3).

Table 1. Wyoming Regions

Region	Counties
Southeast	Converse, Goshen, Niobrara, Laramie, Platte
South-central	Albany, Carbon, Natrona
Northeast	Campbell, Crook, Johnson, Sheridan, Weston
Northwest	Big Horn, Fremont, Hot Springs, Park, Teton, Washakie
Southwest	Lincoln, Sweetwater, Sublette, Uinta

Figure 7. Wyoming County Map

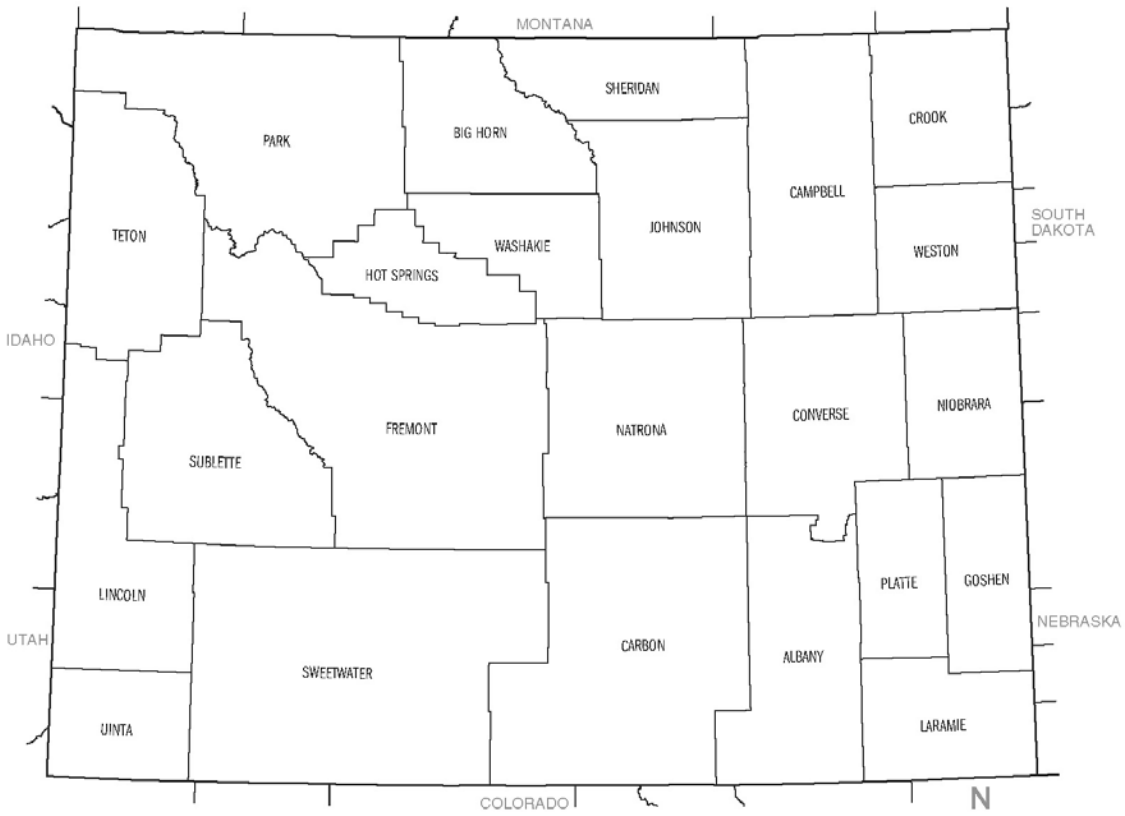


Table 2. Cigarette Price Elasticity Estimates for Wyoming Regions

Region	Price Elasticity	Standard Error	t-stat	P > |t|
Southeast Region	-0.31	0.06	-5.00	0.00
South-Central Region	-0.48	0.05	-8.78	0.00
Northeast region	-0.17	0.05	-3.72	0.00
Northwest Region	-0.50	0.07	-6.77	0.00
Southwest Region	-0.57	0.07	-8.55	0.00

Table 3. Cigarette Price Elasticity Estimates for Wyoming Counties

County	Price Elasticity	Standard Error	t-stat	P > |t|
Albany County	-0.57	0.06	-9.09	0.00
Big Horn County	-0.46	0.15	-3.07	0.00
Campbell County	-0.13	0.05	-2.54	0.01
Carbon County	-0.51	0.08	-6.63	0.00
Converse County	-0.26	0.06	-4.44	0.00
Crook County	-0.01	0.15	-0.05	0.96
Fremont County	-0.29	0.06	-4.49	0.00
Goshen County	-0.65	0.08	-8.67	0.00
Hot Springs County	0.23	0.14	1.58	0.12
Johnson County	-0.11	0.08	-1.43	0.15
Laramie County	-0.25	0.08	-3.24	0.00
Lincoln County	-0.33	0.12	-2.74	0.01
Natrona County	-0.46	0.07	-7.23	0.00
Niobrara County	-0.21	0.10	-2.27	0.03
Park County	-0.51	0.07	-7.15	0.00
Platte County	-0.26	0.07	-3.70	0.00
Sheridan County	-0.31	0.06	-4.89	0.00
Sublette County	-0.55	0.13	-4.27	0.00
Sweetwater County	-0.22	0.05	-4.08	0.00
Teton County	-1.10	0.07	-16.46	0.00
Uinta County	-1.00	0.11	-9.35	0.00
Washakie County	-0.59	0.17	-3.57	0.00
Weston County	-0.15	0.07	-1.98	0.05

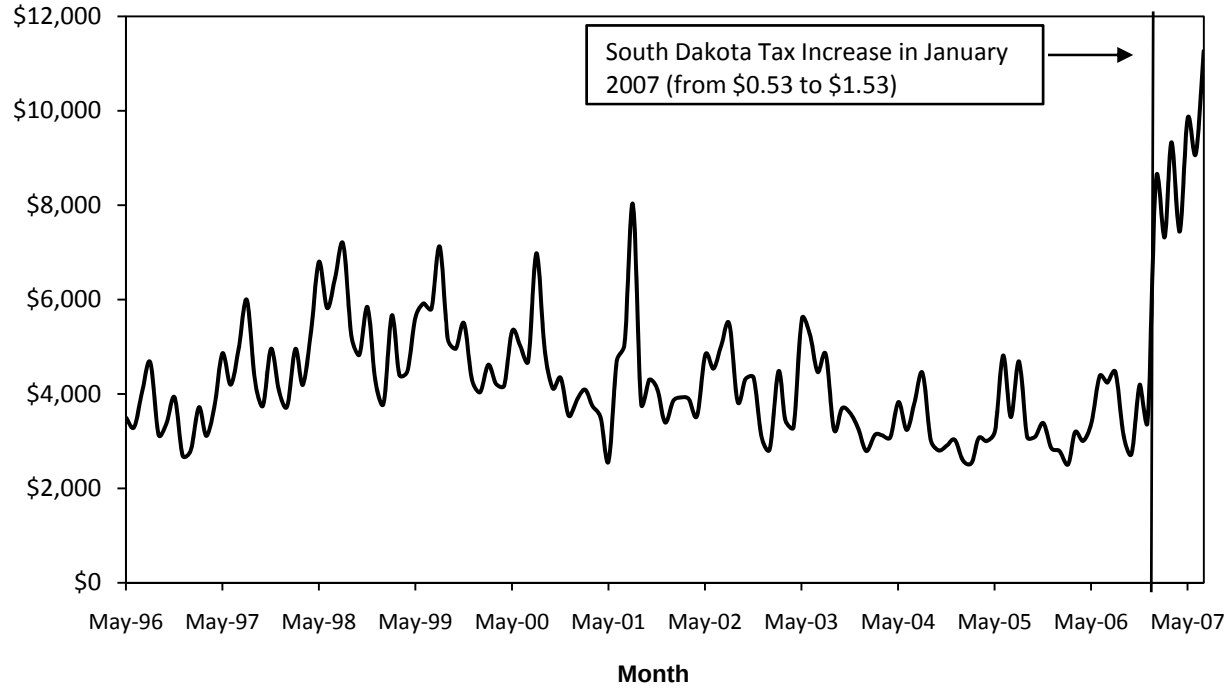
The estimated price elasticities in Tables 1 and 2 all have the expected negative sign (cigarette consumption is expected to be inversely related to cigarette price) except for Hot Springs County,

and all are significant except for Crook, Hot Springs, and Johnson Counties. The elasticity estimates are generally within the range reported by others (-0.30 to -0.50; discussed in Section 3.1).

Plots of monthly cigarette tax revenue for Crook County (for which the estimated price elasticity was not significant) and for Hot Springs County (for which the estimated price elasticity was not significant and also had the wrong sign) are given in Figures 8 and 9, respectively. The distinguishing feature in both plots is a sudden increase in sales occurring at about the time that a bordering state increased its cigarette excise tax. Crook County borders South Dakota, where the cigarette excise tax increased from $0.53 to $1.53 in January 2007, and Crook County is the Wyoming county nearest Rapid City (South Dakota's second largest city). Cigarette smuggling from Wyoming to South Dakota is a plausible explanation for the Crook County cigarette sales increase. This possibility is further explored in Section 5.3 which addresses bordering state impacts.

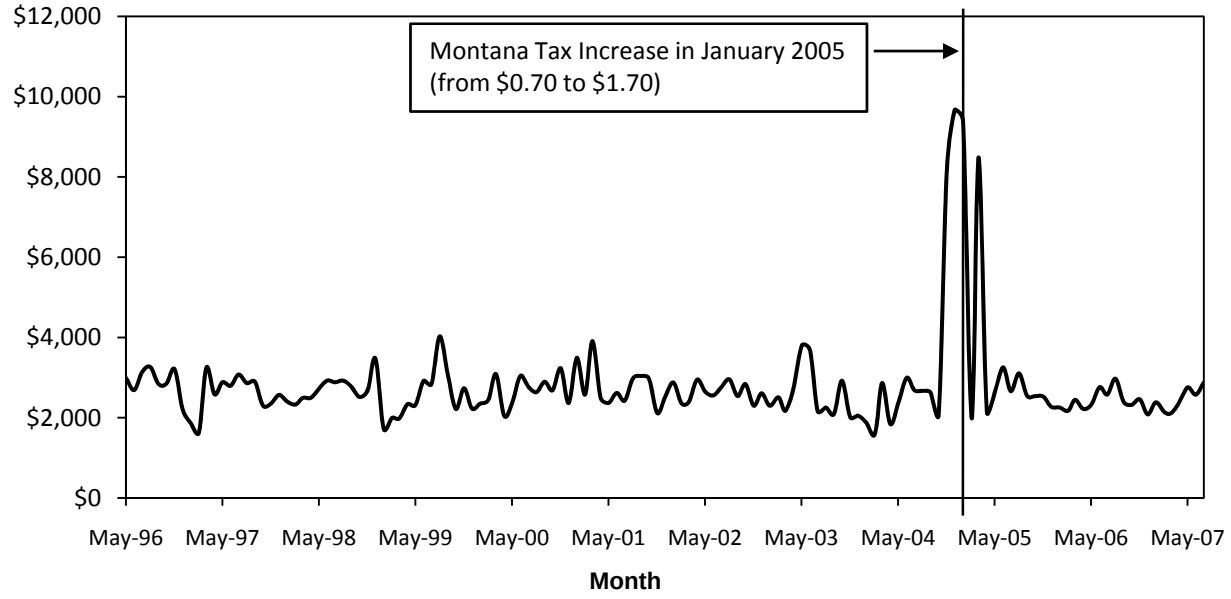
The increase in Hot Springs cigarette sales (see Figure 8) corresponds to the increase in Montana's cigarette excise tax from $0.73 to $1.73 in January 2005. However, a smuggling scenario is a less credible explanation for the Hot Springs increase. Hot Springs does not directly border Montana and the increase was only temporary, with sales returning to normal levels after a few months. Adding to the dilemma, Big Horn and Washakie Counties, which are near Hot Springs County and Montana, showed similar spikes in cigarette tax revenues, but the other counties that directly border Montana (Park, Sheridan, Campbell, and Crook) did not. Further analysis will be required to fully understand the behavior of cigarette stamp sales in Hot Springs County. The plot of cigarette tax revenue for Johnson County, the third county with non-significant price elasticity, revealed no unusual patterns.

Figure 8. Crook County Monthly Cigarette Excise Tax Revenue, May 1996-July 2007



Source: Wyoming Department of Revenue, n.d.

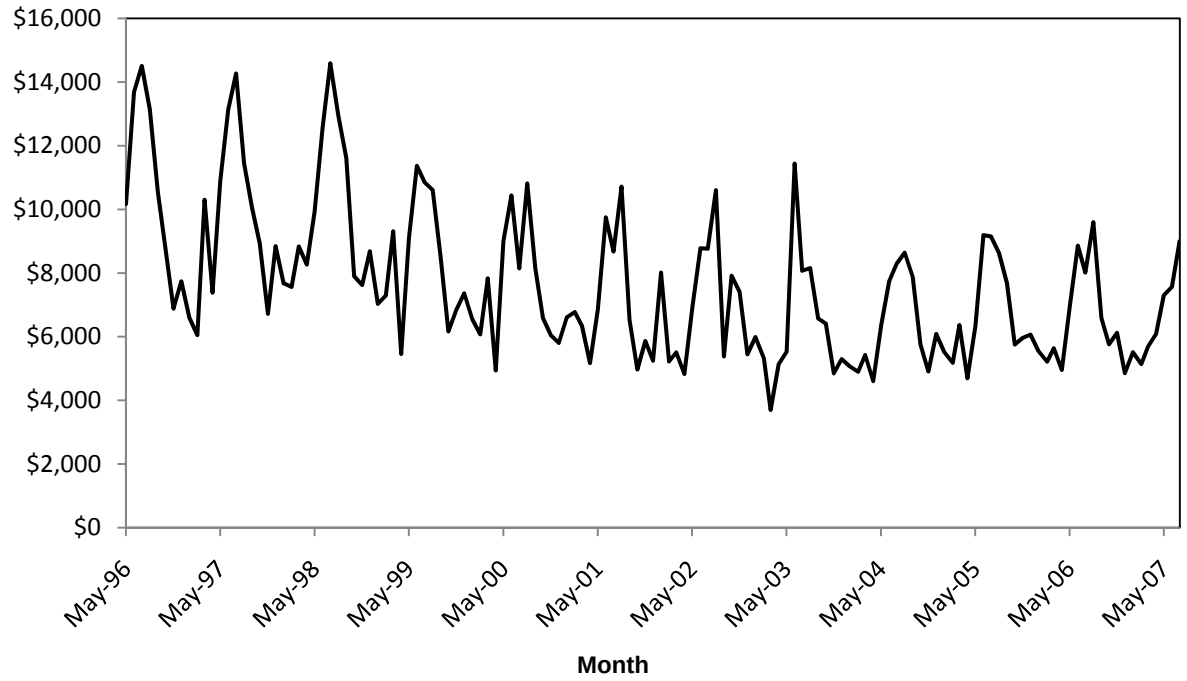
Figure 9. Hot Springs Monthly Cigarette Excise Tax Revenue, May 1996-July 2007



Source: Wyoming Department of Revenue, n.d.

Table 3 identifies two anomalous values, the estimated price elasticities of -1.10 and -1.00 for Teton and Uinta Counties, respectively, which makes those counties appear exceptionally price responsive. When fitting several regression models at once, as done here, we expect to obtain a few anomalous regression results by chance. However, anomalous regression results may also occur because of modeling error. Modeling error arises when the model fails to capture some important source of variability in the response variable (in this case, stamp sales per capita). If severe enough, modeling error can invalidate the results of a regression analysis. Consequently, we examined the data more closely to investigate the possibility of modeling error for the two counties with anomalous results. The regression analysis showed that Teton County cigarette sales were unusually responsive to price changes. Figure 10 gives a plot of cigarette tax revenues for Teton County, which is dominated by a strong seasonal pattern. We found that the seasonal pattern in Teton County cigarette sales matched the seasonal pattern in the number of visitors to Grand Teton National Park, which is adjacent to Teton County. The unusually high price elasticity in Teton County may be partly due to the number of out-of-town visitors that purchase cigarettes in the county. The plot of cigarette tax revenue for Uinta County, the second county with highly responsive cigarette sales, revealed no unusual patterns. Consequently, there is no reason to question the validity of the Uinta county estimate.

Figure 10. Teton County Monthly Cigarette Excise Tax Revenue, May 1996-July 2007



Source: Wyoming Department of Revenue, n.d.

5.3 Bordering State Tax Impacts

As shown in Figure 1, cigarette taxes vary considerably among the states. These tax differentials create an incentive for individuals and smugglers in high-tax states to travel to low-tax states to purchase cigarettes at a lower cost. Table 5 gives state cigarette taxes for Wyoming and its six border states from May 1996 to July 2007 with tax increases for each state shaded. Wyoming cigarette taxes have generally been lower than taxes in bordering states, creating an incentive for residents of bordering states to purchase cigarettes in Wyoming. However, during three periods (given in Table 4) Wyoming residents had a tax incentive to purchase cigarettes in bordering states. At the present time, only Idaho has lower cigarette taxes than Wyoming and the Idaho tax incentive is small ($0.03). Consequently, Wyoming is probably a net exporter of cigarettes, and tax differentials with bordering states result in a net gain to Wyoming tax revenues.

Table 4. Wyoming Tax Savings from Purchases in Bordering States

Period	From	Tax Savings
Jul 2003 – Dec 2004	Colorado	$0.40
Jul 2003 - Dec 2006	South Dakota	$0.07
Jul 2003 – Present	Idaho	$0.03

Table 5. Wyoming and Bordering State Cigarette Taxes

Date	Utah	Nebraska	South Dakota	Montana	Idaho	Wyoming	Colorado
May-96	$0.27	$0.34	$0.33	$0.18	$0.28	$0.12	$0.20
Jul-97	$0.52	$0.34	$0.33	$0.18	$0.28	$0.12	$0.20
May-02	$0.70	$0.34	$0.33	$0.18	$0.28	$0.12	$0.20
Oct-02	$0.70	$0.64	$0.33	$0.18	$0.28	$0.12	$0.20
Apr-03	$0.70	$0.64	$0.53	$0.18	$0.28	$0.12	$0.20
May-03	$0.70	$0.64	$0.53	$0.70	$0.28	$0.12	$0.20
Jun-03	$0.70	$0.64	$0.53	$0.70	$0.57	$0.12	$0.20
Jul-03	$0.70	$0.64	$0.53	$0.70	$0.57	$0.60	$0.20
Jan-05	$0.70	$0.64	$0.53	$1.70	$0.57	$0.60	$0.84
Dec-06	$0.70	$0.64	$0.53	$1.70	$0.57	$0.60	$0.84
Jan-07	$0.70	$0.64	$1.53	$1.70	$0.57	$0.60	$0.84

Source: Campaign for Tobacco-Free Kids, 2005b, 2007a. Shading indicates a tax increase.

We use regression analysis to investigate the effect of between-state tax differentials on cigarette purchases in five Wyoming counties that lie on the Wyoming border: Crook, Goshen, Laramie, Sheridan, and Uinta. The states bordering these counties are South Dakota, Nebraska, Colorado, Montana, and Utah, respectively. We examine these Wyoming counties because they are most likely to experience interstate cigarette commerce. Their location makes travel costs to and from neighboring states relatively low and increases the likelihood of interstate cigarette sales. In addition, these counties contain the towns of Sundance, Torrington, Cheyenne, Sheridan, and Evanston, respectively. Counties that contain retail centers also have an increased likelihood of interstate cigarette sales.

We fit the regression model described in Appendix A to each of the five selected counties with one modification. We include the logarithm of the inflation-adjusted cigarette price in the nearest bordering state (constructed in the same manner as Wyoming cigarette price, described in Section 5.1) as an additional explanatory variable. We expect the coefficient on the bordering state cigarette price to be positive: when bordering state cigarette prices rise, Wyoming sales will increase; conversely, when bordering state cigarette prices fall, Wyoming sales will decrease.

Rather than report all regression results for all five models, we only report the estimated cigarette price elasticities for each county (see Table 6).

Table 6. Wyoming and Bordering State Price Elasticity Estimates

County	Variable	Estimate	Standard Error	t	P>|t|
Crook					
	Wyoming Price Elasticity	-3.76	0.29	-12.79	0.00
	South Dakota Price Elasticity	4.34	0.32	13.45	0.00
Goshen					
	Wyoming Price Elasticity	-2.34	0.45	-5.19	0.00
	Nebraska Price Elasticity	1.93	0.51	3.79	0.00
Laramie					
	Wyoming Price Elasticity	0.15	0.28	0.54	0.59
	Colorado Price Elasticity	-0.43	0.29	-1.50	0.14
Sheridan					
	Wyoming Price Elasticity	-0.58	0.14	-4.08	0.00
	Montana Price Elasticity	0.25	0.12	2.09	0.04
Uinta					
	Wyoming Price Elasticity	-3.96	0.37	-10.79	0.00
	Utah Price Elasticity	3.14	0.38	8.29	0.00

The bordering state price coefficient is positive and significant for Crook, Goshen, Sheridan, and Uinta counties. These findings suggest that there is an interstate tax impact on cigarette purchases in these border counties. However, while the price elasticities generally have the correct sign and are statistically significant, the magnitude of the coefficients seems unreasonably large. For Crook, Goshen, and Uinta counties, the Wyoming price elasticities are -3.8, -2.3, and -4.0, respectively, and the bordering state price elasticities are 4.3, 1.9, and 3.1, respectively. These are implausibly large values and are likely due to the high degree of correlation between the Wyoming and bordering state price measures. The high correlation in the price measures creates a technical difficulty for the regression analysis, resulting in imprecise estimates. The Colorado price coefficient is not significant for Laramie County, implying no detectible interstate tax impacts on Laramie County cigarette purchases.

6. Impact of State Tobacco Control Expenditures

We also use regression analysis to examine the effect of WDH tobacco prevention and control expenditures on Wyoming cigarette consumption. The explanatory variable of primary interest in this section (tobacco prevention and control expenditures) differs in fundamental ways from the explanatory variable of primary interest in Section 5 (cigarette price). For example, tobacco prevention and control expenditures vary greatly across counties and are constant over the fiscal year while cigarettes prices are fairly constant across counties and can vary from month to month. Consequently, the regression model used to analyze the effect of tobacco prevention and control

expenditures in this section is quite different from the regression model used to analyze the effect of cigarette excise taxes in Section 5.

The response variable is the logarithm of annual (matching Wyoming's fiscal year, July 1 – June 30) county per capita cigarette stamp sales. We measure cigarette sales for eleven years (beginning in 1997 and ending in 2007, the first and last years complete data are available) for each of the 23 Wyoming counties, giving 253 observations for analysis.

Numerous factors other than WDH tobacco prevention and control expenditures can affect cigarette sales. These factors include cigarette prices, tobacco control activities at the state and national level, and the unique socio-economic characteristics of each county (e.g., urban versus rural). The regression model must account for these factors to obtain an unbiased estimate of the impact of WDH expenditures. We used dummy variables to account for these factors. We included one dummy variable for each of the eleven years. The yearly dummy variables account for factors that affect cigarette sales in all counties in the same way in a given year. These factors included prices and tobacco control activities at the state and national levels. We also included one dummy variable for each of the 23 counties. The county dummy variables account for factors that affect cigarette sales in all years in the same way for a given county. These factors include the unique socio-economic characteristics of each county.

The goal of the analysis is to relate cigarette consumption to WDH tobacco prevention and control expenditures. WDH expenditures are allocated at both the state and county levels. Because state-level expenditures are constant for all counties in each fiscal year, they are mathematically redundant with the yearly dummy variables described in the preceding paragraph, and they contribute no additional information to the analysis. Consequently, the analysis only includes county-level WDH expenditures, which are administered through the Tobacco-Free Wyoming Communities (TFWC) program (see Evaluation of the Tobacco-Free Wyoming Communities Program: 2002-2006, (WYSAC, 2007) for a thorough discussion of the TFWC program). Total TFWC expenditures for fiscal years 2002 (the first year of community program funding) through 2007 are given in Table 8 in Appendix B. Annual state expenditures for the TFWC program averaged $1,229,000 with an average annual increase of $377,000, and county TFWC allocations ranged from $0 to $185,000 with an average allocation of $65,000. The regression model includes the logarithm of annual TFWC county expenditures to measure the impact of the TFWC program.

The results of the regression analysis are given in Table 9 in Appendix B. The R-squared of 0.84 indicates a good fit to the data (the model explains 84% of the variability in per capita cigarette sales). The primary variable of interest, TFWC expenditures, has the expected negative sign (TFWC expenditures reduce cigarette sales) and is significant at the 0.05 level. The direct interpretation of the TFWC coefficient (-0.0077) is that a 1% increase in TFWC expenditures will reduce annual per capita cigarette sales by 0.0077%. Because cigarette tax revenue is directly proportional to cigarette sales, the results also imply that a 1% increase in TFWC expenditures will reduce tax revenue by 0.0077%. The implication is that increasing annual TFWC expenditures by $100,000 (from the current $1,460,000) will reduce annual per capita cigarette consumption by about 0.04 packs and will reduce annual tax revenues by about $13,000.

7. Conclusions

In July 2003, the Wyoming cigarette excise tax increased from $0.12 to $0.60 per pack. We estimate the reduction in consumption due to the tax at 0.44 packs per capita per month, for a total decrease

of 221,000 packs per month in 2003 and of 229,000 packs per month in 2007. (The change between 2003 and 2007 is due to the increase in Wyoming population.) Tax revenues have more than quadrupled from pre-tax levels (an increase of about $2.1 million per month), even with the reduced per capita consumption due to the tax. Based on the analysis presented in this report and on state and national trends reported in the literature, state tax revenues should remain above pre-tax levels despite declines in per capita consumption. Regional and county analyses gave results consistent with the statewide analysis. Because Wyoming has a lower cigarette excise tax rate than bordering states (with the exception of Idaho), Wyoming is probably a net exporter of cigarettes and tax differentials with bordering states increases Wyoming cigarette tax revenue. We found evidence that tax differentials do influence cigarette sales in four of five border counties examined. We also found that Wyoming Department of Health tobacco prevention and control expenditures reduce cigarette consumption, and hence, cigarette tax revenue.

This study produced several results that warrant further examination. For some counties, the consumption response to changes in cigarette prices was extremely low; for other counties, the response was extremely high. While we found evidence of interstate tax effects, the magnitude of the effects were sometimes implausibly large. It is important that we understanding the reasons for these anomalies in order to correctly predict the impact of further changes in the cigarette excise tax. In addition, we found some evidence of interstate tax effects on counties far from the Wyoming border. Consequently, the interstate tax analysis should be expanded to include all Wyoming counties.

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Appendix A. Regression Analysis

This section presents the details of our regression analysis of the impact of the 2003 Wyoming cigarette excise tax increase on cigarette consumption and tax revenues.

The optimal response variable would be Wyoming cigarette consumption per capita. But as discussed in Section 4, cigarette consumption is not measured, and the best available proxy measure is the number of cigarette stamps purchased by cigarette wholesalers. When we measure cigarette stamps purchased on a per capita basis, we eliminate variations in stamp sales that occur because of changes in population and more accurately estimate a typical smoker's response to cigarette price changes. The response variable is determined as follows:

Stamps per Capita = Stamps/Wyoming Population

We would like to use real (inflation adjusted to current dollars) Wyoming retail cigarette price as an explanatory variable, but this measure is not available. The best available proxy is a price measure constructed with the following formula:

Price = (Wholesale Price + Federal Excise Tax + State Excise Tax + Distributor and Retailer Markup) * State Sales Tax Factor/Consumer Price Index

The U.S. Department of Agriculture provides wholesale price data (2006, 2007). The Campaign for Tobacco-Free Kids (2007c) estimates Wyoming's Distributor and Retailer Markup at $0.55. The Wyoming state sales tax is 4%, so the State Sales Tax Factor is 1.04. The CPI (Consumer Price Index) is given by the U.S. Department of Labor (n.d.a).

We included the following additional explanatory variables in the model to account for seasonal, calendar, and inventory effects in the response variable (i.e., Stamps per Capita).

Seasonal effects are accounted for by the explanatory variables:

- Jan = 1 in January, 0 otherwise
- Feb = 1 in February, 0 otherwise
- Mar = 1 in March, 0 otherwise
- Apr = 1 in April, 0 otherwise
- May = 1 in May, 0 otherwise
- Jun = 1 in June, 0 otherwise
- Jul = 1 in July, 0 otherwise
- Aug = 1 in August, 0 otherwise
- Sep = 1 in September, 0 otherwise
- Oct = 1 in October, 0 otherwise
- Nov = 1 in November, 0 otherwise

We do not include a December variable for a technical reason that arises in all regression models with seasonal variables of this type: all twelve monthly variables and the model intercept are mathematically redundant and give a regression problem that does not have a unique solution.

Calendar effects are accounted for by the explanatory variable Work days:

Workdays = the number of work days (Monday through Friday) in the month

This variable accounts for variation that arises because of the calendar's arrangement. When economic data are measured precisely on a monthly basis, and the level of economic activity varies over the work week, then the data will contain a component of variability due to the arrangement of the calendar (McNulty & Huffman, 1989). For example, suppose that economic activity is positive on workdays (Monday through Friday) and is zero on Saturday and Sunday. Calendar variation arises because the number of workdays in a month can range from 20 to 23. Months that have 23 workdays tend to have larger economic measures than months with 20 workdays. Because wholesalers only purchase cigarette stamps on workdays, we expect the response variable to contain calendar variation and to have a positive coefficient.

The explanatory variables Inventory Accumulation and Inventory Depletion account for the inventory effects defined below:

Inventory Accumulation = 1 in May and June of 2003, 0 otherwise

This variable accounts for the buildup of inventories just before the July 2003 tax increase. We expect this variable to have a positive coefficient.

Inventory Depletion = 1/(1 + log[Time Since Tax]),

where Time Since Tax = 1 on July 2003 plus 1 for every month thereafter, 0 otherwise. This variable accounts for the depletion of inventories accumulated just before the July 2003 tax increase. This functional form allows for a diminishing effect as time progresses, and approaches 0 as time progresses. We selected it from a number of specifications with the same property of time-diminishing effects. We expect this variable to have a negative coefficient.

We fit the model using data from May 1996 to July 2007 (n = 135). The model was fit in logarithmic form so that the estimated coefficient of Price is a direct estimate of consumer responsiveness. The logarithmic form also gives a slightly better fit than the level (i.e., without a logarithmic transformation applied to the variables) form. Table 7 reports the results of the regression analysis. The R-squared of 0.81 indicates a good fit to the data (the model explains 81% of the variability in Stamps Per Capita). The variables Price, Workdays, Inventory Accumulation, and Inventory Depletion all have the expected signs and are significant at the 0.01 level. Most of the seasonal month variables (i.e., January through November) are significant at the 0.05 level, and the coefficients show heightened stamp sales during the summer months.

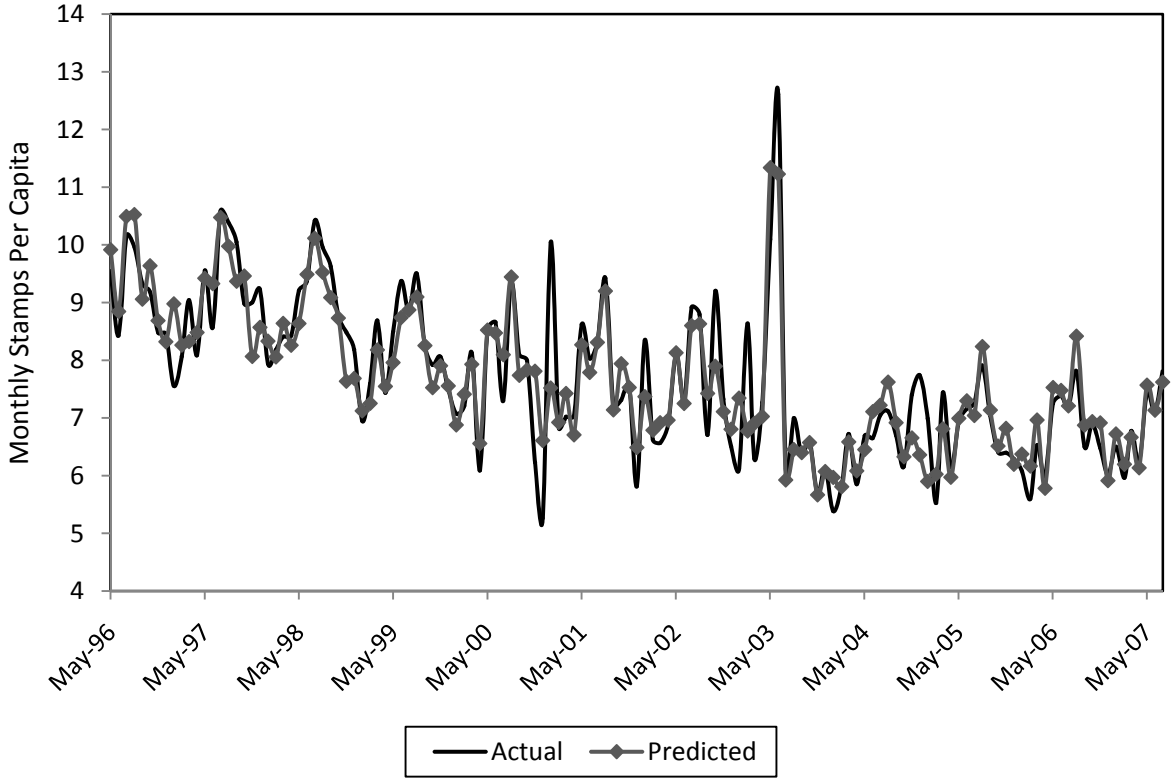
Figure 11 contains a plot of actual and predicted Stamps Per Capita. The plot shows a good correspondence between predicted and actual values, especially around the time of the July 2003 tax increase. Thus, the variables Inventory Accumulation and Inventory Depletion appear to help account for tax-induced inventory adjustments.

Table 7. Regression Analysis of Wyoming Cigarette Stamp Sales

The dependent variable is log(Stamps Per Capita),
May 1996–July 2007 (n = 135).

Variable	Coefficient	Std. Error	t-stat	P > |t|
log(Price)	-0.41	0.04	-9.54	0.00
January	0.02	0.03	0.74	0.46
February	0.10	0.04	2.53	0.01
March	0.06	0.03	1.78	0.08
April	0.03	0.03	0.75	0.46
May	0.13	0.03	3.95	0.00
June	0.17	0.03	5.09	0.00
July	0.19	0.03	5.65	0.00
August	0.24	0.03	7.12	0.00
September	0.14	0.03	4.08	0.00
October	0.10	0.03	2.93	0.00
November	0.09	0.03	2.78	0.01
log(Work Days)	1.12	0.19	5.83	0.00
Inventory Accumulation	0.37	0.06	6.38	0.00
Inventory Depletion	-0.33	0.06	-5.89	0.00
Intercept	-3.17	0.62	-5.12	0.00
R-squared	0.81			
Adj. R-squared	0.79			
Durbin-Watson	2.22			

Figure 11. Actual and Predicted Monthly Wyoming per Capita Cigarette Stamp Sales, May 1996–July 2007



Appendix B. TFWC Regression Analysis

Table 8. WDH Tobacco Prevention and Control Expenditures

County	FY 02	FY03	FY 04	FY 05	FY 06	FY 07
Albany	$35,757	$70,000	$107,004	$90,008	$96,288	$65,000
Big Horn		$50,000	$51,218	$50,982	$68,639	$50,000
Campbell	$35,599	$70,000	$73,340	$76,923	$97,650	$65,000
Carbon		$55,000	$56,756	$56,277	$71,090	$65,000
Converse	$24,776	$50,000	$51,139	$51,578	$86,789	$65,000
Crook			$40,880	$40,870	$60,838	$50,000
Fremont	$36,652	$70,000	$72,049	$72,049	$109,000	$65,000
Goshen		$50,000	$50,950	$50,925		
Hot Springs			$40,000		$60,663	$50,000
Johnson	$22,472	$67,000	$58,507	$57,781	$76,295	$65,000
Laramie				$91,747	$185,718	$110,000
Lincoln		$55,000	$56,397	$55,777	$62,210	$65,000
Natrona	$53,017	$135,000	$108,307	$125,751	$172,963	$110,000
Niobrara						$50,000
Park	$31,643	$65,538	$65,794	$66,316	$82,945	$65,000
Platte	$23,154	$50,000	$51,637	$50,983	$69,198	$65,000
Sheridan	$32,030	$70,000	$71,848	$75,490	$90,814	$65,000
Sublette						
Sweetwater		$70,000	$72,382	$71,938	$97,050	$65,000
Teton	$27,621	$60,000	$62,479	$62,502	$75,550	$65,000
Uinta	$29,839	$60,000	$66,744	$66,387	$86,395	$65,000
Washakie	$21,500	$50,000	$51,391	$50,651	$86,721	$65,000
Weston		$45,110	$31,184	$45,684	$70,374	$65,000
Wind River		$55,000	$59,000	$82,000	$74,688	$65,000
Wyoming	$374,060	$1,197,648	$1,299,006	$1,392,619	$1,881,878	$1,460,000

Source: Wyoming Department of Health (n.d.)

Table 9. Regression Analysis of WDH Tobacco Prevention and Control Expenditures

The dependent variable is log (Stamps Per Capita), 1997-2007 (n = 253)				
Variable[1]	**Coef.**	**Std. Err.**	**t**	**P>|t|**
log(TFWC $)	-0.00767	0.003	-2.31	0.022
1998	0.027768	0.039	0.72	0.474
1999	-0.02447	0.039	-0.63	0.528
2000	-0.09896	0.039	-2.55	0.011
2001	-0.13892	0.039	-3.59	0.000
2002	-0.13053	0.043	-3.06	0.002
2003	-0.02254	0.048	-0.47	0.641
2004	-0.24421	0.050	-4.88	0.000
2005	-0.09202	0.050	-1.83	0.068
2006	-0.17876	0.051	-3.52	0.001
2007	-0.16398	0.051	-3.20	0.002
Big Horn	0.006188	0.056	0.11	0.912
Campbell	0.593669	0.056	10.60	0.000
Carbon	0.733611	0.056	13.07	0.000
Converse	0.287512	0.056	5.13	0.000
Crook	0.531282	0.056	9.41	0.000
Fremont	0.014342	0.056	0.26	0.798
Goshen	0.524234	0.057	9.20	0.000
Hot Springs	0.31474	0.057	5.52	0.000
Johnson	0.270184	0.056	4.82	0.000
Laramie	0.426462	0.057	7.50	0.000
Lincoln	0.029345	0.056	0.52	0.602
Natrona	0.577994	0.056	10.32	0.000
Niobrara	0.296946	0.059	5.07	0.000
Park	0.261177	0.056	4.66	0.000
Platte	0.255959	0.056	4.57	0.000
Sheridan	0.418429	0.056	7.47	0.000
Sublette	0.055011	0.060	0.92	0.357
Sweetwater	0.643242	0.056	11.46	0.000
Teton	-0.00773	0.056	-0.14	0.890
Uinta	1.042055	0.056	18.60	0.000
Washakie	0.340584	0.056	6.08	0.000
Weston	0.397764	0.056	7.08	0.000
Intercept	4.214253	0.048	88.48	0.000
R-Square	0.84			

[1] One yearly dummy variable and one county dummy variable have been dropped for a technical reason; a complete set of dummy variables and the intercept are mathematically redundant. The model was also fit with a correction for first-order serial correlation of the error with little change in the results.