# Evaluating Cigarette Demand Models

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**Abstract**

In the past 15 years there has been a substantial increase in the taxation of cigarettes in the United States. The federal government and most state governments have increased taxes on cigarettes in an effort to reduce smoking. In the period 1990-2003, the national average price of cigarettes increased by 85%. This paper will use data from 1990-2003 to examine the effect that these large price increases have had on cigarette consumption. For the standard non-addiction cigarette demand model I obtained an elasticity of roughly -.5 and for the rational addiction cigarette model I obtained a long-run price elasticity of roughly -.6.

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## 1. Introduction

In the past 15 years there has been a substantial increase in the taxation of cigarettes in the United States. The federal government and most state governments have increased taxes on cigarettes in an effort to reduce smoking. The rise in taxes coupled with the cost imposed on cigarette manufacturers by the Master Settlement Agreement of 1998, an agreement between large tobacco manufacturers and 46 of the 50 states that required payments by the tobacco companies to the states, has led to a substantial rise in prices for cigarettes across the country. In the period 1990-2003, the national average price of cigarettes increased by 85%. However, the price change was not the same in all states. For example, the price increased 138% in New York between 1990 and 2003, but increased only 45% in Nevada for the same period.

This paper will use data from 1990-2003 to examine the effect that these large price increases have had on cigarette consumption. The large increase in overall prices together with the differential increases across states provides a natural test of economic models of cigarette consumption which predict that these price increases should lead to substantial declines in consumption. While many people might expect consumption of an addictive good like cigarettes to respond only weakly to price changes most cigarette demand models from the economic literature suggest substantial price responses with a typical finding predicting a 4% reduction in consumption in response to a 10% increase in price.[1]

In this paper I examine two types of demand models. One will be a simple model that abstracts from the addictive nature of cigarette consumption and estimates a "standard" demand model where cigarette consumption depends negatively on price. The second model is the Becker, Grossman and Murphy model of rational addiction (Becker, Grossman and Murphy 1994) which explicitly builds addiction into the demand framework.

In general, I find that both models do a reasonably good job of explaining recent consumption behavior. Cigarette consumption over the sample period has declined by roughly the amount predicted by these models and versions of these models estimated over the 1990-2003 period yield parameter estimates similar to those found in the previous literature – with the rational addiction model doing a somewhat better job of explaining the overall decline in cigarette consumption across states. I interpret these results as broadly supportive of economic models of cigarette consumption.

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[1] For a survey of these findings see Chaloupka 2000 or Huang et al., 2002.

The paper is organized as follows. Section 2 describes the recent history of price, tax, and consumption changes. Section 3 reviews the basic demand theory that underlies my analysis and section 4 reviews the previous literature. Section 5 describes the data used for the analysis and section 6 uses the data to evaluate previous models. Section 7 discusses identification of the models based on the available data. Section 8 describes the estimation results while section 9 compares the results for the rational addiction and basic demand models.

**2. Recent History**

The past fifteen years have seen a large increase in the taxation of cigarettes. There have been increases in both state and federal taxes on cigarettes. The Master Settlement Agreement of 1998 also acted as an effective increase in cigarette taxes. Under the Master Settlement Agreement, large tobacco companies have to make payments to states in exchange for exemption from tort liability claims. Because the companies have to pay proportionately to the number of packs sold, the MSA payments amount to a tax on cigarettes.

Over the 1990-2003 period, the average state tax on cigarettes increased 109% from 22.3 cents per pack to 46.5 cents per pack measured in constant 1990 dollars.[2] Federal taxes, excluding the MSA payments, have increased 71%, from 16 cents per pack in 1990 to 27.38 cents per pack in 2003, again in 1990 dollars.[3] Including the MSA payments, nationwide taxes increased 224% from 16 cents in 1990 to 52 cents in 2003 (measured in constant 1990 dollars). Overall taxes on cigarettes, including state taxes, federal taxes and the costs imposed by the MSA have increased 157% from 38.3 cents per pack in 1990 to 98.5 cents per pack in 2003.[4]

The rise in taxes led to a large increase in cigarette prices. Nationwide, average cigarette prices increased 85% between 1990 and 2003. Interestingly, cigarette prices have increased substantially more than taxes. Between 1990 and 2003 taxes increased by roughly 60 cents per pack while cigarette prices increased by $1.24 (both measured in 1990 dollars).

Table 1 summarizes the relationship between taxes and prices based on a regression of cigarette prices per pack on the federal tax per pack, state taxes per pack and a dummy variable for the MSA. The

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[2] Arithmetic average.
[3] Arithmetic average.
[4] Arithmetic average.

tax and cigarette price data are from Orzechowski and Walker's 2004 Tax Burden on Tobacco, which provides estimates of cigarette taxes, consumption and prices by state through 2003. This data allows me to analyze how much of the increased tax on cigarettes in passed on to the consumer in the form of higher prices. The data used for the regression has observation on taxes and prices for 50 states and the District of Columbia for 1990-2003. The results of the regression shown in Table 1 imply that cigarette companies passed through the state taxes at almost exactly a 1:1 ratio. However, the model estimates imply that these companies passed through federal taxes at a 1.13:1 ratio, meaning that for every one penny increase in federal tax, cigarette companies increased the price 1.13 pennies, though this estimate is not significantly different from 1.0. Most importantly the estimates imply that the introduction of the MSA was associated with a 69 cent increase in prices roughly double the 35 cent per pack cost imposed by the MSA. This corresponds to a pass through significantly greater than one for one.

**Table 1**

**Tax Pass Through Regression**

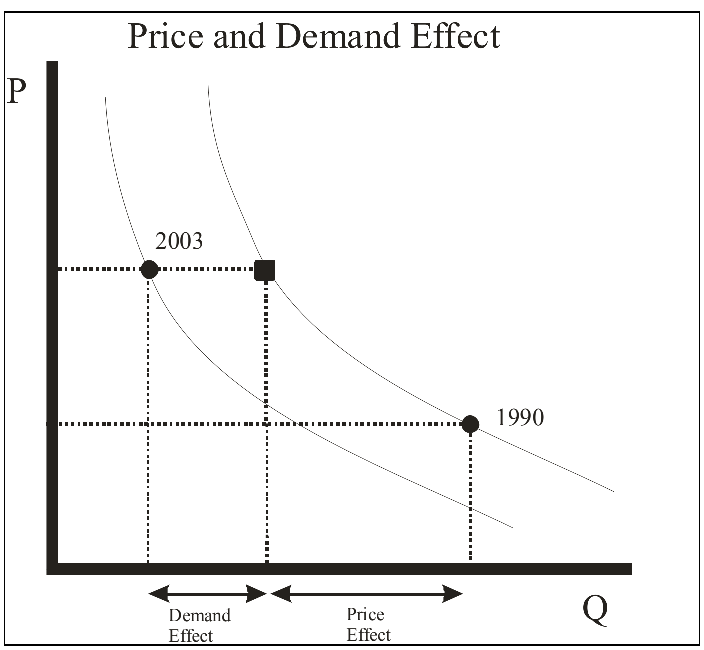
| | (1) |
|---|---|
| Method | OLS |
| State Tax Per Pack | 1.004<br>(.112) |
| Federal Tax | 1.136<br>(.751) |
| MSA dummy | 69.400<br>(6.1) |
| Year Dummies | No |
| State Dummies | Yes |
| Instruments | N/A |
| N | 714 |
| Adj. R-squared | 0.944 |

Notes:
1. Dependent variable is price.

## 3. Theory

Economic theory predicts that there are two components to the change in consumption. There is the price effect, which is a movement along the demand curve and the demand effect which is a shifting of the demand curve. The price effect equals the elasticity of demand multiplied by the percentage change in price. The demand effect represents the change in consumption holding price fixed. Figure 1 demonstrates these two components. In Figure 1, we have two consumption points representing cigarette consumption per capita in 1990 and 2003 that lie on demand curves for the respective years. In moving from the 1990 to the 2003 point we see two different movements. The first movement is the price effect. This is the reduction in consumption purely from the increase in price and is a movement along a fixed demand curve. The square in the diagram represents what 1990 consumption would be at 2003 prices and is at a lower level than the 1990 consumption point due to the fact that prices increased over the period. The shift in demand is represented by movement of the curve. The curve moves back to represent the reduction in consumption holding price fixed. Although the data leads me to believe that the figure represents the relevant situation, if demand were elastic enough, we could actually have an upward shift in the demand curve even though consumption fell over the period.

**Figure 1**



**4. Previous Literature**

Traditionally cigarette demand models have predicted a negative price elasticity of demand for cigarettes – what economists call the "law of demand," the higher the price the less people will demand, all else constant. Thus, the recent rise in prices for cigarettes would imply a predicted negative consumption response. While different papers have produced different results for the elasticity, the general consensus is that the value is "highly"[5] negative with typical estimates centered around -0.40. Chaloupka points out that many including Baltagi and Levin, 1986; Chaloupka and Saffer, 1992; Keeler et al., 1996 all calculated a price elasticity with a narrow range centered around -0.40 (Chaloupka, p5). This means that most authors predict that a 10% rise in cigarette prices will cause roughly a 4% decrease in the consumption of cigarettes.

A different way to look at cigarette consumption was proposed in 1989 by Becker and Murphy in their 1989 paper "A Theory of Rational Addiction." Their theory was that addicted consumers act rationally in their consumption of an addictive good. Addicts consider their past consumption, current prices, and expected future consumption in making their consumption choices. A follow up paper specifically on cigarettes by Becker, Grossman, and Murphy entitled "An Empirical Analysis of Cigarette Addiction" tested their theory an obtained a value of -.407 for the short-run elasticity of demand of cigarettes (Becker et al., p407). While Becker, Grossman, and Murphy may have used a different approach to cigarette consumption, they still obtained a similar elasticity for the short-run. Their model implies a larger long-run elasticity which they estimate to be about -0.75.

**5. Data**

The data for this paper covers three dimensions; consumption or quantity data, price and tax data, and population data. The data was obtained form various sources and analyzed using the statistical program STATA.

The consumption data is from Orzechowski and Walker's 2004 <u>Tax Burden on Tobacco.</u> I obtained state consumption data for all 50 states plus the District of Columbia for the years 1990-2003. The data are in millions of packs and is measured on an annual basis. With 51 states and 14 years, I ended up with 714 consumption points. Price and tax data for 1990-2003 are also from Orzechowski and Walker's

[5] High in the sense that it is larger than one would predict for an addictive good.

2004 Tax Burden on Tobacco and are recorded on an annual basis for the same years and the 50 states plus the District of Columbia. The price and tax data are broken into state tax per pack in pennies and federal tax per pack in pennies and the price data represent an estimate of the average retail price in pennies per pack.

Population estimates for the 51 states were obtained from Census data. I collected estimates of overall population by state for the years 1990-2003. To create a relevant population of cigarette consumers I collected estimates of the population of persons age 15-64 for all 51 states in the years 1990 and 2000 (based on the 1990 and 2000 U.S. Census files) and interpolated the fraction of the population falling in this age range for the other years assuming linear growth. The formulas for the fraction of 15-64 year-olds and the relevant population were:

(1) $Fraction_t = Fraction_{1990}*(2000-t)/10 + Fraction_{2000}*(t-1990)/10$

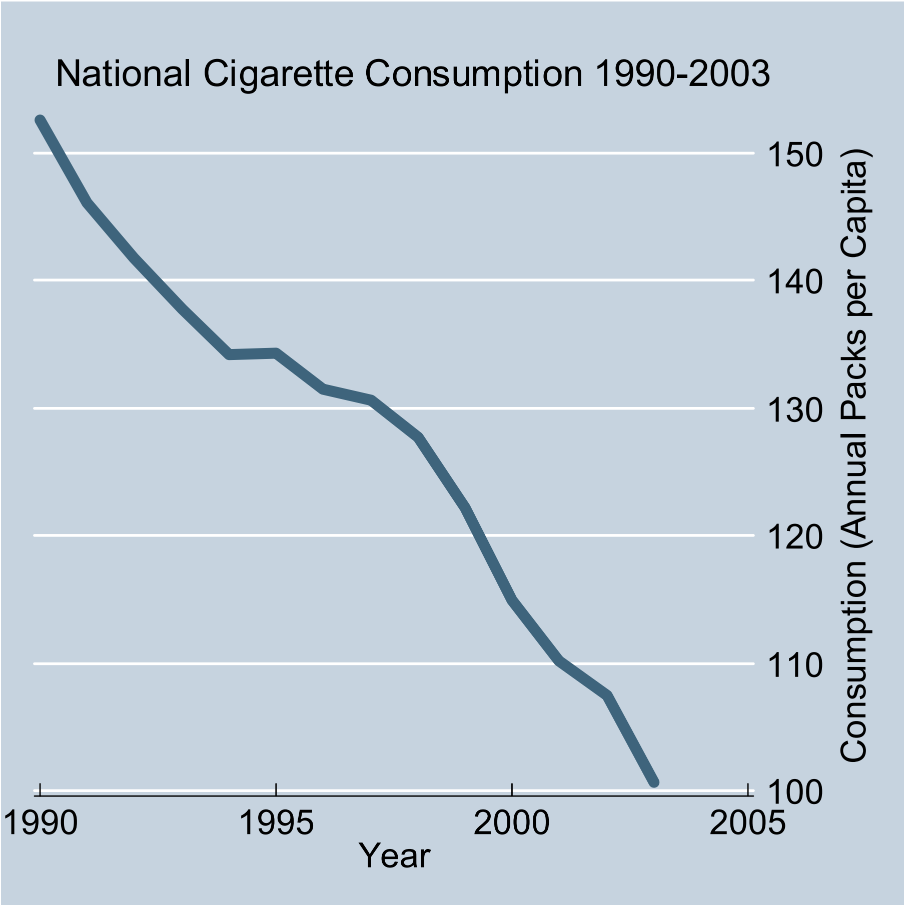
$Relevant\ Population_t = Fraction_t*Population_t$

Figure 2 shows consumption per capita at the national level over time.[6] There is a clear downward trend to the graph. Consumption per capita fell from over 150 packs per year to roughly 100 packs per year with the biggest declines coming after the MSA. Figure 3 shows prices per pack and total tax (including MSA) per pack over time. As can be seen from the figure, prices and taxes move closely together with both rising the most after the MSA became effective in 1999.[7]

[6] The national figures are calculated by aggregating total packs and population across states and the taking the ratio. As a result, the national figures for per-capita consumption represent a population weighted average of consumption per capita at the state level.

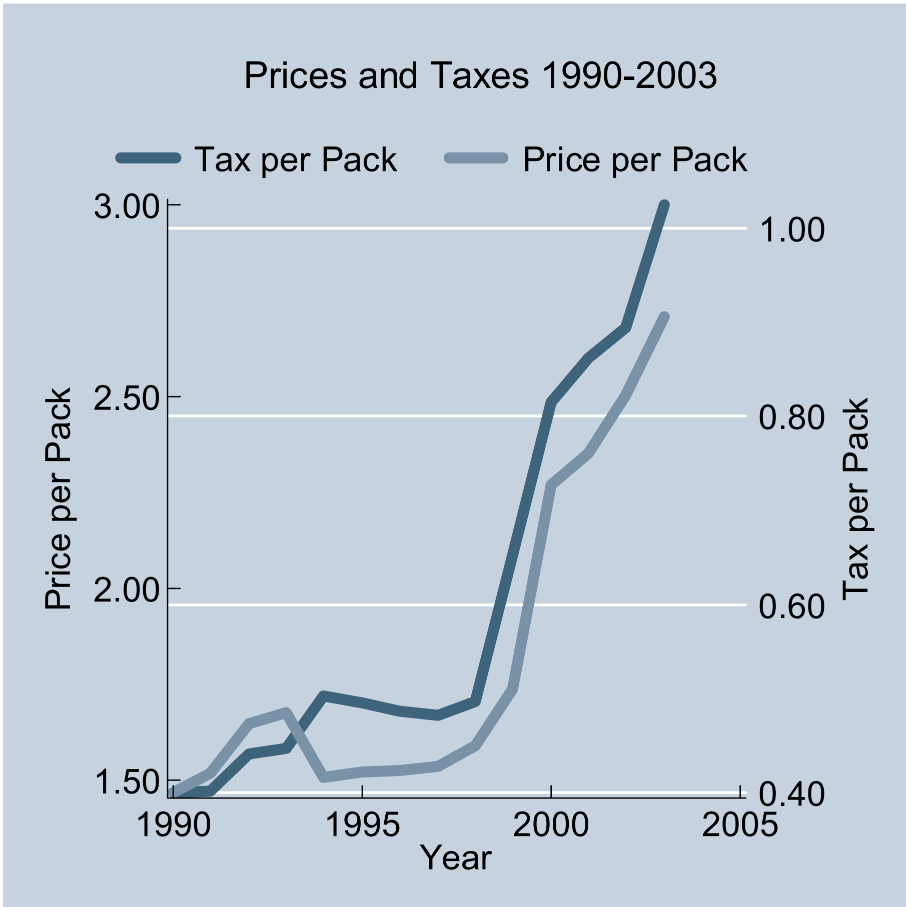
[7] In order to correspond to the consumption figures shown in the previous figure the national level price and tax data are also constructed as a population weighted average of the state level data.

**Figure 2**



National Cigarette Consumption 1990-2003
150
140
130
120
110
100
Consumption (Annual Packs per Capita)
1990
1995
2000
2005
Year

**Figure 3**[8]




**6. Evaluation of Previous Models**

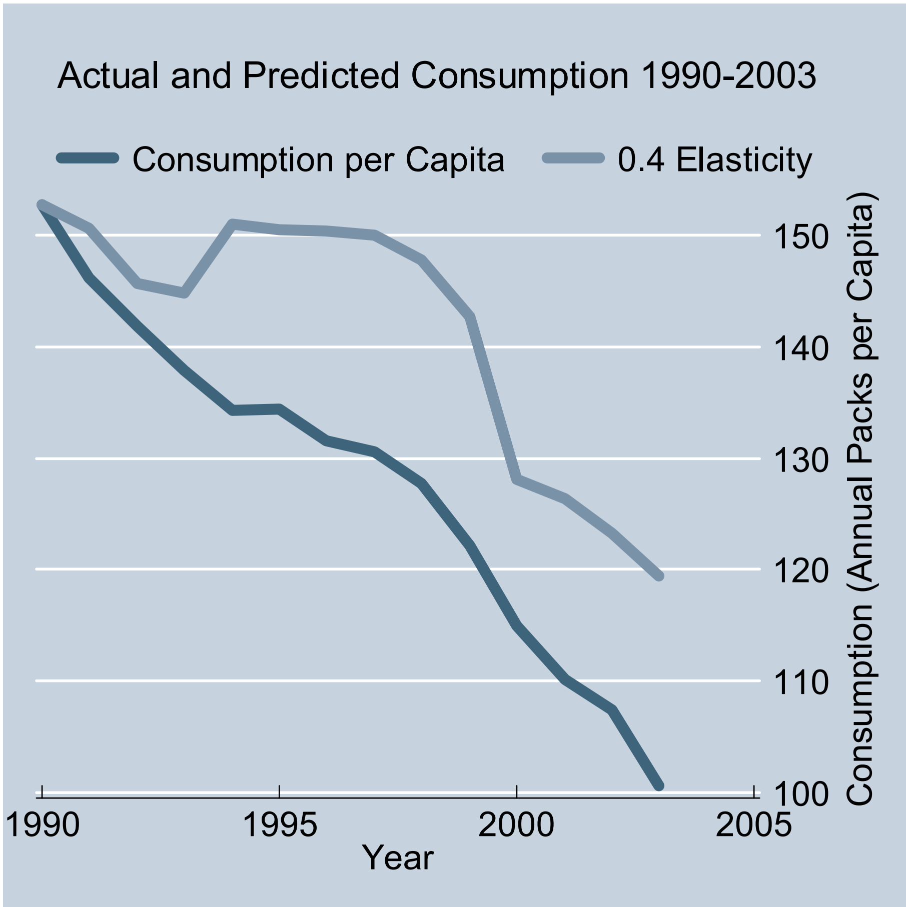
As noted earlier, previous models predict a price elasticity of -0.4. Figure 4 shows a plot of the log of consumption per capita over time and the predicted consumption per capita over time with a value of -0.4 plugged in for the elasticity of demand based on the same data used for figures 2 and 3. The predicted series starts with the actual value for 1990 and simply reduces consumption by 4 percent for every 10 percent increase in price. The model does fairly well in predicting the change in consumption over time. The prediction seems to be the worst in the year 1993 when cigarette prices fell sharply. This decline in price corresponds to "Marlboro Friday." On Friday, April 2, 2003, Philip Morris, who manufactures Marlboro cigarettes, cut its price by 20% in order to compete with bargain brands which had been gradually taking share away from the major brands. Because the price went down, the predicted value of

[8] Price and tax data uses a weighted average with consumption used as weights.

consumption went up but actual consumption did not rise. However, this divergence may be due to the fact that while overall prices fell – prices for discount cigarettes actually rose and those customers smoking discount cigarettes are likely to be the most price sensitive. Other than this deviation, the model seems to do reasonably well in that consumption fell over the period by roughly 50 packs per-capita while the model predicts a decline of roughly 30 packs. By comparison, if I use Becker, Grossman and Murphy's long run estimate of -0.73 I predict that consumption would decline to 96 packs per capita versus the 100 packs per capita we actually see.[9]

[9] I cannot provide year by year predictions using the same technique used for the simple model since the BGM model predicts differential responses depending on the duration of price changes and the degree to which they were anticipated. However, I do perform a comparison of the models based on estimates of the two models for my sample period in section 9 below.

**Figure 4**




**7. Identification**

In my empirical estimation I will use both OLS and instrumental variables (two-stage least squares) to estimate the cigarette demand models. The use of OLS requires some specific conditions that do not hold for estimating demand systems in general but may be reasonable assumptions for the cigarette market. In particular, in order to justify estimating the demand function by regressing quantity on price using OLS techniques we need to assume perfectly elastic supply for cigarettes. When supply is perfectly elastic demand shocks will not feed back into price changes since the supply price does not vary with demand in that case. This eliminates the most obvious way in which price would be correlated with unobserved sources of demand variation. In addition, we need supply shocks (in this case price shocks since supply is perfectly elastic) to be uncorrelated with demand shocks. If supply shocks are not uncorrelated with demand shocks then we will have biased estimates even with perfectly elastic demand. If we do not assume perfectly elastic supply for cigarettes, then we will have biased estimates because of simultaneous causality bias. For models that focus on differences across states, we need to justify that the supply of cigarettes is perfectly elastic across states. For models that use national level changes in prices and consumption we need to justify the assumption that the supply of cigarettes is perfectly elastic at the national level.

The justification for the supply of cigarettes being perfectly elastic for the entire nation is that the cigarette industry is basically a constant cost industry even in the short-run. The cost of growing, curing, rolling, and packaging cigarettes is very small compared to the total cost of producing cigarettes. The major cost of producing cigarettes is the tax stamp that producers have to buy in order to be allowed to produce cigarettes. This tax stamp is certainly perfectly elastically supplied because it costs the same no matter how many packs you wish to produce.

There are two ways to justify that the supply of cigarettes within a state is perfectly elastic. The first is that the price does not change with an increase in demand for cigarettes, only the supply does. Because cigarettes do not cost anything to produce within a state (they are produced and shipped), all that an increase in demand will do is increase the number of cigarettes shipped to a state. Secondly, as mentioned earlier, the fact that the state tax on cigarettes is passed on at a 1:1 ratio suggests that perfectly elastic supply is consistent with the existing evidence. Figure 5 shows how a tax is passed on for a market with an upward sloping supply curve, and Figure 6 a market with a perfectly elastic supply curve. Notice that for the market with the perfectly elastic supply curve the tax is passed on 1:1, but in the market with the upward sloping supply curve, the tax is passed on at less than 1:1. [10]

[10] There is no direct test of whether supply shocks and demand shocks are uncorrelated but I know of no particular reason why they would be. Most discussions of demand shocks for cigarettes have focused on health information while supply shocks come from cost changes.

**Figure 5**

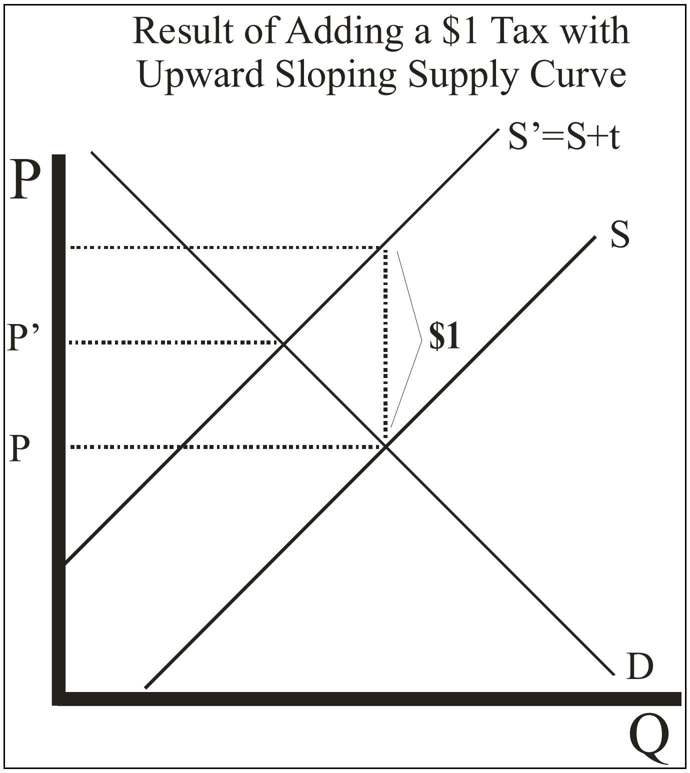
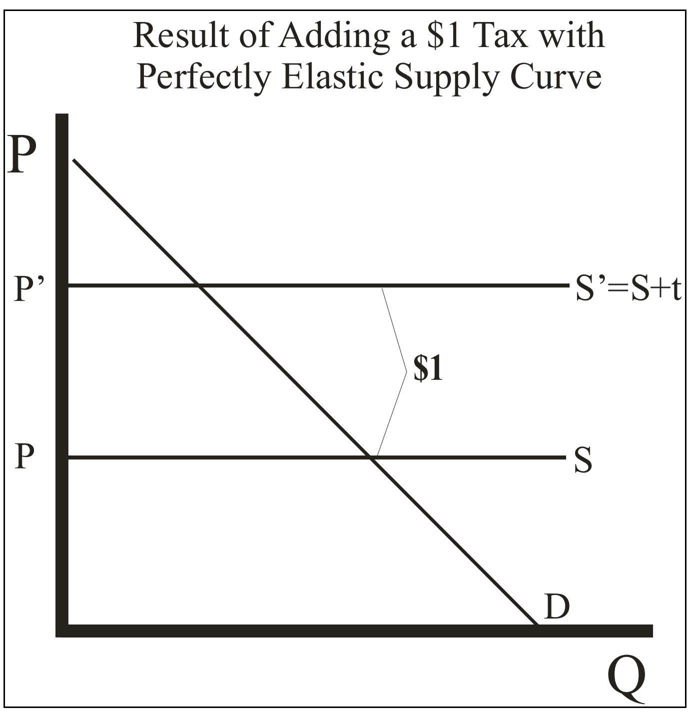



**Figure 6**



To use instrumental variable regressions, we do not need to assume perfectly elastic supply. If we want to use instruments in our regressions the most likely candidate would be taxes. Taxes are not likely to be correlated with the fundamentals of consumer demand but probably influence supply. However, taxes may be correlated with other demand reducing effects such as smoking bans since states may introduce these measures at the same time that they change taxes. Given the potential problems with price itself (supply might not be perfectly elastic) and taxes (they may be correlated with other demand reducing efforts) I try both in my analysis in section 8.

There are essentially three sources of variation that could be used in the regressions. The first is the differences across states that are independent of time (fixed state effects). An example of this is where a state is located within the country, the Northwest, Midwest, or Tobacco Road, for example. The second type of variation is differences over time common across states (i.e. national level effects). Examples of national level effects on prices would be the MSA and federal taxes while national level shifts in demand would be generated by changes in health information and nationwide advertising bans. The last type of variation is differences in the changes across states (changes that net out both fixed time and fixed state effects) that exist when you use state and time fixed effects. An example of this would be the differences in the change in tax level between states.

To run my regressions I decided to use state fixed effects for all of the regressions. The reason to include state effects is that high smoking states may be likely to have low taxes because of political reasons – many cigarette consumers means more pressure to keep taxes low. Time fixed effects are most likely present, but likely to be going in one direction because demand for cigarettes is likely to be falling over time due to other efforts to reduce smoking and increased health information. This leaves us with three options. The first is to simply include the time fixed effects and avoid this problem. The second is to not include time fixed effects but also to include a time trend. This means restricting demand to fall (or rise) at a constant rate over time. Thus, the variation of decreasing demand is isolated. The last option is to completely leave out time fixed effects. The problem with this is that leaving out time fixed effects completely will bias the estimate of price elasticity of demand upwards and overestimate it because it will attribute all of the fall in consumption to changes in price, ignoring the fall in demand for cigarettes.

The problem with using both state and time fixed effects is twofold. First, the differences in changes across states may be correlated with changes in other factors like attitudes and smoking bans. Second, because of interstate smuggling, the price elasticity may be overstated. Smokers that live in states that experienced large price changes are able to shift their consumption (consumption data is number of packs sold) to states with lower prices. Therefore, states with large price changes experience larger changes in purchases than in consumption. This creates the impression that consumers are more price sensitive than they actually are.

**8. Regressions of general model**

In order to re-estimate a general model for cigarette demand I performed eight regressions. All the regressions are regressions of quantity on price in log-log form. The dependent variable in all of the regressions is the natural log of consumption per capita. Since both quantity and price are measured in logs the estimated coefficient on price can be interpreted as the elasticity of demand. Consumption per capita is the number of packs of cigarettes on which state excise tax were collected divided by the estimated population 15-64 years old. All of the regressions are over the time period 1990-2003. All of the regressions use state dummies, justification for this, as mentioned in the identification section is that essentially there are political reasons for high smoking states to have low cigarette taxes and hence low prices. Table 2 shows the results.

**Table2**

**Model Estimation**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Method | OLS | OLS | OLS | OLS | IV | IV | IV | IV |
| Price | -0.494<br>(.015) | -0.833<br>(.057) | -0.297<br>(.025) | -0.474<br>(.038) | -0.590<br>(.018) | -1.59<br>(.12) | -0.586<br>(.039) | -0.515<br>(.058) |
| Trend | --- | --- | -0.013<br>(.001) | --- | --- | --- | -0.0002<br>(.002) | --- |
| Year Dummies | No | Yes | No | No | No | Yes | No | No |
| State Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Instruments | N/A | N/A | N/A | N/A | Taxes | Taxes | Taxes | Taxes |
| N | 714 | 714 | 714 | 14 | 714 | 714 | 714 | 14 |
| Adj. R-squared | 0.7324 | 0.7971 | 0.7648 | 0.751 | 0.7167 | 0.7416 | 0.7177 | |

Notes:
1. All regressions use time period 1990-2003.
2. Dependent variable in all regressions is the ln of consumption per capita.
3. Consumption per capita is the number of packs of cigarettes on which state excise tax were collected divided by the estimated population 15-64 years old.
4. Standard errors in parenthesis.
5. Estimate in columns (4) and (8) are based on observations aggregated over states within year.

The first regression is an OLS regression that regresses quantity on price only using state dummies. The value of -.494 is statistically significant different from zero. This value may be biased upwards because time fixed effects were not used as mentioned in the identification section. The second regression uses state and time fixed effects. The rather large coefficient of -.833 for the price elasticity of demand is probably too large, but as mentioned in the identification section, this is may be a result of interstate smuggling. One would expect that including the time dummies would lower the elasticity coefficient, but because of interstate smuggling, states with larger changes in taxes have larger consumption changes (consumption measured in sales) and thus, the elasticity is greater. The third regression is similar to the other regressions, but instead of using year dummies, a trend variable is used that constrains demand to be falling at a constant rate over time. This specification yields the smallest elasticity estimate of roughly -.30. The fourth regression uses an arithmetic average of the quantity and price over all states and regresses aggregate quantity on this aggregate price, thus there are only 14 data points, one for every year from 1990-2003. This estimate corresponds to fitting the aggregate time series and implies a price elasticity of -0.47. In general the models in columns (1), (2), and (4) suggest a price elasticity reasonably close though in some cases statistically different from the -0.40 value suggested by the previous literature.

The second set of regressions 5-8 all use taxes as an instrument for price and use the same specifications used in columns 1-4. As mentioned previously taxes are unlikely to be correlated with demand, but should influence the supply price by increasing costs. Regressions 5-8 use the same regressors that regressions 1-4 use, except in every case, taxes are used as an instrument for price. In general, the models in columns 5-8 suggest somewhat larger price elasticities than the corresponding models in columns 1-4 which is the reverse of what we would expect due to simultaneous equation bias where price would be positively correlated with the errors in the demand equation. This together with the large coefficient of -1.59 for price in the sixth regression may be a result of two things, the first as mentioned before being interstate smuggling and the second being the problem that taxes may be correlated with other demand reducing effects such as smoking bans.

One possible way to deal with interstate smuggling is to aggregate the data by census regions. This works because the consumption figures for the regions are comprised of one state and most or all of its surrounding states. For example, the consumption data will no longer be thrown off by Illinois smokers who reside in Chicago, but buy their cigarettes in Indiana where they are cheaper. When you aggregate over the 9 regions and run an OLS regression of quantity on price with region and year dummies (regression 2 from above that had the smuggling problem) you get a smaller coefficient of -.713 which means that grouping by region helps and that there indeed may indeed be some element of smuggling. Table 3 displays the regression result for the model aggregated to the regional level.

**Table 3**

**Aggregated Region Regression**

| | (2*) |
|---|---|
| Method | OLS |
| Price | -0.713<br>(.132) |
| Year Dummies | Yes |
| Region Dummies | Yes |
| Instruments | N/A |
| N | 126 |
| Adj. R-squared | 0.9621 |

Notes:
1. All consumption and price aggregated over census region by year
2. Standard error in parenthesis

**9. Rational Addiction Model**

All the regressions of the general model in the previous section ignore addiction. However, it may be unrealistic to look at cigarette demand without looking at addiction. In 1989 in their paper, "A Theory of Rational Addiction," Becker and Murphy proposed a way to look at the consumption of addictive goods. Namely, they said that consumption today depends on past consumption, current prices, and expected future consumption. Becker, Grossman and Murphy (1994) estimate this model using data through 1985.

The basic specification is that consumption at date t will be a function of the price at date t, consumption at date t-1 and expected consumption at date t+1. I estimate a version of this model by adding lagged and future consumption (measured in logs) to the model estimated in section 8 and using lagged prices and future prices as instruments for past and future consumption. I instrument for past consumption since errors in the demand equation are likely to be correlated over time and to proxy for expected future consumption based on the assumption that consumers can accurately forecast price one period forward.[11] Table 4 presents the estimates of the rational addition model for the same specification and data used in Table 3, a model with year and region effects where observations have been aggregated to the regional level to control for smuggling. Since I need data on past and future variables, estimating the rational addiction model reduces the sample period to 1991-2002. For comparison, I include the estimates of the general model that ignores addiction for this same period.

**Table 4**

**BGM vs. General Model**

| | (1) | (2) |
|---|---|---|
| Method | OLS | IV |
| Price | -0.56<br>(.153) | -0.24<br>(.139) |
| Cons t-1 | --- | 0.394<br>(.274) |
| Cons t+1 | --- | 0.209<br>(.143) |
| Year Dummies | Yes | Yes |
| State Dummies | Yes | Yes |
| Instruments | N/A | Price |
| N | 108 | 108 |
| Adj. R-squared | 0.9665 | 0.9917 |

Notes:
1. Regressions use time period 1991-2002.

The results for the rational addiction model suggest that prices have the predicted negative effect and that increases in both past and future consumption increase current consumption though the variables are not individually significant. However, an F-test of the hypothesis that both past and future consumption

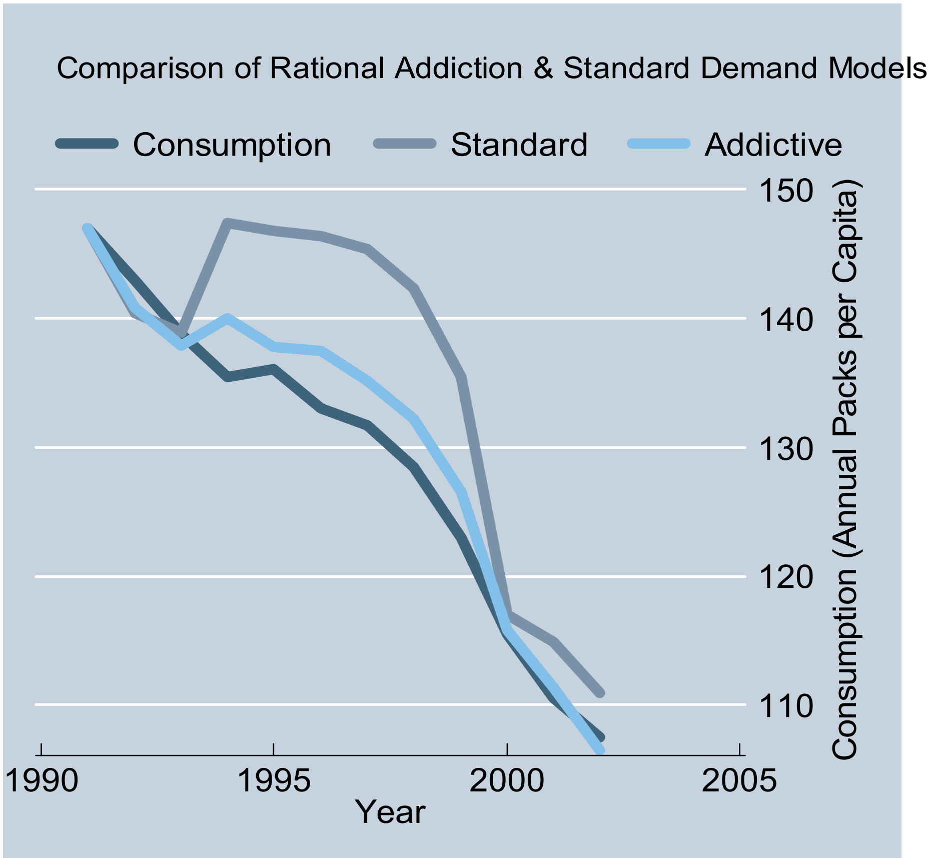
[11] This is the assumption made by BGM. They discuss the potential problems with the approach and the alternatives. The fact that people cannot perfectly forecast price will make the coefficient on future consumption biased downward.

coefficients are zero is rejected at the 1% level (F-statistic = 6.66). This implies that we can reject the non-addictive model in favor the rational addiction model since the non-addictive model corresponds to the restriction that these two coefficients are zero.

The estimates of the rational addition model in table 4 imply a long-run elasticity of -0.60 somewhat smaller than BGM's estimates that range from -0.73 to -0.79.

One way to compare the simple and rational addition models is to see how well they explain the national level time series. Figure 7 shows the results. Since both estimated models include time dummies, neither model used this variation to estimate the model parameters. For the simple model I predict using the same procedure used in Figure 4 using the coefficients from table 4. For the rational addiction model I use actual values for lagged consumption and predicted consumption based on the reduced form for future consumption (since the BGM model implies that current consumption depends on actual past and expected future consumption). While both models do reasonably well at explaining these data, the rational addiction model does better in almost every year. Based on these results and the results in section 6, I conclude that the rational addiction model does a somewhat better job of explaining the consumption data for 1990-2003.

**Figure 7**[12]




**10. Conclusion**

Evidence from the recent period shows that traditional economic models do a reasonably good job of predicting the nationwide decline in cigarette consumption over the last 15 years. The decrease in consumption that has resulted from the sharp rise in price over the last 15 years has, if anything, been slightly under predicted by these models. However, the predictions of consumption are off by a relatively small amount and other factors such as smoking bans could certainly explain the excess decrease in consumption. Most importantly, the economic view that cigarette consumers respond to increase in prices certainly would not be rejected by the recent evidence – if anything the recent evidence would supply somewhat higher elasticity estimates.

[12] The predicted values in the figure omit time dummies for both models. In fact, the differences between the actual and predicted values in the figure will be equal the coefficients on the time dummies from the regressions. Both models fit 1991 by construction because 1991 is the omitted year for both models.

The view that consumers respond to price is also supported by the fact that states that experienced large increases in prices experienced larger reductions in consumption. This evidence implies an elasticity possibly even larger than -0.40. For example, the regression run in this paper aggregating over regions in order to get rid of the problem of interstate smuggling generates a price elasticity of demand of roughly -.7.

The estimates for price elasticity of demand for cigarettes obtained in this paper seem to be slightly larger than previous estimates, but they are pretty close from an economic perspective. Most of the price elasticities obtained in this paper vary from -.3 to -.5. This coincides with Chalopuka's notion that many estimates have been close to -.4 (Chaloupka, p5).

Finally, between the two models I estimated, a general model ignoring addiction and a rational addiction model that does not ignore addiction, the rational addiction model seems to fit the data better over the recent period. First, the decrease in overall consumption per capita is predicted to be 57 packs by the BGM model and in reality the fall is 53 packs. Secondly, the rational addiction model seems to fit the time series better (see figure 7).

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