

## Econometrics Final Project

Team members: Kota, Tony, Jeanette

Source of Data:

CDC, BLS, BEA

SURGEON GENERAL'S WARNING: Smoking Causes Lung Cancer, Heart Disease, Emphysema, And May Complicate Pregnancy. SURGEON GENERAL'S WARNING: Quitting Smoking Now Greatly Reduces Serious Risks to Your Health.

The glaring warning on a package of cigarettes ought to cause a smoker to take pause before lighting up a cigarette. And yet, the warning label has not been enough to reduce smoking rates among the citizens of Utah. Long term risks of smoking include cancer, heart disease, emphysema, and stroke, to name just a few serious diseases, although smoking harms literally every part of the body. Cigarettes pose a risk to non-smokers too. The dangers of breathing second hand smoke have been well documented to show adverse and immediate effects on the cardiovascular system. Exposure to second hand smoke is a real threat to children, in particular, who don't have the option of removing themselves from smoky environments. In addition to health hazards, there are other public externalities associated with cigarette smoke, including the financial burden on the health care system. In a quest to reduce illness and deaths from smoking, and the externalities imposed on the rest of society, lawmakers have proposed a tax hike on cigarettes in order to encourage current smokers to cut back and to deter potential new smokers from taking up the habit. A team of economists, Tony, Kota, and Jeanette, from the Utah Department of Health, have been commissioned to compile an analysis to determine the effectiveness of a tax hike in order to achieve a reduction in cigarette consumption. Our specific

task is to determine the elasticity of demand for cigarettes. These findings will be presented in a legislative session where laws determining public policy will be made.

Data was gathered from Government Agencies to ensure that the numbers we used came from reliable sources. The CDC provided a large source of data on the tax burden of tobacco and the negative financial effects of tobacco on public health. We assembled information about cigarette consumption per state, the prices for cigarettes over the years, and the cigarette-specific taxes. The BEA website provided state population and personal income data, from which we calculated the per capita income values. CPI data was collected from the BLS and the year 2014 was used as the base year to adjust for inflation. All variables measured in units of dollars were converted to real 2014 dollars in order to make accurate comparisons. A panel data structure, organizing the information by state and for the years 1970 to 2014, was utilized in order to eliminate the influence of factors that vary across states. Once the data was organized into one single combined data set, in a tidy format, we were able to begin defining variables and making calculations. \*See Variables Table

One of the first steps in looking at data over time is to plot the data points and look for general trends or any outliers on the graph. For the first graph, we looked at the inflation-adjusted price of cigarettes by state for the years 1970 to 2014. An obvious upward trend in the price of cigarettes was noted starting from the year 1980, at which time cigarette cost less than \$3 a pack. Prices increased steeply (an increase of 200%!) over the next three decades to more than triple the cost around 2010. All states had fairly concentrated pricing in the earlier years of the graph, but more variation in prices between the states is apparent as time progresses toward 2014, and ends with differences in prices ranging from \$4.50 to \$10.50 per pack after taxes and adjusted for inflation. \*See Graphs

A consistent pattern of decreased consumption by state from the years 1980 to 2014 is noticeable. Whereas the data is a bit more spread out in 1980, representing variation among states in cigarette use, all states begin to merge closer together in 2014 at overall much lower rates of cigarette use.

It is truly remarkable to look at the graph of average cigarette consumption by year across all states over the years 1970 to 2014. The peak consumption per capita appears around 1977 (a really great year), at which point we estimate that the cigarette consumption was at 138 packs. Over the next 37 years, consumption dramatically declines to under 50 packs per capita per year, with a steep and significant decline between 1982 and 1992. These changes in consumption are attributable to various factors, including the increase in overall prices of cigarettes, partially due to taxation. Additionally, it is important to consider the effect of public anti-smoking campaigns of the 1980s in addition to the fact that the Marlboro man, a very well-known smoker, developed lung cancer in the late 80's.

Ultimately, our goal was to compare the cigarette consumption with inflation adjusted prices over time in an attempt to evaluate the price elasticity of cigarettes. Some of the questions we considered in the analysis were: Are the taxes levied specifically on cigarettes an effective way to discourage smoking? What is the price elasticity of cigarettes? In order to evaluate this, we ran several regressions. First, we used sales tax as an instrumental variable in our regression. A high sales tax increases the after-tax sales price per pack and satisfies the condition for instrument relevance because it affects the demand for cigarettes only indirectly through price. The results of our regression (1) in Table 1 suggest that for a 1% increase in price, consumption is reduced by 1.01%. This suggests that the demand for cigarettes is very elastic, which is not what one might initially assume considering the powerfully addictive effects of nicotine.

We considered whether there may be disregarded omitted variables that are correlated with the sales tax per pack. We realized that income would be a potentially omitted variable and decided to include income data in our regression. Demand for cigarettes would naturally depend on income. Furthermore, it could be argued that states which rely more on income tax for revenue, would have lower sales tax rates. As you can see, income is a plausible variable which we should include as a control variable in our model. When included in regression, we see that for a 1% change in price, consumption is reduced by 1.21%, and is considered statistically significant at the 0.1% level. \*See Regression Tables

Next, we decided to use another instrumental variable for our regressions. The cigarette specific tax seemed relevant because it increases the price of cigarettes paid by the consumer. We believed it to be exogenous as well. After using cigarette specific tax as an instrument for price in regression (3) and we noted an even larger estimated change in consumption. A decrease of 1.32% in consumption is noted for a 1% change in price.

Thus far, we had not considered historical factors influencing demand, such as whether a particular state grows tobacco and is a producer of cigarettes. If this circumstance is correlated with cigarette-specific taxes, then we would be dealing with an omitted factor in the cigarette demand regression. We used panel data to eliminate the influence of these variables and control for entity fixed effects by looking at changes in the variables between two different time periods. The years spanning 1996 to 2014 were used in our analysis.

We analyzed changes over time using the change in log functions. Our analysis considers the price elasticity over an 18-year time period. The length of the time period influences how the estimated elasticity should be interpreted. Because of the addictive nature of cigarettes, an

increase in price might have little effect on demand initially. However, over time, a higher price might contribute to a smoker's decision to quit, and could discourage non-smokers from beginning. Therefore, demand might be somewhat inelastic in the short run, but be more elastic in the long run.

In the first regression of Table 2, using the panel data structure, we measured changes in price and income to determine changes in consumption, using sales tax as the instrumental variable. Our results show that for a 1% change in price, consumption is reduced by 1.16%. This is similar to our first set of regressions, except that this time our findings were not statistically significant. The second regression uses the cigarette-specific tax as an instrument for price. Again, we see a reduction in consumption for a 1% change in price, but not as large in magnitude as before, at .76%. These results point to a large difference in estimated elasticities between sales tax as an instrument versus cigarette specific taxes as an instrument. If in fact both instruments are exogenous, then we would expect consistent estimates on the price elasticities with differences in magnitude only coming from random sampling variation. This doesn't appear to be the case in our regression and leads us to believe that one of our instrumental variables is not exogenous. Finally, in our third regression, both the sales tax and the cigarette-specific tax were used as instruments for price. The results show an .86% decrease in consumption for a 1% change in price, and again we believe that this number may suggest one of our instrumental variables is not exogenous.

The political process and lobbying are strongly linked to changes in the cigarette market and smoking policy. Perhaps factors such as change in tastes could affect political policy and therefore be correlated with changes in cigarette specific taxes. This would mean that cigarette specific tax is not an entirely exogenous instrument, so use of the general sales tax as our only

instrument in this analysis is justified. Using regression (1) of our panel data analysis with changes in price and changes in income as independent variables, we estimate the long run elasticity of demand at -1.16 and conclude that an increase in price of 1% will lead to an estimated decrease in consumption of 1.16%.

Overall, our findings show that the price elasticity of demand for cigarettes is much more elastic than one might initially believe, especially over time periods of a decade or more. The estimates of our regressions suggest that increased taxes can make a considerable dent in consumption of cigarettes in a long run as smokers are more sensitive to changes in price over time. We propose a tax increase as an effective method in reducing the externalities associated with smoking, and estimate the elasticity of demand at around -1.16.