Consumption and Welfare Effects of Taxes on "Sin"

by

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A thesis submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Master of Science

Auburn, Alabama
May 9, 2011

Keywords: Economics, Welfare Measures, Demand Systems, Sin Taxes

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Abstract

An Indirect Translog System and Linear Expenditure System are applied to Consumer Expenditure Survey data to estimate the effects of "sin taxes" on tobacco, alcohol, and food consumed away from home. Own-price elasticities of demand for tobacco and alcohol are found to be relatively elastic while FAFH is relatively inelastic. This indicates that taxes on FAFH may be an effective means of raising revenue but will have very little effect on consumption. Also, equivalent variations are calculated in order to observe the welfare effects of a 10% tax on each of the commodity groups. For tobacco, alcohol, and FAFH, the equivalent variations indicate a negative short-run effect. The equivalent variations also point toward each tax being regressive as lower incomes face a larger welfare decrease than higher incomes.

Acknowledgments

The author would like to thank his parents, Stan and Angelia Reeder, his brother, Brandon Reeder, and his grandparents, Kenny Reeder and Beverly Gipson, for their enduring love and support. He would also like to thank Dr. Diane Hite, Dr. Richard Beil, and Dr. Randolph Beard for their assistance, patience, and advice.

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Chapter I

Introduction

A "sin tax" is an excise tax levied on a legal product or activity which may be viewed by a society as unhealthy or immoral. Alcohol, tobacco, gambling, prostitution, pollution, firearms, soft drinks, sugar, and fast food have all been targeted by U.S. lawmakers in tax proposals. A sin tax is intended to serve two purposes. The first purpose, which is common to all taxes, is to increase revenues in order to fund government expenditures. In addition to generating higher revenues, a sin tax is proposed with the objective of decreasing or even abolishing the consumption of the good on which the tax is levied. However, if the tax is successful at decreasing consumption, the revenue effects of the tax would decrease over time. Therefore, it could be argued that a sin tax would be only a short-term remedy to budget deficits. These taxes are controversial beyond their effectiveness as budget and consumption manipulating tools. Some of those who oppose sin taxes have argued that a black market is created for the good on which the tax is placed, particularly when there are large price differentials across small geographic areas. Sin taxes are also controversial because they are perceived to be more burdensome to the low income and minority populations. In this thesis, I study whether a tax levied on alcohol, tobacco, or food consumed away from home will be an effective source of revenue, whether such a tax will cause a significant change in consumption across different races and income levels, and how it will affect the welfare of consumers.

The Indirect Translog System will be estimated in order to analyze an individual's expenditure distribution across the selection of consumption goods. The set of consumption

goods included in this study are food consumed at home, food consumed away from home, alcohol, and tobacco. In order to forecast the revenue and consumption effects of a sin tax, I calculate demand elasticities for the demand system then interpret the results. Also, elasticities are generated for the different races and incomes. This is done so that I can observe how consumption patterns change across different races and income levels. Inelastic demand for the good on which the tax will be imposed indicates the tax will likely be a significant generator of revenue. If consumers are not very responsive to a change in the good's price, then legislators could potentially raise billions of dollars in revenue by imposing a sizable tax with little effect on consumption. However, if the sin tax is aimed at curbing consumption of a good perceived as harmful, then an elastic demand is the preferred result. Consumers would be sensitive to higher prices thus reducing their quantity demanded.

To measure the effect the taxes will have on the welfare of consumers, I utilize a common method of welfare measurement called equivalent variation. Equivalent variation is the maximum amount of money a consumer would pay to avoid the tax increase. It is the amount that allows the consumer to remain at the new level of utility for the original price level. This measurement will give an indication of the changes in consumer welfare that result from a tax imposed on alcohol, tobacco, or prepared meals.

This thesis is comprised of eight chapters. The first chapter is an introduction which presents the topic, goals, and utilized methods of the study. Chapter two includes a review of relevant legislation history and trends regarding taxes on alcohol, tobacco, and prepared meals. Chapter three contains a review of previous literature about sin taxes. Chapter four explains, in detail, the demand system and welfare measure used to analyze the expenditure data. The fifth chapter describes the data, data sources, and variables. Chapter six presents the estimation results

of the Indirect Translog System with special attention given to interpreting the elasticities. This chapter also presents the welfare measurement results for the selected commodity groups. Chapter seven is the conclusion to the thesis. It includes a summary of the main arguments and a set of policy suggestions.

Chapter II

History, Trends, and Legislation

A. Alcohol Taxes

Alcohol is often subject to a sin tax because of the perception that the consumption of it leads to unruly behavior and health problems. These claims are not unsubstantiated. In the United States alone, roughly 79,000 deaths are directly attributable to alcohol use each year which makes it the third most likely lifestyle-related cause of death. According to the Center for Disease Control, approximately 35% of victims of violent attacks report that the violent offenders were under the influence of alcohol. In cases of intimate partner violence, alcohol is associated 2 out of 3 incidences. Alcohol also can lead to unintentional injuries such as vehicle-related injuries, burns, and drowning among others. Other immediate health risks include alcohol poisoning and miscarriage and stillbirth among pregnant women. Alcohol is also attributed to some long-term health problems. These often include: neurological problems, cardiovascular problems, psychiatric problems, cancers, and liver diseases. In addition to immediate and long-term health problems, alcohol has been linked to several social problems as well such as: unemployment, family problems, and a decrease in worker productivity.[1] For many of these reasons, alcohol has been focused on as a potential subject of a sin tax.

Alcohol has an extended history of being targeted in sin tax proposals. Adam Smith, often referred to as the father of modern economics, mentioned taxes on alcoholic beverages in his seminal work *The Wealth of Nations* (1776) by writing, "It has for some time past been the

[1] http://www.cdc.gov/alcohol/fact-sheets/alcohol-use.htm

policy of Great Britain to discourage the consumption of spirituous liquors, on account of their supposed tendency to ruin the health and to corrupt the morals of the common people." Britain first imposed a tax on distilled spirits in 1643. A tax on alcohol didn't reach the United States until the Act of 1791, also called the "Whiskey Tax," which placed a tax on distilled whiskey. This led to the Whiskey Rebellion in Pennsylvania in 1793, during which distilleries refused to pay the taxes. In 1802, the "Whiskey Tax," was repealed. An alcohol tax was imposed from 1814 to 1817 as a method of financing the War of 1812. President Lincoln placed a twenty cents per gallon tax on liquor in the Act of July 1 in 1862 to fund the Union's efforts in the Civil War. By 1865, the liquor tax had increased to $2 per gallon. The public's distaste for the negative externalities of alcohol during the early 20th century culminated in the passage of the 18th amendment which prohibited alcoholic beverages. The amendment took effect in 1920 and lasted until it was repealed by the passage of the 21st amendment in 1933. Since 1933, alcohol taxes have changed very little. For example, as of 2004, there were twenty-two states that had not raised taxes on beer for over twenty years. Many of the states that have chosen to increase taxes on beer have seen the value since eroded by inflation.[2]

As of February 1, 2010, the average state tax on spirits was $6.60 per gallon with the highest being Washington at $26.45 per gallon. The average state tax on table wine was $0.79 with the highest being Alaska at $2.50. The average state tax on beer is $0.29 with the highest being Alabama at $1.05.[3] According to the 2009 National Health Interview Survey, fifty-two percent of adults were current regular drinkers, meaning they had consumed at least twelve drinks in the

[2] Center for Science in the Public Interest, Factbook on State Beer Taxes
[3] Tax Foundation, State Sales Tax Rates Gasoline, Cigarette, and Alcohol Taxes, 2000-2010 http://www.taxfoundation.org/taxdata/show/245.html

past year.[4] This provides policy makers intent on increasing revenue a large tax base to target. The revenue garnered by taxing alcohol in the United States was $5,763,336,000 in 2008.[5]

B. Tobacco Taxes

Tobacco has long been a target of sin taxes because of the health and social problems associated with its use. Long-term consumption of tobacco has been linked to both lung and throat cancer. Use of smokeless tobacco has also been linked to mouth cancer. Some of the negative attention toward tobacco use in the cigarette or cigar form has arisen from the loss of work productivity and from second-hand smoke. According the Center for Disease Control, cigarette smoking is responsible for total economic costs, which include lost productivity and medical costs, at an estimated $10.47 per pack. Cigarette smoking was estimated to have cost Americans $93 billion annually in direct medical bills from 2000 to 2004. Other health-related economic losses over this same period of time totaled out to roughly another $100 billion annually.

The first federal excise tax on tobacco products was proposed by Alexander Hamilton in 1794. The bill was quickly repealed after much opposition. A federal excise tax on tobacco resurfaced in 1862 as lawmakers were looking for methods of financing the Civil War. From that point on, the tobacco tax has been a mainstay piece of legislation in the United States.[6] Between 1951 and 1982, the federal cigarette tax was constant at eight cents per pack. In 1983, the cigarette tax doubled to sixteen cents per pack. The tax increased again to twenty cents per pack in 1991. It rose again the next year to twenty-four cents per pack (Grossman, Sindelar, Mullahy, and Anderson, 1993).

[4] Summary Health Statistics for U.S. Adults: National Health Survey, 2009, Table 27
[5] U.S. Census Bureau, Annual Survey of State and Local Government Finances, Vol. 4
[6] http://www.druglibrary.org/schaeffer/library/studies/nc/nc2b.htm

The supposed addictive quality of tobacco products makes them ideal for tax policy because most people will continue to buy even with the price increase. Approximately $90 billion was spent on tobacco products in 2006 in the United States. $83.6 billion was spent on cigarettes. $3.2 billion was spent on cigars and $2.6 billion was spent on smokeless tobacco. Tobacco is the target of both federal and state excise taxes. Average state cigarette taxes were an estimated $1.44 per pack as of July 1, 2010. The state of Missouri had the lowest rate at 17 cents per pack while New York had the highest at $4.35 per pack. The federal excise tax on cigarettes was increased to $1.01 per pack from 62 cents per pack on April 1, 2009. This was one of the largest increases in U.S. history. Revenues from state and local tobacco taxes have steadily increased recently. They have climbed from $15,012,247,000 in 2006 to $16,575,613,000 in 2008.

C. Prepared Meals Taxes

Taxes on food consumed away from home, often labeled as prepared meals taxes or meals taxes, are excise taxes generally placed on food purchased at restaurants or other establishments that sell food for immediate consumption such as fast food places, cafés, and catered affairs. Food consumed away from home as a share of total food dollars has steadily risen in the past thirty years. In 1970, food consumed away from home as a share of total food dollars was 33.4%. As of 2009, the share had risen to 47.5%.[7] Beginning in 2000, an 18% increase in per capita spending at full-service restaurants is expected. Fast food spending is estimated to increase by 6% over the same period of time (Stewart, Blisard, Bhuyan, and Nyaga 2004). Many studies point to food away from home as being worse for your health than home

[7] Food CPI, Prices, and Expenditures: Expenditure Tables. Economic Research Service. Table 10.

cooked food. Food choices away from the home are inclined to be less likely sources of iron, calcium, and dietary fiber. They also tend to have higher fat contents (Gutherie, Lin, and Frazao 2002). According to one recent study, an estimated 134 calories are added to the average person's total daily intake with each meal eaten away from home (Todd, Mancino, Lin 2010).

Prepared meals taxes are relatively new and, thus, have a very short legislative history. Several state and local governments have recently implemented or proposed prepared meals taxes. An example of such legislation is in the state of Virginia where there is a 5% state sales tax on prepared food and beverages.[8] Another example is Utah where there is a 1% restaurant tax in addition to the state sales tax.[9]

[8] http://www.roanokeva.gov/85256a8d0062af37/vwContentByKey/N2529QXP691JEASEN
[9] http://tax.utah.gov/sales/rates.html

Chapter III

Literature Review

A "sin tax" is often referred to as a tax placed upon a good that, at the immediate time of consumption, is pleasurable to the consumer but may cause health problems for the consumer in the future. Consumption of a sin good creates what Hernstein (2003) called a negative internality. This phenomenon occurs when the consumption of a good generates a problem for the consumer's future self. The attractiveness of a sin tax is that it potentially addresses these long-run internalities. The rationalization for implementing a sin tax is the immediate welfare losses suffered by consumers at the time of the price increase will be counterbalanced by the improvements to health in the future.

However, people may not have the foresight to understand the long-term benefits of a sin tax, therefore focusing only on the price increase in the short-term. This could be exacerbated by people with self-control problems who over-consume. Lack of self-control is often associated with people who consume sin goods such as tobacco or alcohol. Gruber and Koszegi (2004) argued that the higher prices resulting from a tax on cigarettes would cause people to exercise a higher level of long-term self-control. Further research into self-control problems was conducted by O'Donoghue and Rabin (2006) as part of determining optimal sin taxes. O'Donoghue and Rabin substitute the usual assumption that total self-control is displayed by all consumers within the standard model of optimal taxation with one in which the consumers may display self-control problems. The researchers argue for the implementation of optimal sin taxes on goods that cause negative health effects and distributing the revenue to those who do not have self-control issues.

According to the research, this redistribution of tax proceeds could potentially improve Pareto efficiency while increasing social surplus.

Much of the empirical work regarding taxes on tobacco has focused on cigarettes. Cigarette demands, in both the long-run and short-run, have been found to be relatively inelastic but that the elasticity increases over time (Becker and Murphy, 1988; Chaloupka, 1991; Becker, Grossman, and Murphy, 1993; Keeler et. al., 1993). These findings would suggest that the ability of tax increases to curb cigarette consumption would increase over time, making the taxes an effective policy tool. Revenue can be generated while still curtailing consumption. Though some people will resort to methods of more intense smoking such as buying cigarettes with higher nicotine levels, a larger proportion of the effect of a cigarette tax is attributable to a decrease in the number of smokers (Lewit, Coate, and Grossman, 1981; Lewit and Coate, 1982; Wasserman et. al., 1991). Utilizing Canadian survey data, Gruber and Mullainathan (2003) find evidence that a positive correlation exists between high local cigarette tax rates and happiness. This would suggest that, over time, the overall welfare of a population could be increased with a reduction in cigarette consumption.

The consumption and health effects of an excise tax on alcohol are well-documented. As was the case in discussing the demand for cigarettes, the price elasticity for distilled spirits is significantly larger in the long-run than in the short-run (Chaloupka et. al., 1993). This suggests that the consumption of alcohol decreases over time after a tax is implemented. Also, the price elasticity is much higher for underage drinkers, suggesting they are more sensitive to changes in price (Kenkel, 1993). This would imply that a higher alcohol tax would reduce the amount of underage drinking. Saffer and Grossman (1987) found that 1,022 young people between the ages of 18 and 20 would have been saved from motor vehicle crashes every year from 1975-1981 had

the beer tax been indexed to the rate of inflation since 1951. In a later study, Chaloupka, Saffer, and Grossman (1993) found that 1,660 lives would have been saved annually on average from 1982-1988. When all ages were taken into account, it was discovered that 5,000 people would have been saved from motor vehicle accidents. Substantial decreases in crime rates have also been associated with increases in alcohol tax rates (Chaloupka and Saffer, 1992; Cook and Moore, 1992).

A sin tax on unhealthy food has usually taken the form of a "fat tax" in the literature. Allais, Bertail, and Nichele (2010) estimated nutrient and price elasticities for 32 nutrients and 22 food prices in France from 1996 to 2001. They found that a "fat tax" has a minimal short-run effect on body weight with the effect growing slightly over time. The nutrient price elasticities were very inelastic which indicates the effectiveness of such a tax as a revenue generator but raises doubt as to the effectiveness of the policy with regards to health improvements. The researchers also confirm the regressive nature of such a tax. Another related study conducted for United States dairy consumption using scanner data came to many of the same conclusions (Chouinard et. al., 2007). Taxes on fat were also found to fall more heavily on the poor and to be ineffective at curbing consumption. In addition to calculating demand elasticities for a set of dairy goods to measure the consumption and revenue effects of a "fat tax", Chouinard et. al. (2007) also used equivalent variations to measure the short-run welfare effects. In the short-run, a 10% tax on the dairy goods did not raise welfare for consumers. Also, welfare losses were greater for the poor and elderly. It is a common recommendation of researchers that the most effective food tax policy with the goal of improving health would be to tax based on the trans- or saturated fat content of food (Jacobsen and Brownell, 2000). However, policy makers may

conclude it more practical to tax broader food categories. This has made a tax on prepared meals an attractive option for legislators.

Chapter IV

Theory and Methodology

A. Indirect Translog Model

The econometric model used to analyze consumers' behavior regarding the selected commodities for this thesis is the Indirect Translog System. Elasticities for the model are also calculated so that the responsiveness of the consumers to a change in the commodity prices can be examined. Finally, equivalent variations will be calculated to evaluate the welfare effects of a price increase for each good. In this chapter, I present the theoretical models and formulas.

In order to derive the Indirect Translog System model (Christensen, Jorgenson, and Lau 1975) which will be estimated for the selected commodities in this thesis, we begin with an indirect utility function. This utility function is a function of the ratios of all the commodities' prices to total expenditure. Therefore, it is expressed in the form:

$$\ln v = \ln v(\frac{p_i}{Y}, \dots, \frac{p_n}{Y})$$

where *Y* is total expenditure. The budget share for the jth commodity is obtained from the logarithmic form of Roy's Identity which is:

$$\frac{p_j q_j}{Y} = -\frac{\partial \ln v / \partial \ln p_j}{\partial \ln v / \partial \ln Y}$$

Using a function quadratic in the logarithms of the ratios of prices to the value of total expenditure, we approximate the logarithm of the indirect utility function:

$$\ln v = \alpha_0 + \sum \alpha_i \ln \frac{p_i}{Y} + \frac{1}{2} \sum\sum \beta_{ij} \ln \frac{p_i}{Y} \ln \frac{p_j}{Y}$$

Utilizing this form as the utility function, the following are derived:

$$\frac{\partial \ln v}{\partial \ln p_j} = \alpha_j + \sum \beta_{ji} \ln \frac{p_i}{Y}$$

$$-\frac{\partial \ln v}{\partial \ln Y} = \sum \alpha_k + \sum\sum \beta_{ki} \ln \frac{p_i}{Y}$$

This gives the budget share form of the ITS:

$$w_i = \frac{p_i q_i}{Y} = \frac{\alpha_j + \sum \beta_{ji} \ln \frac{p_i}{Y}}{\sum \alpha_k + \sum\sum \beta_{ki} \ln \frac{p_i}{Y}}$$

The following restrictions must be placed on the system for proper estimation:

$$\sum \alpha_k = 1$$

$$\sum \beta_{ij} = 0$$

$$\sum \beta_{ji} = 0$$

$$\sum\sum \beta_{ij} = 0$$

The attempt to estimate a demand system consisting of only the four commodities chosen must be justified with an assumption which would allow the need for a category of all other goods to be circumvented. A common assumption used in similar studies is that consumers do not make all budgeting decisions at one time but that these decisions are separated into groups of commodities that are weighed against each other in the process of budgeting. This means that a price change in one of the goods has an effect on the demand of each of the other goods in the group. In other words, the cross-price elasticities are meaningful (Edgerton, 1997).

The Indirect Translog System yields the following elasticity formulas by differentiating the budget share form:

$$\varepsilon_{ii} = -1 - \frac{\partial w_i}{\partial p_i} \frac{p_i}{w_i} = -1 - \frac{1}{D} \left(\frac{\beta_{ii}}{w_i} - \sum \beta_{ij} \right)$$

$$\varepsilon_{ij} = \frac{\partial w_i}{\partial p_j}\frac{p_j}{w_i} = \frac{1}{D}\left(\frac{\beta_{ij}}{w_i} - \sum\beta_{ij}\right)$$

$$\varepsilon_{iY} = 1 - \frac{\partial w_i}{\delta Y}\frac{Y}{w_i} = 1 + \frac{1}{D}\left(-\frac{\sum\beta_{ij}}{w_i} + \sum\sum\beta_{ij}\right)$$

where D = $\sum\alpha + \sum\beta_{ij} ln\frac{p_j}{Y} + \sum\beta_{ji} ln\frac{p_i}{Y}$. Elasticities provide an accessible way to evaluate the consumption behavior of households. An own-price elasticity measures the effect the change in the price of a good has on the quantity demanded. A cross-price elasticity shows the responsiveness of quantity demanded with a change in price of a different good. An expenditure elasticity shows the responsiveness of quantity demanded with a change in the expenditure on all other goods in the specified group which, in this case, is tobacco, alcohol, food at home, food away from home. In this study, elasticities are estimated for all individual observations then reported at the mean. Elasticities are also generated for each income level and race in order to examine the differences. When evaluating the policy implications of a tax increase with the intentions of curbing consumption, the elasticities provide additional insight into revenue and consumption effects. The desired result of the elasticities depends on the policy makers' true intentions. If the tax is intended to be a significant generator of revenue, then an inelastic demand for the good on which tax is imposed is desired. The policy makers can impose a larger and larger tax without consumers significantly decreasing their consumption of the good. This could greatly increase revenues. However, if the tax is implemented as a public health or welfare mechanism, policy makers would prefer an elastic demand which would indicate that consumers have a high price sensitivity with regards to the particular good being taxed. Thus, the consumers would reduce their quantity demanded of the good and, theoretically, be better off.

B. Equivalent Variation

Equivalent variation (EV) is a measurement of welfare change following a price change. Theoretically, the equivalent variation is the minimum amount a consumer would be willing to accept for the implementation of a tax that results in a price increase.

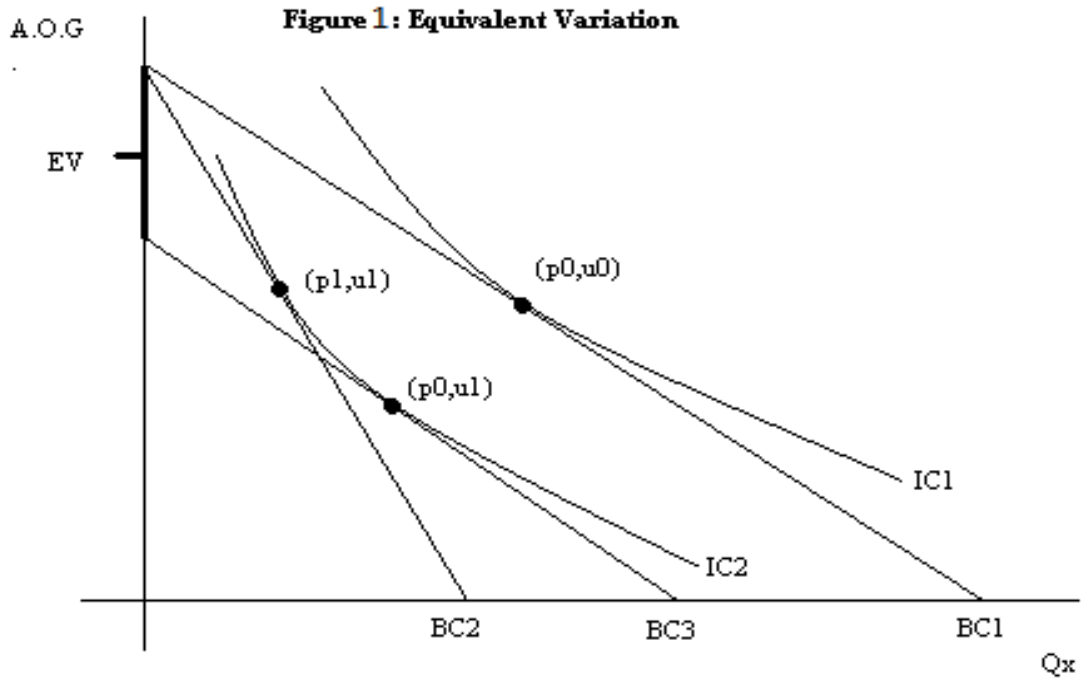

Figure 1: Equivalent Variation

This would make the consumer indifferent between the initial state and the after-tax state. If the after-tax state is preferred to the initial state, then the equivalent variation will have value greater than zero. The equivalent variation can be defined using both the expenditure function and the indirect utility function. In terms of the expenditure function, the equivalent variation is defined as:

$$EV = e(p^0,u^1) - e(p^0,u^0)$$

$$= e(p^0,u^1) - e(p^1,u^1)$$

$$= e(p^0,u^1) - Y$$

In terms of the indirect utility function, the equivalent variation is defined as:

$$v(p^1,Y) = v(p^0,Y+EV)$$

For the purposes of this study, the indirect translog utility function was utilized to derive the equivalent variation. In order to measure the welfare effects of a tax increase on the selected commodity groups, I solve for EV in the following specification:

$$\sum\alpha_i ln\frac{p_i}{Y} + \frac{1}{2}\sum\sum\beta_{ij} ln\frac{p_i}{Y} ln\frac{p_j}{Y} = \sum\alpha_i ln\frac{p_i}{Y+EV} + \frac{1}{2}\sum\sum\beta_{ij} ln\frac{p_i}{Y+EV} ln\frac{p_j}{Y+EV}$$

Once I equated the indirect utilities in the two states, the non-price terms were dropped (Hanemann and Morey, 1992).

Chapter V

Data and Variables

The expenditure and demographic data used in this study was collected by the Bureau of Labor Statistics as the quarterly interview portion of its continuously conducted Consumer Expenditure Survey. The survey year chosen for this study was 2003 due to its public availability. The sample population of the utilized survey is a national probability sample that was designed as a representation of the total civilian population. Each consumer unit included in the sample is subjected to an interview every three months over a fifteen month period in order to obtain information about their buying habits. Included in the interview survey are questions about major purchases, household demographics, and household income. For the purposes of this study, I extracted the quarterly expenditures on several consumption goods and combined them to create the commodity groups that are to be included in the demand system: Tobacco, Alcohol, Food Consumed at Home, and Food Consumed Away from Home. Tobacco consists of expenditures on cigarettes, cigars, pipe tobacco, and others. Alcohol consists of expenditures on alcoholic beverages purchased at restaurants, cafes, and bars on trips; beer and wine for home use; other alcoholic beverages for home use; and alcoholic beverages purchased at restaurants, cafeterias, drive-ins, etc. Food Consumed at Home (FAH) consists of food and beverages purchased and prepared on trips, food and beverages purchased at grocery stores, and food and beverages purchased at convenience or specialty stores. Food Consumed Away from Home (FAFH) consists of food or board at school and rooming/boarding houses; food at catered affairs, food and beverages purchased at restaurants, cafés, and fast food places on trips; dining out at

restaurants, cafeterias, drive-ins, etc.; school meals for preschool and school age children; and meals received as pay.

I also extracted information about the geographic region of residence, the amount of earned income before taxes, and the race of the reference person. The income information was split into three income levels. Low income households were classified as those with an earned income of less than $34,000 for the year. Middle income households were classified as those with an earned income of between $34,000 and $70,000 for the year. High income households were classified as those with an earned income of greater than $70,000 for the year. The consumer units were each categorized by their individual region of residence in order to analyze the differences in empirical results across geographic space and also to obtain a higher level of price variability within the model. The geographic regions, as defined by the U.S. Census Bureau, are the following: Northeast[10], Midwest[11], South[12], and West[13].

Because actual price information for each of the products is not available, regional CPIs were used for each of the commodity groups. The regional CPI data were obtained from the Bureau of Labor Statistics' Consumer Price Index Detailed Report Tables. [14] By utilizing price data from each different region, I was able to achieve a higher level of price variability which, in turn, produces a more accurate account of how people react to price changes. The differences in prices across the regions will simulate a change in prices, thus portraying how consumer expenditure habits change with price.

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[10] Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Pennsylvania

[11] Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas

[12] Delaware, Maryland, Washington D.C., Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, and Texas

[13] Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Oregon, California, Alaska, and Hawaii

[14] Table 31: 2003 Consumer Price Index Detailed Report Tables

**Table 1: Summary Statistics (Standard Deviations in Parentheses)*

Variable	Overall	Northeast	Midwest	South	West
Share Tobacco (w1)	0.1691 (0.1150)	0.1880 (0.1250)	0.1741 (0.1089)	0.1609 (0.1151)	0.1604 (0.1135)
Share Alcohol (w2)	0.1198 (0.1070)	0.1145 (0.1018)	0.1252 (0.1171)	0.1225 (0.1029)	0.1142 (0.1034)
Share FAH (w3)	0.5161 (0.1716)	0.5113 (0.1644)	0.5054 (0.1765)	0.5140 (0.1727)	0.5338 (0.1692)
Share FAFH (w4)	0.1948 (0.1335)	0.1859 (0.1396)	0.1951 (0.1355)	0.2024 (0.1322)	0.1914 (0.1287)
Tobacco Exp.	330.29 (312.85)	379.77 (302.33)	310.77 (220.85)	321.72 (409.50)	329.08 (273.58)
Alcohol Exp.	252.51 (294.62)	240.37 (271.75)	242.88 (303.44)	255.01 (285.24)	268.52 (310.60)
FAH Exp.	1060.01 (621.34)	1131.95 (725.07)	943.22 (514.70)	1035.90 (608.84)	1171.08 (647.78)
FAFH Exp.	444.10 (600.22)	500.34 (1067.92)	403.35 (418.09)	438.08 (444.36)	459.20 (487.52)
Total Exp.	2086.92 (1126.63)	2252.45 (1485.02)	1900.24 (866.13)	2050.73 (1097.23)	2227.89 (1113.45)
Income	46633.30 (48957)	50213.05 (50510.56)	42891.90 (43140.49)	48577.50 (51706.43)	46167.04 (50717.51)
Number of Observations	970	164	275	286	245

In the specification of the Indirect Translog System, both prices and quantities are required to run the model. Since the exact quantities purchased were not included and because price

multiplied by quantity gives the total expenditure, I divided the expenditure on each commodity group by the CPI. Therefore, when price and quantity interact within the model, the expenditures for each commodity group are produced.

The elasticities calculated for each of the commodity groups will provide much insight into the behaviors of consumers and whether or not a tax on the items will be a good source of revenue. The own-price elasticity for tobacco is expected to be more inelastic relative to the other commodity groups because of its addictive qualities. Because it is used at higher rates by lower income groups, the demand elasticities for tobacco are expected to increase with income level. The own-price elasticity for alcohol is hypothesized to have a more elastic demand due to it not being extremely addictive and because it is not absolutely necessary for most people. Incomes should have a similar effect on the elasticities as tobacco. The change in demand for FAFH with respect to a change in its own prices is expected to be relatively elastic. This is based on the assumption that FAH is a viable substitute for FAFH when the price of FAFH rises. Under this assumption, the cross-price elasticity between FAH and FAFH would be a positive value. A particularly interesting relationship is that between alcohol and tobacco. The resulting cross-price elasticities will reveal whether they are compliments or substitutes for each other.

Calculating the equivalent variations for the three commodity groups will provide information on the welfare effects of a 10% tax on each. A negative equivalent variation indicates the tax will have a negative effect on the consumer while a positive value will indicate a positive effect. Tobacco, alcohol, and FAFH are all likely to have negative equivalent variations because the consumers will likely consider themselves worse off in the short-run. Because this study only takes into account one year's worth of data, the long-run welfare effects

of the tax cannot be evaluated. Lower income people will probably be worse off from a tax than higher income groups for each of the commodities.

Chapter VI

Estimation Results

In order to produce the elasticities for each of the commodity groups, an Indirect Translog System was estimated to receive the parameter estimates required in the calculations. The previously specified model was estimated in the software program SAS 9.2. The parameter estimates are presented in Table 2. Tobacco is good 1, alcohol is good 2, FAH is good 3, and FAFH is good 4.

**Table 2: Parameter Estimates (n=970)*

Parameters	Estimates	Robust Standard Errors
$\alpha 1$	0.132	0.637
$\alpha 2$	0.134	0.071
$\alpha 3$	1.404	3.630
$\alpha 4$	-0.688	2.093
$\beta 11$	0.007	0.640
$\beta 12$	-0.068	0.000
$\beta 13$	-0.329	1.486
$\beta 14$	0.390	1.084
$\beta 22$	0.098	0.180
$\beta 23$	0.024	0.234
$\beta 24$	-0.060	0.199
$\beta 33$	0.257	1.028
$\beta 34$	0.135	0.445
$\beta 44$	-0.546	1.553

The resulting parameter estimates were then plugged into the elasticity formulas for the Indirect Translog System. I then estimated demand elasticities for each region, income, and race. Much can be gleaned about the behavior of consumers regarding the selected commodity groups from the resulting elasticities. The elasticities for the entire sample and for each region are listed

in Table 3. The elasticities by income level are listed in Table 4. The elasticities by race are listed in Table 5. Each of the elasticities is reported at the mean.

**Table 3: Elasticities by Region (Own-Price Elasticities in Bold)*

	Tobacco	Alcohol	FAH	FAFH
		Northeast		
Tobacco	**-1.511**	-2.142	-0.718	3.461
Alcohol	-0.860	**-4.296**	0.241	-1.092
FAH	-4.202	0.915	**-2.013**	0.887
FAFH	4.994	-1.891	0.543	**4.857**
Expenditure	1.092	4.442	1.462	-3.701
		Midwest		
Tobacco	**-1.502**	-2.020	-0.805	3.824
Alcohol	-0.783	**-4.121**	0.248	-1.149
FAH	-3.826	0.872	**-2.082**	1.012
FAFH	4.549	-1.783	0.579	**5.365**
Expenditure	1.084	4.256	1.507	-4.133
		South		
Tobacco	**-1.501**	-2.398	-0.634	3.014
Alcohol	-0.761	**-4.667**	0.236	-1.025
FAH	-3.719	1.008	**-1.949**	0.730
FAFH	4.422	-2.118	0.509	**4.235**
Expenditure	1.082	4.834	1.419	-3.169
		West		
Tobacco	**-1.515**	-1.823	-0.549	3.218
Alcohol	-0.952	**-3.832**	0.226	-1.046
FAH	-4.645	0.799	**-1.875**	0.807
FAFH	5.519	-1.607	0.470	**4.502**
Expenditure	1.102	3.952	1.374	-3.402
		United States		
Tobacco	**-1.501**	-0.834	-4.098	4.871
Alcohol	-2.084	**-4.216**	0.902	-1.854
FAH	-0.677	0.238	**-1.979**	0.525
FAFH	3.379	-1.079	0.859	**4.739**
Expenditure	1.085	4.359	1.440	-3.601

The elasticities seem to vary little across the regions. Each of the own-price elasticities have the relative magnitudes that were hypothesized. Tobacco, relative to the commodity groups in the demand system, is inelastic with an elasticity of -1.501 for the entire United States. This result is consistent with the idea that tobacco is a more addictive product than alcohol and FAFH. Alcohol appears to be very elastic compared to tobacco. This was expected due to it not

necessarily being highly addictive and because most people can curb their consumption quickly with a price increase. The cross-price elasticities between alcohol and tobacco are both negative, indicating they are complimentary goods. As the price of alcohol rises, the demand for tobacco falls. Conversely, as the price of tobacco rises, the demand for alcohol falls. This relationship would suggest that if a person consumes tobacco, they are also likely to consume alcohol, and vice versa. The own-price elasticity for FAFH is relatively elastic. This result is consistent with the expectations for the commodity group. The hypothesis was based on the idea that FAH is a viable substitute for FAFH when the price of FAFH rises. The cross-price elasticities between FAH and FAFH were both positive which is evidence in support of this claim. However, the own-price elasticity for FAFH is a positive value which indicates that there may be a lack of price variability in the variable.

**Table 4: Elasticities by Income Level (Own-Price Elasticities in Bold)*

	Tobacco	Alcohol	FAH	FAFH
		Low		
Tobacco	**-1.486**	-1.920	-0.774	3.783
Alcohol	-0.654	**-3.976**	0.245	-1.140
FAH	-3.203	0.835	**-2.056**	0.999
FAFH	3.810	-1.694	0565	**5.304**
Expenditure	1.071	4.103	1.491	-4.082
		Middle		
Tobacco	**-1.503**	-2.131	-0.581	3.501
Alcohol	-0.797	**-4.280**	0.231	-1.097
FAH	-3.894	0.911	**-1.906**	0.901
FAFH	4.629	-1.881	0.486	**4.911**
Expenditure	1.086	4.425	1.391	-3.747
		High		
Tobacco	**-1.555**	-2.411	-0.578	2.421
Alcohol	-1.255	**-4.685**	0.231	-0.930
FAH	-6.113	1.012	**-1.903**	0.526
FAFH	7.259	-2.130	0.485	**3.401**
Expenditure	1.134	4.854	1.389	-2.460

Much of the criticism surrounding sin taxes comes from the perception that they are regressive. This means the taxes fall more heavily on the poor. If there is any truth to this view, then the lower income classes will have more inelastic demands than the higher incomes. The poor would be less sensitive to price changes, thus a tax will be less likely to curb their consumption of tobacco and alcohol. According to the findings of this study, low-income consumer units do have a more inelastic demand than higher incomes. The own-price elasticities for tobacco do seem progressively more elastic as the income levels rise. The lowest income class has an elasticity of -1.486. The middle income class has an elasticity of -1.503 while the highest income class has an elasticity of -1.555. For alcohol, the same progressive quality is observed among the own-price elasticities. As incomes rise, the elasticities simultaneously increase from -3.976 to -4.280 to -4.685. The own-price elasticity for FAFH, again, does not have the expected sign. Also, the expenditure elasticity is negative when it should be positive.

**Table 5: Elasticities by Race (Own-Price Elasticities in Bold)*

	Tobacco	Alcohol	FAH	FAFH
		White		
Tobacco	**-1.508**	-2.169	-0.678	3.393
Alcohol	-0.843	**-4.335**	0.238	-1.080
FAH	-4.118	0.925	**-1.981**	0.864
FAFH	4.894	-1.915	0.526	**4.760**
Expenditure	1.091	4.484	1.441	-3.618
		Black		
Tobacco	**-1.497**	-1.444	-0.679	3.933
Alcohol	-0.735	**-3.288**	0.239	-1.165
FAH	-3.595	0.665	**-1.983**	1.050
FAFH	4.275	-1.271	0.527	**5.518**
Expenditure	1.079	3.376	1.442	-4.264
		Asian		
Tobacco	**-1.505**	-1.852	-0.612	2.044
Alcohol	-0.843	**-3.875**	0.232	-0.868
FAH	-4.115	0.810	**-1.927**	0.397
FAFH	4.892	-1.633	0.497	**2.867**
Expenditure	1.091	3.998	1.406	-2.006

This is problematic and indicates a lack of price variability.

Elasticities were also calculated by race in order to examine differences in consumption behaviors across self-identified racial backgrounds. The own-price elasticities for tobacco are all about the same across the races with the elasticity for whites being slightly more elastic. Whites also have a more elastic demand for alcohol than blacks and Asians. At -4.335, the alcohol elasticity for whites is much higher than the elasticity for blacks, which is -3.288.

**Table 6: % Change Equivalent Variations with Respect to Income with 10% Tax*

	Tobacco	Alcohol	FAFH
Overall	-2.72	-7.62	22.61
Low Inc.	-4.34	-7.90	24.00
Middle Inc.	-3.19	-2.81	96.20
High Inc.	-1.45	-2.19	-3.53
White	-2.57	-7.78	16.10
Black	-5.87	-13.70	42.91
Asian	-2.87	-0.98	76.16

The equivalent variations for the three commodity groups, tobacco, alcohol, and FAFH, were calculated in order to demonstrate the welfare effects of a 10% tax. The welfare effect is negative when the equivalent variation value is negative, and vice versa. Because CPI was used in the calculations instead of actual retail prices, the equivalent variation values are reported as the percentage change relative to income. As expected, tobacco had a negative equivalent variation which indicates that a tax would cause consumers to consider themselves worse off in the short run. The same is true for the welfare effects of a 10% tax on alcohol. Lower incomes were also worse off than higher incomes for both of these commodities as expected. However, the equivalent variations for FAFH seem to be skewed and unrealistic. This hints further toward a lack of price variability for the variable.

In order to see if the estimates for FAFH were affected by the lack of price variability, I also ran a Linear Expenditure System (LES) which does not require as many parameters to be estimated. Elasticities were recalculated using the parameter estimates obtained from the new specification. The LES (Stone, 1954) is obtained from the maximization of the Stone-Geary Utility function. The Stone-Geary is written in general form as:

$$u = lnU = \sum \beta \ln (q_i - \gamma_i)$$

The result of this derivation is the system of demand funtions to be estimated. The demand curves are in the form:

$$q_i = \gamma_i + \beta_i \frac{Y - \sum p_i \gamma_j}{p_i}$$

where γ_i is the intercept, or the subsistence level of good i. β_i is the marginal budget share for good i, or the fraction of each additional unit of expenditure spent on each good. $Y - \Sigma p_j \gamma_j$ is the budget left after expenditures at the subsistence level. This is called the supernumerary income and is used to buy additional amounts of the goods purchased at the subsistence level. The goods

**Table 7: Parameter Estimates for LES (n=975)*

Parameters	Estimates	Robust Standard Errors
γ1	58.209	23.169***
γ2	98.178	44.782***
γ3	478.863	136.4***
γ4	146.308	109.1
β1	0.130	0.032***
β2	0.134	0.019***
β3	0.402	0.056***
β4	0.334	0.084***

included in the system were tobacco (Good 1), alcohol (Good 2), FAH (Good 3), and FAFH (Good 4). The elasticity formulas for the LES are specified as follows:

$$\varepsilon_{ii} = -\frac{\beta_i [1 - \left(\frac{p_i \gamma_i}{Y}\right)]}{w_i}$$

$$\varepsilon_{ij} = -\frac{\beta_i(\frac{p_j\gamma_j}{Y})}{w_i}$$

$$\varepsilon_{iY} = \frac{\beta_i}{w_i}$$

**Table 8: Elasticities by Region for LES (Own-Price Elasticities in Bold)*

	Tobacco	Alcohol	FAH	FAFH
		Northeast		
Tobacco	**-4.308**	7.931	2.016	6.385
Alcohol	-0.157	**-3.831**	-0.117	-0.370
FAH	-0.723	-2.113	**-0.515**	-1.701
FAFH	-0.227	-0.664	-0.168	**-2.724**
Expenditure	1.594	4.291	1.052	3.260
		Midwest		
Tobacco	**-4.305**	9.441	2.312	7.994
Alcohol	-0.153	**-3.551**	-0.123	-0.428
FAH	-0.691	-2.285	**-0.595**	-1.935
FAFH	-0.219	-0.725	-0.177	**-2.941**
Expenditure	1.450	4.057	1.154	3.555
		South		
Tobacco	**-4.086**	9.696	1.847	6.132
Alcohol	-0.150	**-4.222**	-0.103	-0.343
FAH	-0.716	-2.593	**-0.457**	-1.640
FAFH	-0.230	-0.835	-0.159	**-2.352**
Expenditure	1.406	4.766	0.951	2.881
		West		
Tobacco	**-4.842**	7.348	1.709	6.435
Alcohol	-0.168	**-3.328**	-0.094	-0.355
FAH	-0.798	-1.920	**-0.417**	-1.681
FAFH	-0.230	-0.555	-0.129	**-2.610**
Expenditure	1.787	3.733	0.864	3.097
		United States		
Tobacco	**-4.377**	8.732	1.973	6.779
Alcohol	-0.156	**-3.740**	-0.109	-0.375
FAH	-0.731	-2.255	**-0.496**	-1.744
FAFH	-0.227	-0.704	-0.158	**-2.647**
Expenditure	1.547	4.224	1.004	3.190

The results of the elasticity calculations for the LES are presented, by region, in Table 8. Tobacco was found to have an elastic own-price elasticity relative to that of alcohol. The cross-

price relationship between the two commodity groups was indeterminable because the demand for tobacco relative to the price of alcohol was a negative value while the demand for alcohol relative to the price of tobacco was a positive value. The expenditure elasticity for tobacco indicates the good is inferior. Alcohol and FAFH both had expenditure elasticities that pointed to each being a luxury good. FAFH had problematic elasticities generated by the Indirect Translog System. The LES produced a negative own-price elasticity for FAFH. However, contrary to the hypothesis for FAFH, the elasticity was rather inelastic. This could be due to the convenience of eating away from the home.

**Table 9: Elasticities by Income for LES (Own-Price Elasticities in Bold)*

	Tobacco	Alcohol	FAH	FAFH
		Low		
Tobacco	**-3.923**	9.479	2.535	8.411
Alcohol	-0.149	**-3.357**	-0.140	-0.464
FAH	-0.698	-2.437	**-0.470**	-2.157
FAFH	-0.217	-0.758	-0.702	**-2.864**
Expenditure	1.219	3.881	1.121	3.535
		Middle		
Tobacco	**-4.127**	8.687	1.684	6.688
Alcohol	-0.147	**-3.794**	-0.093	-0.371
FAH	-0.686	-2.250	**-0.458**	-1.728
FAFH	-0.212	-0.705	-0.135	**-2.755**
Expenditure	1.482	4.278	0.892	3.295
		High		
Tobacco	**-5.622**	7.058	1.202	3.641
Alcohol	-0.182	**-4.415**	-0.066	-0.202
FAH	-0.849	-1.847	**-0.576**	-0.942
FAFH	-0.262	-0.579	-0.096	**-2.109**
Expenditure	2.324	4.808	0.888	2.402

The own-price elasticities for both tobacco and alcohol are progressively more elastic as income level rises. This result is consistent with the Indirect Translog System. Also, the own-price elasticities for FAFH are more inelastic as income level increases. Again, the social aspect of eating out is the suspected reason for this result.

**Table 10: % Change Equivalent Variations with Respect to Income for LES with 10% Tax*

	Tobacco	Alcohol	FAFH
Overall	-2.054	-6.757	-6.317
Low Inc.	-4.876	-16.151	-14.194
Middle Inc.	-0.693	-2.217	-2.398
High Inc.	-0.334	-1.175	-1.772
White	-2.138	-7.004	-6.388
Black	-1.125	-4.835	-4.180
Asian	-1.438	-4.579	-7.750

The equivalent variations calculated for the LES are more consistent with the hypothesized outcomes for each good. Each good has negative equivalent variations which indicate that the implantation of a 10% tax would cause a reduction in short-run consumer welfare. Lower income individuals appear to face a much larger negative welfare effect than higher incomes. This is evidence of the regressive nature of such taxes.

Chapter VII

Summary and Conclusions

Utilizing 2003 Consumer Expenditure Survey and Consumer Price Index data, I estimate an Indirect Translog System then calculate the price elasticities and the equivalent variations associated with a change in prices for a selected set of commodity groups. However, the ITS produced biased estimates due to a lack of price variability in the model. Therefore, I also ran a Linear Expenditure System and recalculated the elasticities. The elasticities and equivalent variations were then examined in order to extrapolate the consumption and welfare effects of taxing tobacco, alcohol, and food away from home.

The own-price elasticity for FAFH is inelastic relative to the other commodity groups included in this study. This is possibly due to the convenience of eating away from the home. Tobacco and alcohol were both found to be relatively elastic compared to FAFH. These elasticity results suggest that a tax on FAFH would yield substantial revenue but would be a weak political tool in the attempt to curb consumption. However, taxes on alcohol and tobacco would have some effect on consumption but would not be a significant source of government receipts. As evidenced by the calculated equivalent variations, forcing consumers to change consumption habits by applying a tax decreases their short-run welfare for tobacco, alcohol, and FAFH with lower incomes facing a higher level of welfare loss than higher incomes.

The question remains as to whether or not “sin taxes” are actually an effective health policy tool. However, even if the taxes do not cause significant changes in the consumption of these potentially harmful goods, government revenue could still be generated which may be put

toward other means of curbing consumption. The revenue could finance subsidies for exercise equipment or healthy foods. It could also be used to fund healthy eating, responsible drinking, or anti-smoking advertising campaigns.

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