Tobacco Product Demand, Cigarette Taxes, and Market Substitution

By Michelle Da Pra[1] and Carlos Arnade[2]

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[1] U.S. Department of Agriculture, Economic Research Service, 1800 M Street, NW, Washington DC, 20036-5831 mdapra@ers.usda.gov
[2] U.S. Department of Agriculture, Economic Research Service, carnade@ers.usda.gov

"Economic theory proceeds largely to take wants as fixed. This is primarily a case of division of
labor. The economist has little to say about the formation of wants; that is the province of the psychologist. The economist's task is to trace the consequences of any given set of wants”

- Milton Friedman (1962)

Introduction

Strategies aimed at limiting tobacco consumption are at the forefront of U.S. health and international policy. Proposed legislation in 2009 includes: ratification of an international treaty to curb tobacco use through price and non-price measures and regulation of tobacco products by the Food and Drug administration (FDA)[3]. Additionally on February 4, 2009, congress enacted an increase in the Federal tax rate on cigarettes from $.61 to $1.01 per pack, along with increases in other tobacco taxes, to fund expansion of the State Children's Health Insurance Program (SCHIP). The federal tax increase went into effect April 1, 2009, while the effect on cigarette consumption and extent of substitution to other tobacco-containing products remains unknown.

There is extensive literature estimating cigarette demand elasticity and how cigarette consumption is effected by real and relative price increases, including tax increases. However understanding the entire market for tobacco products in order to assist public policy makers in grappling with tobacco consumption implies estimating more than cigarette consumption. No studies that we are aware of consider the cross-price effects or substitutability of cigarettes with other tobacco-containing products. Industry sources increasingly claim that consumers are switching tobacco consumption away from cigarettes toward other tobacco products such as chewing tobacco, and cigars due to lower monetary or perceived health costs. A perception of reduced health effects and reduced public externalities from smoking cigarettes make chewing tobacco a likely substitute for cigarettes. Additionally, an increase in public smoking restrictions outside designated smoking areas, and increases in per capita consumption of cigar-type and dark

[3] On April 2, 2009, the U.S. House of Representatives voted 298-112 to approve H.R. 1256 The Senate will next consider the legislation. Library of Congress, THOMAS http://www.thomas.gov/cgi-bin/query/z?c111:H.R.1256

tobacco suggests cross-commodity analysis is needed to fully study tobacco product demand and substitutability and the effects on U.S. tobacco growers.

This paper presents a model of estimated demand for four tobacco products: cigarettes, cigars, chewing tobacco, and smoking tobacco products[4]. Own elasticities and cross-price elasticites are used to obtain insights into the effectiveness and implications of new policy measures. Of particular interest is whether substitution of various tobacco products varies by market outlet. In addition to estimating overall demand for the four tobacco products—cigarettes, cigars, chewing tobacco and roll-your-own tobacco—models are also estimated for tobacco products from three specific outlets: grocery stores, drug stores, and convenience stores. Tests are applied to determine if consumers first choose tobacco products and then choose the outlet of purchase, or whether outlet and product choices are jointly made. The paper investigates whether the various outlets, for example drug and convenience stores, substitute or complement each other and briefly deals with the issue of the premium consumers pay when purchasing tobacco products at convenience stores.

The next section discusses various issues related to tobacco demand, pricing, and policy. The following section introduces a standard demand system, which is used to model tobacco consumption. After that, estimated models and various test results are presented. The next section briefly discusses these results and deals with the issue of the convenience store premium. This is followed by a brief conclusion.

[4] Smoking tobacco products include Roll-your-own tobacco, loose leaf tobacco and pipe tobacco

Tobacco Leaf Consumption and Production

Achieving a better understanding of the relationships among the tobacco products, such as cigarettes, relative to other tobacco products may also allow agricultural economists and growers to better anticipate the future of domestic tobacco leaf demand. Per capita tobacco product consumption in the United States continues to decline although the decline in the consumption of overall tobacco products is not as steep as it is for cigarettes. For example, from 1996 to 2006 per capita cigarette consumption declined 29.2% while per capita consumption of tobacco products in general declined 15.2%, suggesting that the share of per capita tobacco consumption for products other than cigarettes may be growing (ERS, Tobacco Outlook 2007). Additionally, U.S. per capita consumption of cigars has increased almost every year for the past ten years (ERS Tobacco Outlook 2007). It is not clear whether the increase in cigar consumption reflects a response to price or tax increases on cigarette consumption, is a result of other restrictions imposed on consumers of cigarettes or is independent from cigarette prices and restrictions. In any case, policies that restrict and tax certain tobacco products, like cigarettes, at higher rates that other tobacco products may produce uncertain outcomes if the interrelationship among tobacco products is not well understood. [5]

Although per capita consumption has been shown to decrease, the total domestic consumption of nonsmoking tobacco, especially snuff, has increased steadily since the 1980's as workplace and restaurant smoking restrictions expanded (Bickers, March 15, 2006). Additionally, total U.S. consumption of cigars and smoking tobacco has risen over the past five years, while consumption of cigarettes has fallen (Table 1).

[5] Tobacco Outlook: http://usda.mannlib.cornell.edu/usda/ers/TBS//2000s/2007/TBS-10-24-2007.pdf

Table 1-- Total U.S. consumption of cigarettes, cigars and smoking tobacco 1998-2007 1

	Cigarettes	Cigars 2/	Smoking tobacco:
	billion cigarettes	*million cigars*	*million pounds*
1998	465	3,655	14.9
1999	435	3,845	15.1
2000	430	3,850	14.5
2001	425	4,107	16.8
2002	415	4,206	18.0
2003	400	4,527	18.7
2004	388	4,935	17.0
2005	376	5,121	19.4
2006	371	5,298	19.7
2007 3/	353	5,550	20.1

1/ Consumption is total removals (or sales) from U.S. factories plus those from Puerto Rico, and imports
2/ Includes Large Cigars and Cigarillos
3/ Economic Research Servive Discountinued Situation and Outlook Reporting on Tobacco after 2007

The demand for U.S. dark and cigar tobacco leaf types differs considerably from burley and flue-cured tobacco, used primarily for cigarettes. After the 2004 tobacco buyout, prices for dark and cigar tobacco fell less the prices for burley and flue-cured tobacco, while prices for cigar tobacco (types 41-61) have increased (Economic Research Service, *Tobacco Outlook)*. Since dark tobacco is used in snuff, the demand for dark tobacco has increased and the prices for dark tobacco have fallen less than for burley and flue-cured tobacco. With little competition from foreign dark tobacco producers and rising domestic demand, U.S. dark tobacco producers have seen smaller impacts from the tobacco buyout than burley and flue-cured tobacco producers (Dohlman, Foreman and Da Pra, *forthcoming* 2009). Rising demand along with higher prices and yields have led to increases in dark tobacco acreage. Acreage of dark tobacco expanded 67 percent between 2004 and 2008 compared with a 37 percent decline for burley tobacco and 1 percent decline for flue (NASS). After the tobacco buyout in 2004, some tobacco farmers may have switched from burley tobacco acreage to dark tobacco acreage since dark tobacco is more profitable than burley and the production region for many of the dark tobacco types overlap with the burley production regions (Snell, June 2008).

Tobacco Product Consumption and Policy

Because tobacco growers are affected by tobacco product demand, studying the effects of shifting demand in the product market may help growers determine what type of tobacco to grow and market. Only by measuring the cross-price effects of tobacco product consumption can one determine if the increased consumption of tobacco products, other than cigarettes, is a function of cigarette prices or instead, a function other factors. Of particular interest is whether smoking tobacco products, such as chewing tobacco, and smoking tobacco products, are responsive to changes in the prices of cigarettes and cigars.

While information on cross-price elasticites can be useful it should be noted that policymakers have little information related to the fundamental issue of consumer reaction to *own* price increases in tobacco products. For example, previous studies of cigarette consumption display wide disparities in elasticity estimates and have been shown by Gallet and List to be sensitive to demand specification, estimation methodology, and the type of data used. The mean price elasticity among 86 studies has been shown to be -.48 for cigarettes but ranges from -3.12 to 1.41 with large standard deviations[6]. This wide disparity of own elasticity result estimates, in light of recent legislation to increase Federal cigarette taxes, illustrates the need for further investigation of consumer response to increases in the price cigarettes.

The sensitivity of consumer response to price changes of tobacco products may shed light on whether overall increased public health can be achieved by raising cigarette taxes. Recent Federal legislation raising cigarette taxes may improve public health two ways: by decreased cigarette consumption and by raising revenue for the State Children's

Health Insurance Program (SCHIP). That is, while there exists a range of elasticity estimates where both goals can be met, improvement in one goal comes at the expense of the other, as negative elasticities represent an improvement in public health along with decreased Federal revenues and positive elasticities represent the reverse scenario. If demand for cigarettes is heavily elastic, only health-related goals related to decreased consumption can be attained by raising cigarette taxes, at the expense of decreased revenue for SCHIP.

The argument of contradictory health goals in relation to elasticity estimates and taxes also applies to states facing budget shortfalls that may look to increase cigarette taxes both as a means of improving public health and for revenue raising purposes. This point is illustrated in Figure 1.[7] Movement along the X-axis reflects a rising elasticity of demand for cigarettes. At zero elasticity the revenue enhancing goal reaches its full potential raising revenues by the amount of the tax increase times the quantity sold.

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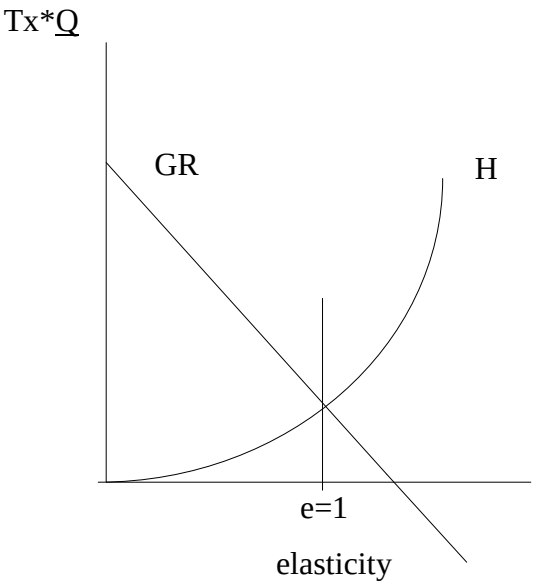
[6] Craig A. Gallet and John A List: "Cigarette Demand: A Meta-analysis of Elasticities" http://www3.interscience.wiley.com/journal/101520325/abstract

[7] If demand is downward sloping any rise in taxes will reduce tobacco consumption and produce some health benefit. This is why the health benefit curve in Figure 1 rises from the x and y axis origin.

Figure 1: Health Benefits from Cigarette Tax: Reduced Consumption versus Decreased Revenue



It's interesting to note, the health benefits when the elasticity is zero are also zero. As consumption becomes more elastic, the health benefits from reduced consumption rises and the revenue benefit falls. When the elasticity equals one there is no government revenue benefit but the health benefit from reduced consumption is significant. As elasticities rise above one, the health benefit from reduced consumption continues to rise but the revenue "benefit" becomes not a benefit, but a loss. Changes in the level of the tax produces a non-parallel shift where the health benefit, crossing the origin, and the revenue benefit cross at one (figure 1).

Data: Retail Outlet Sales of Tobacco Products

For our analysis of tobacco product retail sales, we used monthly national level supermarket, drug, and convenience store scanner data of cigarettes, cigars, chewing tobacco, and smoking tobacco from September 2006 to September 2008[8]. Aggregate-

[8] While Store and Drug store sales were available from July 2003 to September of 2008 convenience store data was only available from September 2006- September 2008. We estimated data from this later period as convenience store sales are essential to the study.

level scanner data was compiled by AC Neilson Marketing Research to estimate sales for eight U.S. regions and summed to a national total, representing roughly 90% of the U.S. retail market for tobacco products[9][10]. Nielsen's definition of a grocery store is any store selling dairy, produce, fresh meat, packaged food and nonfood items with annual sales of $2 million or more.

This study estimates demand for tobacco products by market outlet—grocery store, drug store, and convenience store—to determine if consumers respond similarly to price changes. If so, the effect of raising tobacco product taxes will have differential effects on various retails establishments. Also, we are interested in whether retail market outlet sales substitute or complement one another. For most products, purchases from a particular retail outlet would likely substitute purchases in another particular outlet. However, because many economists characterize tobacco product consumption as addictive and habit-forming, retail outlet sales of tobacco products may complement one another due to imperfectly rational purchasing (Becker and Murphy 1988).

Consumers pay more for tobacco products in convenience stores (table 12).[11] There are many factors which can influence the difference in retail prices of a particular product. For example, retailers may be able to price discriminate between consumers who purchase at drug and grocery stores. Grocery store consumers may purchase cigarettes while shopping for other grocery products and may not be able to switch to purchasing a tobacco product at a drug store—especially if one is not located nearby— if the grocery price is high. On the other hand, drug store buyers may be unwilling to enter a grocery

[9] The study does not account for the wholesale market, direct internet sales, illegal sales, or Indian reservation sales.
[10] Data does not include price discount due to coupons or frequent shopper cards and may contain errors when aggregating across grocery, drug store or convenience store chain. Although scanner data may contain some errors, it remains one of the most accurate measure of prices paid at the retail level (Federal Trade Commission)

(food) store to purchase tobacco products or consumers may not know which grocery stores carry tobacco products and where stores are located.

In summary, various retail outlets may be segmented markets, where sellers face distinct elasticities, and have enough market power to raise prices to an optimal level. One necessary condition for practicing price discrimination is that consumers have distinct elasticities. In the results section, it is shown that for each tobacco product, the elasticity of demand is different according to the outlet in which it is sold.

Product Demand Model

Our model was specified as a standard linear Almost-Ideal Demand System, AIDS (Deaton and Muellbauer), and a specific functional form frequently used in demand studies using consumer data. Share equations for tobacco products are specified as:

1) $S_{it} = \alpha_i + \gamma_i * S_{i,t-1} + \sum_{t=1}^{4} \beta_{ij} \ln(P_{jt}) + \lambda_{ij} \ln(E_t /(PS)_t) + \varepsilon_i$ t=1, 2…T

Where the S_i's are the expenditure shares for i[th] item of four tobacco products, lnP_j are log prices, and *E/PS* is total expenditures on tobacco products deflated by the price index of tobacco products. The price deflator is the Stone's Price Index (Deaton and Muellbauer 1980):

2) $PS = \sum_{j=1}^{6} S_i \ln(P_{it})$

[11] . Its would be interesting to know to what extent this price difference represents the price of convenience to consumers. In this paper we do not fully address this issue.

The restriction $\beta_{ij} = \beta_{ji}$ was imposed to insure symmetry. Homogeneity was imposed by the restriction $\sum_{j=1}^{6} \beta_{ij} = 0$. Adding up implied that for each j $\sum_{i=1}^{6} \beta_{ij} = 0$, $\sum_{i=1}^{6} \alpha_i = 1$, and $\sum_{i=1}^{6} \lambda_i = 0$. The adding-up restrictions were used, along with symmetry and homogeneity restrictions, to obtain the parameters of the dropped equation. Because habit formation tends to be an important factor with tobacco product consumption, a lag dependent variable (lag shares) was included in the model.

Combining product level data with outlet data makes possible the estimation of the following model:

3) $S_{i,k} = \alpha_{i,k} + \gamma_{i,k},*S_{,ki,t-1} + \sum_{k=1}^{3} \sum_{j=1}^{4} \beta_{ij,k} \ln(P_{k,t}) + \lambda_{i,k} \ln(E_t / PS_t) + e_{i,k}$

Where the subscript k denotes: grocery stores, drug stores, and convenience stores.

In the model portrayed in equation 3, consumers make both product and store choices simultaneously. A likely alternative to this model is a two-stage budgeting model where first equation 1 is estimated first, and then a product-specific retail outlet choice model is estimated. The two-stage budgeting model rests on the assumption that retail outlet choice for different products are separable. Given the small size of our sample data, the fact that chewing tobacco and smoking tobacco make up such small shares of sales, and given the potential for multicollineary when all 12 prices are included in each equation, estimating a two stage model is hypothesized to yield a better fit.

Model Results

Product and Retail Outlet Shares

Tables 2-4 report the mean, maximum, and minimum expenditure shares of each the tobacco products. Table 2 reports the product share across all outlets and illustrates the degree to which cigarettes dominate the tobacco product market. On average cigarettes represent 92 percent of expenditures on tobacco products, while cigars, chewing tobacco and smoking tobacco represent 3, 4, and .7 percent of the market, respectively.

Table 2: Descriptive Statistics, Tobacco Product Shares

	Mean	Max	Min
Cigarettes	0.92	0.92	0.92
Cigars	0.03	0.03	0.03
Chew	0.04	0.05	0.04
Smoking	0.007	0.010	0.006

Table 3 lists product shares in the three different retail outlets and indicates that cigarettes large dominant share is robust across product markets, and is not that much different than cigarette shares of expenditures in the overall market.

Expenditures on chewing tobacco represent 4% of overall tobacco product expenditures on average, but shares vary across the different outlets, ranging from 6% of tobacco product expenditures at grocery stores, to 1% at drug stores (table 3).

In contrast, expenditures on cigars represent 3% of overall tobacco product expenditures but are sold more at drug stores, where cigars represent an average of 5% of expenditures on tobacco products. Consumer expenditures on smoking tobacco products are barely over one half of 1% over overall tobacco expenditures. However in drug and grocery stores they have reached 1% of expenditures.

Table 3: Tobacco Product Shares, by Market

	Mean	Max	Min
Grocery Stores			
Cigarettes	0.91	0.92	0.91
Cigars	0.02	0.02	0.02
Chew	0.06	0.06	0.05
Smoking	0.01	1/	1/
Drug Stores			
Cigarettes	0.94	0.94	0.93
Cigars	0.05	0.05	0.04
Chew	0.01	0.01	0.01
Smoking	0.01	0.01	0.01
Convenience Stores			
Cigarettes	0.92	0.93	0.92
Cigars	0.03	0.03	0
Chew	0.04	0.05	0.04
Smoking	0.002	0.002	0

1/ Yet to calculate

Table 4 in contrast, presents the outlet shares of expenditures for each tobacco product. Consumer expenditures at convenient stores represent almost half of all cigarette purchases while drug stores only represent 18%. A similar story holds for Cigars and Chewing Tobacco. It is interesting to note that over half all expenditures on Chewing Tobacco occurs at convenient stores. Retail outlet sales for Smoking tobacco products appear to be different than other tobacco products. In contrast to the other products, almost 60% of smoking tobacco products are purchased at grocery stores and only nine percent are purchased at convenient stores.

Table 4: Tobacco Market Shares, by Product

	Mean	Max	Min
Cigarettes			
Grocery	0.35	0.42	0.32
Drug	0.18	0.24	0.16
Convenience	0.47	0.48	0.34
Cigars			
Grocery	0.26	0.32	0.25
Drug	0.28	0.34	0.26
Convenience	0.46	0.48	0.33
Chew			
Grocery	0.47	0.58	0.43
Drug	0.027	0.04	0.02
Convenience	0.51	0.54	0.39
Smoking			
Grocery	0.58	0.62	0.58
Drug	0.33	0.35	0.31
Convenience	0.09	0.11	0.06

1/ Yet to calculate

Estimated Model Results

Several variations of the tobacco product-outlet models were estimated using iterative SUR. In the most general form, a large system an AIDS system of 11 share equations, representing consumers who jointly make Product and Outlet decisions (4 products, 3 outlets) was estimated without imposing any economic restrictions on model parameters. Since error terms must sum to zero, one equation, representing chewing tobacco sold at drug stores, was dropped.

Estimating variations of this model included imposing the economic restrictions of symmetry and homogeneity, dropping the lagged shares, doing both, and imposing a restriction consistent with separability between the two smoked and non-smoked tobacco products. Table 11 presents the χ^2 statistics from likelihood ratio tests, with various

restrictions to test models which are nested within the most general model. The imposition of economic restrictions on the most general model significantly reduces the maximum value of likelihood function. Thus, these restrictions are rejected. That imposition of separability between smoked and smoking products is similarly rejected. The imposition of the restriction on that the coefficient on the lag (dependent) share variable is zero comes close (or is barely) to be rejected.

Using these test results alone, there would be several problems with using the least restricted model. One, with 24 months of data the sample size is small, and the model is limited by the number of degrees of freedom. Reducing the number of variables in each equation may improve the quality of the model and tests derived from it. Two, in this most general model shares can be extremely small, (i.e. the share of total expenditures represented by purchases of smoking tobacco at convenience stores) which could lead to large or unstable elasticity estimates. Three, with twelve tobacco product prices in each equation, multicollinearity may be a problem. Fourth, and perhaps unrelated to the other problems, we found that the estimate of the price elasticity for cigarettes at grocery stores was the wrong sign when estimating the most general model and it's related counterpart model containing economic restrictions imposed on the parameter estimates.

Two Stage Models

Several two stage budgeting models were estimated. A three equation model, similar to that shown in equation 1, was estimated and represents consumers' decision to purchase the four tobacco products (See appendix for model results). Chewing tobacco

represented the dropped equation. Four separate product-specific models where also estimated and represent consumers' choice of an outlet to particular purchase a tobacco product. In contrast to the joint-product-choice model this model rests on the assumption that consumers first choose a tobacco product and then choose where to purchase it, an assumption that was rejected in testing the larger model.

The two-step model has several advantages over a larger model. First, each equation in the top stage model has only four product prices and lower stage models have three outlet prices for the products. Thus, there are more degrees of freedom for each equation and less potential for multicollinerity problems. Second, this specification fits the intuition of how such choices are made. One could easily interpret that buyers of tobacco products first decide that they want to smoke (or chew) and then decide where to purchase their tobacco products. Third, in contrast to the joint-product-outlet decision model, the two stage models produced reasonable elasticity elasticties for cigarettes, which represent the key tobacco product.

Table A1 (appendix) presents the top stage product choice model. Each of the lag shares have significant T statistics and estimated parameters are consistent with the notion that there is a certain amount of habitual consumption of tobacco products (see Appendix). Interestingly "T" statistics for expenditure parameters on cigars and smoking products are significant but not for the more commonly consumed cigarettes. Most coefficients on the estimated prices are significant, though the own price coefficient of cigarettes is not. Despite, the largely reasonable model results, the low "T" statistic on cigarettes means additional model specification is needed to come up with a reasonable

elasticity measure to compare with the wide range of reported cigarette elasticity estimates in the literature.

Table 5: Top Stage Model: Impact Elasticities, Lagged Dependent Variables

	Cigarettes	Cigars	Chew Tob	Smokeing
Impact				
Pcg	-1	0.4	-0.4	1.8
Pcar	0.01	-0.5	-0.5	-1.2
Pcw	-0.02	-0.7	0.1	-1.1
Pnk	0.01	-0.2	-0.1	-0.6
Expend	1	1.01	0.96	1.05
Long run				
Pcg	-1.02	0.98	-0.32	1.6
Pcar	0.1	0.12	-0.33	-1.06
Pcw	-0.16	-1.58	-0.21	-0.98
Pnk	0.08	-0.54	-0.11	-0.61
Expend	1.01	1.03	0.96	1.05

1/ Pcg, Pcar, Pcw and Pnk represents the price of cigarette, cigars, chewing tobacco, and smoking tobacco repectively
2/ Large elasticities for cigar, chew and smoking reflects the products' small shares of tobacco consumption

Table 6: Top Stage Model Elasticities, No Lag Dependent variable

	Cigarettes	Cigar	Chew Tob	Smoking
Pcg	-1.52	-16.6	36.1	-99.1
Pcar	-0.55	-14.6	35.3	-103.7
Pcw	1.65	51.9	-102.2	221.4
Pnk	-0.58	-20.7	30.2	-26.5
Expend	1.01	-0.04	0.63	7.94

1/ Pcg, Pcar, Pcw and Pnk represents the price of cigarette, cigars, chewing tobacco, and smoking tobacco repectively

Table 5 reports elasticity estimates from the top stage model. Combining product elasticity estimates from table 5 with model statistics reveals that prices of other tobacco products (non-cigarette) play a significant role in consumers' decisions to purchase cigarette; in other words, cross-price parameters are significant. This result is robust to whether or not you use a lagged dependent variable (table 6). Interestingly, cigarettes and cigars are substitutes, while smoking tobacco products are also substitutes for cigarettes and chewing tobacco consumption complements cigarette consumption. This is an

important finding since smoking tobacco and cigars are intuitively closer substitutes for cigarettes because they are inhaled and combustible. This may imply that raising the federal price on cigarette prices without raising taxes on smoking tobacco or cigars could foster consumers to switch to other tobacco and nicotine-containing products.

Since the model contains a lagged dependent variable, long run elasticities were estimated (table 5). These estimates represent consumer response to a sustained change in price. Most importantly, we see that chewing tobacco, which has a reverse consumer response to a price change in the short run, has the correct own price elasticity in the long run, while the opposite is true for cigars. Given the strength of tobacco habits and given the increase in chewing tobacco consumption over time, the habitual nature of tobacco consumption, and consumer perceptions that price may be related to quality, positive elasticites for chew that should not be surprising. Another interesting aspect of consumer response estimates is that the impact elasticity for smoking tobacco products is slightly higher than the long run response. Again, such behavior should not be viewed as unusual for products where habitual consumption is strong.

Second Stage Models

Tables 7-10 present the four second stage retail outlet choice models for cigarettes, cigars, chewing tobacco, and smoking tobacco. Cigarette and smoking tobacco retail outlet choice coefficients were insignificant, meaning one must be careful in attaching much confidence in reported elasticity estimates (Table 7 and 8). And in one model, the chewing tobacco model produced wrong sign estimates.

Table 7: Second Stage Elasticities: Cigarettes

	Grocery	Drug	Convenience
Pgs	-0.99	-0.05	-0.69
Pds	-0.03	-3.87	0.77
Pvs	-0.02	2.94	-2.14
Expend	1.07	0.92	0.98

Despite this, some useful information can be gleaned from this second stage model. First, we can be reasonably confident that cigarettes purchases in drug stores and convenient stores are generally more elastic than purchases at grocery stores. This may reflect that fact that grocery store shoppers may be weighed down by other purchases and find grocery store purchases more convenient than making a separate stop at an alternative location for cigarette purchasing. It is also noted that for cigarette consumption, increases in grocery store prices causes decreases in both drug and convenient store outlets (complementary), while drug and convenient stores outlets substitute for one another. This may because drug stores and convenience stores are more apt to advertise specials on cigarettes and market to impulse buyers, while grocery store consumers are less flexible in shifting to other markets.

Table 9: Second Stage Elasticities: Chewing tobacco

	Grocery	Drug	Convenience
Pgs	0.52	2.19	-1.34
Pds	0.12	-0.12	-0.15
Pvs	-1.85	-3.31	0.67
Expend	1.39	1.26	0.63

Table 8: Second Stage Elasticities: Smoking tobacco

	Grocery	Drug	Convenience
Pgs	-0.92	-0.33	0.72
Pds	-0.17	-0.69	0.04
Pvs	0.1	-0.01	-1.7
Expend	1	1.03	0.93

For cigars, more confidence can be attached to parameter estimates. Here convenience stores substitute for both drug and grocery stores. Because, roughly half of

cigar purchases are made at convenience stores and a likely explanation for positive coefficients is the explanation that specials on bulk purchasing (discounts) advertised at convenience stores likely works very effectively on decreasing purchases in other outlets. Generally, cigar purchases tend to be highly elastic (own-price elasticities are high) where cross-price elasticities between grocery and drug stores tend to be marginally elastic.

Table 8: Second Stage Elasticities: Smoking tobacco

	Grocery	Drug	Convenience
Pgs	-0.92	-0.33	0.72
Pds	-0.17	-0.69	0.04
Pvs	0.1	-0.01	-1.7
Expend	1	1.03	0.93

For smoking tobacco, purchases in grocery and drug stores tend to be more elastic than in the convenience outlet, probably because less than one percent of smoking tobacco is purchased at convenience stores (table 3). As with cigars, convenience outlets substitute for the drug and grocery store outlets.

Table 8: Second Stage Elasticities: Smoking tobacco

	Grocery	Drug	Convenience
Pgs	-0.92	-0.33	0.72
Pds	-0.17	-0.69	0.04
Pvs	0.1	-0.01	-1.7
Expend	1	1.03	0.93

Tests

Both a full single system equation, as represented by equation 3 and systems of two-stage models were estimated using iterative SUR. Tests were applied to the single system indicated that, the products were not separable and the both store and product choices appear to be made jointly (Tables 11 and 12). However such tests can be viewed with suspicion due to the limited degrees of freedom and the counterintuitive nature of the model.

Table 11: Tests: Joint Model

	χ^2	DF	Sig
Sep, product 1/	734	66	0.01
Sep, out 2/	778	60	0.01
No lags 3/	196	11	0.01
Economics 4/	154	61	0.01

1/ Tests if chewing tobacco and smokeless are separable from cigars and cigarettes
2/ Tests if convenience store outlets are separable from grocery and drug store outlets.
3/ Tests if lag dependent variables belong in the model
4/ Tests if economic restrictions hold
5/ All tests are significant indicating that restricting the model significantly reduces the model fit.

Furthermore, the joint model produces wrong sign price elasticity for cigarettes consumed from grocery store. In contrast, the two stage model which uses only four prices in the top equation and 3 prices in subsequent 2nd stage systems produced reasonable product elasticity estimates (table 12). Most important is the assumption that the cross price affects are symmetric among the various products. Additionally, in the second stage model, we failed to reject the null hypothesis that the cross price effects are symmetric across all equations in the system wide model and three out of four coefficients produced significant and reasonable elasticity measures.

Table 12: Tests: Top Stage Model

	χ^2	DF	Sig
No Econ R			
Sep, product 1/	71.6	6	0.01
Eco R 2/	313	6	0.01
Econ R			
Sep, product 1/	140.8	6	0.01
No lags 3/	4	3	NS

1/ Sep, products, tests if chewing tobacco and smoking are separable from cigars and cigarettes
2/ Tests if economic restrictions hold
3/ Tests if lag dependent variables significant in the model with economic restrictions imposed.

Price Premiums

Prices at convenience stores appear to be highest, reflecting that consumers are willing to pay premiums for convenience in these stores. Table 13 shows how much consumer expenditures at convenience stores would raise or fall on average if convenience store prices were set equal to grocery store prices. Two estimates are presented; one if convenience store prices were lowered to grocery store prices with no change in consumer purchases (Elas=0) and two, if consumers at convenience stores reacted to the price change, to a degree consistent with estimated elasticities (*Elas=estimate*).

Table 13:**Convience Store Price Premium**

Product	**Direction**	**Expenditure %Change**	**Expenditure %Change**
		Elas=0	*Elas=estimate*
Cigarettes			
	down 1/	17%	
	up 2/		13.20%
Cigar			
	down	58%	
	up		6.80%
Chw tob			
	down	28.70%	42.40%
	up		
Smoking			
	down	36.60%	
	up		2.90%

1/ For example, if the convenience store price were lowered to the price of grocery stores and consumption did not change consumers would spend 17% less on cigarettes at convenience stores. Thus, 17% representing the percentage of expenditures consumers are spending for convenience.
2/ For example, if convenience store prices were lowered to the price grocery stores and consumption allowed to adjust consumption based on estimated price elasticities, expenditures on cigarettes at convenience stores would rise 13.2%. This assumes prices at other outlets remain constant.

Estimates are presented in percentage terms. For the case where convenience store elasticities are assumed to be zero, the reported number is equivalent to the price percentage price markup at convenience stores over grocery stores. This average markup is 17% for cigarettes, 58% for cigars, 29% for chewing tobacco, and 36.5% for smoking

tobacco. Convenience price markups on drug store prices are about half is as high, for three products: cigarettes, cigars and smoking tobacco. However for smoking tobacco, convenience store markups over drug store prices are even higher than the markup over grocery store prices.

Table 13 above reports the percentage that consumer expenditures would fall (or rise) at convenience stores if prices were set to grocery store levels. If consumers are assumed to respond to the price changes, expenditure at convenience stores would fall 17% for cigarettes, 58% for cigars, 29% for chewing tobacco, and 36.5% for new smoking tobacco. Such numbers indicate that consumers who purchase items at convenience stores are willing to pay a considerable amount of money for "convenience". When consumers are assumed to respond in a manner consistent with estimated results, the quantity of consumption increases so that convenience store expenditures rise 13.2% for cigarettes, 6.8% for cigars, and 2.9% for smoking tobacco. Chewing tobacco expenditures fell; however, the chewing tobacco model did not produce credible elasticity estimates.

Conclusion

Most consumer expenditure on tobacco products is on cigarettes and half of these expenditures occur in convenience stores. Results from two stage budgeting models confirm that it is difficult to pinpoint an elasticity measure for cigarettes and thus, the effects of cigarette tax increases on cigarette consumption is undetermined. However, model results confirm that other tobacco-containing products, which are combustible, such as smoking tobacco and cigars are likely substitutes for cigarettes. Additionally, these results vary by market outlet, with general results of convenience stores substituting for grocery and drug stores. Preliminary model results suggest that increases in cigarette

taxes without notable increases in other products may have the effect of consumers switching to other tobacco products. Therefore, more analysis on the sensitivity of substitution to the level of price increased, and the robustness of our model, is necessary.

Future research into this topic will include analysis of quality and brands into the nature of consumer substitution between tobacco products. Due to the addictive nature of most tobacco products and patterns of irrational buying, we look to incorporate different lags into the model and check overall robustness of our results. Lastly, we look to incorporate a longer time series (spanning back to 1998) and possibly include purchases of smoking aids (nicotine gums and patches) into future analysis.

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Appendix: Estimated Model Results for Two-stage Model

Table A1 Top Stage: Product Model

(LLF=334) [1]

	Cigarettes		Cigars		Smoking	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Constant	0.173	1.15	0.081	3.08	0.029	2.43
Lg Share[2]	0.857	5.54	0.571	3.98	-0.1	-0.84
Lpcigarette	-0.003	-0.22	0.013	2.34	0.01	3.82
Lpcigar	0.013	2.34	0.014	2.14	-0.007	-3
Lpchwtob	-0.02	-1.84	-0.02	-2.53	-0.006	-2.45
Lpsmkless	0.01	3.82	-0.007	-3	0.003	1.03
LENT	0.001	1.02	0	0.75	0	1.3

1/ The log of the Likelihood Function at Maximum
2/ Lg share represents the coefficient on the lag dependent share variable.
3/ Lp refers to the log of price. The term chwtob refers to chewing tobacco. Lent represent total expenditure on
4/ Three share equations were estimated using SUR. Chewing tobacco represents the dropped equation.

Table A2 Second Stage: Outlet Model

Cigarettes (LL=168)[1]

Grocery			Conv[2]	
Variable	Coeff	T-Stat	Coeff	T-Stat
Constant	0.69	4.13	0.476	1.59
Lg Share	-0.145	-1.21	-0.163	-1.21
Lpgstore	0.001	0	0.005	0.01
Lpdrg store	-0.006	-0.02	0.527	1.25
Lpcnv store	0.005	0.01	-0.532	-0.52
Expcg	0.023	1.47	-0.009	-0.33

1/ The Log of the Likelihood Function at Maximum
2/ Conv refers to Convenience Stores
3/ The above model represents cigarette consumption by outlet.

4/ Lg Share represents the lag share variable.
5/ Lpgstore is the log price of cigarettes as grocery stores, Lpdrg at drug stores, and Lpcnv at convenience stores.
6/ Expcg represents total expenditures on cigarettes

Table A3. Second Stage: Outlet Model

	Cigars (LLF =169)			
Grocery Store			**Conv**	
Variable	**Coeff**	**T-Stat**	***Store*** **Coeff**	**T-Stat**
Constant	0.42	6.74	-.002	-0.11
Lg Share	01	0.61	0.11	0.77
Lpgstore	-0.126	-1.81	0.25	2.00
Lpdrg store	-0.13	-1.86	0.24	1.76
Lpcnv store	0.25	2.00	-0.49	-1.95
Expcg	,002	3.52	-0.037	-3.93

1/ Similar interpretation as table A2.

Table A4. Second Stage: Outlet Model

	Chewing Tobacco (LLF =192)			
Grocery Store			**Conven Store**	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Constant	0.898	12.37	0.898	12.02
Lg Share	-2.137	-2.82	2.304	2.86
Lpgstore	0.709	1.43	-0.768	-1.45
Lpdrg store	0.060	1.67	-0.082	-2.17
Lpcnv store	-0.768	-1.45	0.851	1.51
Expcg	0.181	2.88	-0.188	-2.79

1/ Similar interpretation as A2.

Table A5 Second Stage: Outlet Model

	Other Tobacco		(LLF =192)	
Grocery Store			Convn Store	
Variable	**Coeff**	**T-Stat**	**Coeff**	**T-Stat**
Constant	0.569	4.07	0.287	4.86
Lg Share	0.081	0.45	-0.084	-0.49
Lpgstore	0.046	0.31	0.058	0.55
Lpdrg store	-0.104	-1.33	0.002	0.03
Lpcnv store	0.058	0.55	-0.060	-0.59
Expcg	-0.002	-1.31	-0.006	-3.16

1/ Similar interpretation of A2.