Elasticity of Demand for Cigarettes in the US: Evidence from Quantile Regression Analysis

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Introduction and Motivation

- Tobacco is the leading cause of preventable and premature death in US.
- 443,000 people die annually due to tobacco use.
- Annual expenses exceed $210 billion in direct medical costs and lost productivity.
- Over 3,800 young people under 18 smoke their first cigarette every day and over 1,000 become daily smokers.
- Vast majority of these young Americans will become addicted to nicotine by young adulthood.
- 99% initiate smoking by age 26.
- **Taxation** has been one of the main tools available to policymakers for reducing tobacco use and regulating the industry.
- It is intended to increase prices for tobacco products and, hence, reduce its consumption while generating revenues for the government.
- Price and income elasticities of demand for cigarettes and other tobacco products are essential elements of tobacco taxation policies.
- Estimation of elasticities across consumption levels (quantiles) is more accurate representation of tobacco consumption patterns and can better aid designing more effective tax policies.

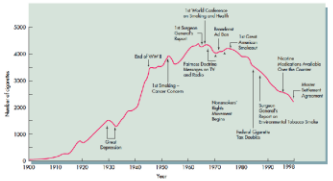

Figure 1. Adult per capita cigarette consumption and major smoking and health events in United States, 1900-1998
Source: Hanson, Venturelli, and Fleckenstein (2009)

Objective

- Previous literature on cigarette elasticities relied on the conditional mean effects of price, income and other determinants of cigarette demand.
- This latter approach does not recognize the heterogeneity across different consumption levels that may be a result of vast differences in terms of consumer income and preferences.
- Therefore, elasticity estimates that are obtained via standard econometric models will likely result in erroneous policy advice and biased forecasts of future demand for cigarettes.

> *What the regression curve does is give a grand summary for the averages of the distributions corresponding to the set of x's. We could go further and compute several different regression curves corresponding to the various percentage points of the distributions and thus get a more complete picture of the set.*
>
> - Koenker and Hallock. *Journal of Economic Prospectives*, 15(4):143-156, 2001.

- The **objective** of this study is to analyze demand for cigarettes in the US using quantile regression framework, which allows to estimate demand elasticities across the different consumption and income contexts.
- Our approach accounts for these inherent differences in cigarette consumption and has the promise of leading to more informed policies.

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Data

- National Adult Tobacco Survey, 2009-10, Centers for Disease Control and Prevention.
- Stratified, national, landline, and cell phone survey of non-institutionalized adults aged 18 years and older residing in the 50 states or District of Columbia.
- Data are representative and comparable at both national and state levels.
- The sample design also provides national estimates for subgroups defined by gender, age, and race/ethnicity.

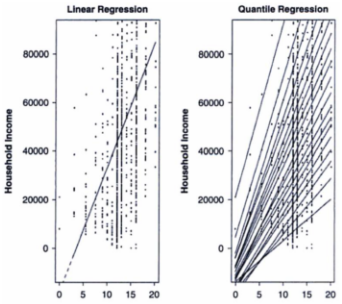

Figure 2. Conditional Mean vs. Conditional Quantiles
Source: Hao and Naiman, p. 32

- Dataset includes 118,581 observations.
- Sample used in this analysis is for 16,928 individuals who have reported currently using cigarettes.

Methods

- We employ a quantile regression framework to estimate the demand for cigarettes in the United States.
- Quantile regressions allow us to evaluate the income and demand elasticities across different consumption levels (quantiles).
- OLS model is:

$$\log(C) = \beta_0 + \beta_1 \log(P) + \beta_2 Y + \beta_3 X + \beta_4 D + \varepsilon$$

  - C: cigarette consumption per month
  - P: price of last pack/carton purchased
  - Y: annual household income
  - X: demographic and individual characteristics
  - D: cigarette specific attributes (e.g. menthol, etc.)

- Corresponding quantile regression model is:

$$\log(C) = \beta_0 + \beta_{1\tau} \log(P) + \beta_{2\tau} Y + \beta_{3\tau} X + \beta_{4\tau} D + \varepsilon_\tau$$

  - τ is the τ^{th} quantile.

Conclusions and Discussion

- Heavy smokers still respond to higher cigarette prices by reducing cigarette consumption.
- Price elasticity of demand differs across quantiles, implying that smokers in different consumption groups respond differently to changes in cigarette price.
  Specifically, price elasticities are found to be -0.649 -0.346 -0.172 for consumers in the 25th, 50th, and 75th percentiles, respectively. Therefore, heavy smokers reduce cigarette consumption to a much lesser extent relative to light smokers in response to price increases.
- Traditional methods (OLS) to estimating cigarette demand yield an elasticity estimate of -0.513, which is an inaccurate estimate for relatively heavier smokers and could be misleading for policy purposes.
- For heavy smokers educational attainment and income growth have only marginal negative effects on cigarette consumption as compared to relatively lighter consumer.

Table 4. Regression Results

Dependent variable: Monthly cigarette consumption (log)					
Independent variables	**OLS**	**Quantile Regressions**			**Bootsrapped**
		25th	50th	75th	50th
Cigarette price (log)	-0.513***	-0.649***	-0.346***	-0.172***	-0.346***
Special promotion or coupon? (ref.=Yes)					
No	-0.118***	-0.148***	-0.053**	-0.022	-0.053***
Unknown	-0.199	-0.027	-0.022	-0.027	-0.022
Annual household income (ref. < $10,000)					
$20,001 - $30,000	-0.034	-0.037	-0.062**	-0.033*	-0.062***
$30,001 - $40,000	-0.024	-0.017	-0.024	-0.031	-0.024
$40,001 - $50,000	-0.061*	-0.047	-0.033	-0.036*	-0.033
$50,001 - $70,000	-0.067*	-0.072	-0.064**	-0.036*	-0.064**
$70,001 - $100,000	-0.135***	-0.107	-0.066**	-0.051**	-0.066**
$100,001 - $150,000	-0.229***	-0.269***	-0.103***	-0.044*	-0.103***
$150,001 and more	-0.306***	-0.526***	-0.175***	-0.065*	-0.175***
Unknown	-0.025	-0.040	-0.040	-0.012	-0.040
Education (ref. less than high school)					
High School or GED	-0.126***	-0.099*	-0.083***	-0.082***	-0.083***
Some College, no degree	-0.207***	-0.200***	-0.140***	-0.122***	-0.140***
Post High School Certificate or Diploma	-0.223***	-0.237***	-0.173***	-0.132***	-0.173***
Bachelor's degree	-0.428***	-0.497***	-0.274***	-0.185***	-0.274***
Master's, Prof., or Doctoral degree	-0.537***	-0.665***	-0.342***	-0.202***	-0.342***
Unknown	-0.181	0.035	-0.068	-0.12	-0.068
Marital status (ref. married)					
Living with partner	0.085**	0.081	0.072**	0.043**	0.072***
Divorced	0.087***	0.117**	0.070***	0.044***	0.070***
Widowed	0.068*	0.037	0.076**	0.042*	0.076**
Seperated	0.109**	0.125	0.083**	0.043	0.083**
Single, never married, not now living w/ partner	0.069**	0.063	0.038	0.025	0.038
Other	-0.208	-0.168	-0.147	-0.136	-0.147
Unknown	0.087	0.225	0.092	-0.016	0.092
Race/Ethnicity (ref. White, Non-Hispanic)					
Black, Non-Hispanic	-0.337***	-0.450***	-0.371***	-0.248***	-0.371***
Asian, Non-Hispanic	-0.417***	-0.652***	-0.399***	-0.407***	-0.399***
Other, Non-Hispanic	-0.143***	-0.185***	-0.132***	-0.066***	-0.132***
Hispanic	-0.463***	-0.773***	-0.448***	-0.311***	-0.448***
Unknown	-0.111	-0.186	-0.148*	-0.046	-0.148*
Age (ref. 18-24 years of age)					
25-34	0.141***	0.248***	0.189***	0.061**	0.189***
35-44	0.373***	0.543***	0.375***	0.167***	0.375***
45-54	0.461***	0.650***	0.443***	0.215***	0.443***
55-64	0.425***	0.565***	0.410***	0.210***	0.410***
Over 65	0.225***	0.333***	0.260***	0.125***	0.260***
Unknown	0.153	0.195	0.251***	0.078	0.251***
Gender (ref. male)					
Female	-0.184***	-0.192***	-0.196***	-0.153***	-0.196***
Unknown	-0.309	-0.218	-1.139*	-0.782*	-1.139***
Sexual orientation (ref. Straight)					
LGBT	0.07	-0.049	0.061	0.058**	0.061
Unknown	-0.075	-0.046	-0.04	-0.036	-0.04
Brand cigarettes? (ref. discount cigarettes)					
Not discount cigarettes	-0.089***	-0.098*	-0.063**	-0.039**	-0.063***
Other	-0.177***	-0.219***	-0.115***	-0.035*	-0.115***
Smoking menthol? (ref. =Yes)					
No	0.019	0.008	0.032*	0.011	0.032*
Unknown	-0.467	0.314	0.11	0.103	0.11
Smoking flavored cigarettes? (ref. =Yes)					
No	0.214***	0.248**	0.122**	0.032	0.122***
Unknown	-0.114	-0.247	-0.018	0.012	-0.018
Intercept	6.322***	6.040***	6.344***	6.669***	6.344***

* 10%; ** 5%; *** 1%

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