A Comprehensive Analysis of Tobacco Control Policies within a Smoothed Instrumental Variables Quantile Regression Framework

Vahe Heboyan, Ph.D.
Associate Professor, Medical College of Georgia, Augusta University
E-mail: VHeboyan@augusta.edu

Vardges Hovhannisyan, Ph.D.
Associate Professor, AAE, University of Wyoming
E-mail: vhovhann@uwyo.edu

Rafael Bakhtavoryan, Ph.D.
Associate Professor of Agribusiness, CASNR, Texas A&M University - Commerce
E-mail: Rafael.Bakhtavoryan@tamuc.edu

Selected Paper prepared for presentation at the 2023 Agricultural & Applied Economics Association Annual Meeting, Washington DC; July 23-25, 2023

A Comprehensive Analysis of Tobacco Control Policies within a Smoothed Instrumental Variables Quantile Regression Framework

Abstract

A sound understanding of the potency of tobacco control policies is key to tobacco prevention. This study exploits a Smoothed Instrumental Variables Quantile Regression estimator to gauge the effectiveness of these policies while addressing major methodological and data limitations plaguing the previous literature. Specifically, smoke-free indoor air laws and tobacco control expenditures are examined in a single framework, which has the promise of accounting for potential synergies thereof. Further, endogeneity of price (a proxy for tax policy) and other tobacco control policies is addressed through a unique set of instruments while allowing for differential impacts across the conditional distribution of cigarette consumption. Finally, our use of the nationally representative individual-level price and consumption data is essential to precise estimation of price elasticities and policy effects.

Results indicate that ignoring price and policy endogeneity leads to inconsistent estimates. Further, tobacco expenditures appear to be effective only for relatively more addicted smokers, while state-level smoke-free indoor laws lack efficacy. In contrast, tax policy appears to be most potent for less addicted individuals. Therefore, optimal policy responses should combine tobacco expenditures with sin taxes.

Keywords: Cigarette price endogeneity, instrumental variables quantile regression, policy endogeneity, tobacco control policies.

JEL: I120, D120.

1. INTRODUCTION

Tobacco is the single most important cause of cancer, especially lung cancer (U.S. Department of Health and Human Services, 2014; Xu, Bishop, Kennedy, Simpson, & Pechacek, 2015). It has further been associated with other illnesses such as emphysema, cardiovascular diseases, chronic bronchitis, and preventable premature deaths (Glynn, 2014). In the United States alone, tobacco-induced annual mortality has reached upwards of 480,000, thus exceeding the combined injuries and incidents brought by the AIDS/HIV, heroin, cocaine, alcohol, motor vehicle, and firearms (Mokdad, Marks, Stroup, & Gerberding, 2004). This resulted in over $300 billion in direct medical costs and lost productivity (U.S. Department of Health and Human Services, 2014; Xu et al., 2015).

The harms of tobacco use have long been recognized by policymakers, health scientists, academics, and researchers alike, with each of these stakeholders having made remarkable contributions to designing and reshaping various tobacco control policies. Sin taxes and tobacco-free laws are two of these major public policy instruments adopted by federal, state, and local governments for preventing tobacco use. The former aims at raising tobacco prices to prohibitive levels, while the latter centers on restricting tobacco use in workplaces, restaurants, bars, and other places where most tobacco consumption occurs. Combined, they strive to create significant disincentives for non-smokers to initiate, while offering financial and other inducement for smokers to abstain from smoking.

The empirical literature points to the potency of taxes and smoke-free air (SFA) policies in reducing smoking, nudging smokers towards quitting, preventing smoking initiation, and improving a broad set of smoking outcomes (Chaloupka, 1991; Colman & Remler, 2008; Hahn, 2010; Liang, Chaloupka, Nichter, & Clayton, 2003; McLellan, Hodgkin, Fagan, Reif, & Horgan, 2012; Nesson, 2017; Peterson, Zeger, Remington, & Anderson, 1992; Wamamili & Garrow, 2017). However, previous literature is plagued by a number of methodological and data limitations, which undoubtedly affects research findings, inferences, and policy implications.

More specifically, tobacco control policies such as tobacco taxes, smoke-free indoor air laws, and tobacco control expenditures are either understudied or studied in isolation, which ignores potential synergetic effects thereof and thus can result in endogeneity of policies (e.g., DeCicca and McLeod, 2008). Endogeneity of policies can also stem from the possibility of policy response being conditioned on the heaviness of smoking, which generates reverse causality (Wilkins, Yurekli, & Hu, 2013). Further, precise estimation of smoker price elasticities in these past studies is often hampered by the econometric issue of price endogeneity, while the effectiveness of tax policies in tobacco control rests on accurate estimates of smoker price sensitivity.[1]

Finally, past studies in this line of literature predominantly focus on state-level analyses (e.g., Chaloupka and Saffer (1992); Farrelly, Pechacek, Thomas, and Nelson (2008); Goel and Ram (2004)), while the handful of individual-level studies are usually limited to specific geographic areas or population subgroups Chaloupka and Wechsler (1997); DeCicca and McLeod (2008); J. C. Maclean, Kessler, and Kenkel (2016). Importantly, many of these studies rely on average state-level price data obtained from the Tax Burden of Tobacco, which masks individual-level price heterogeneity and results in reduced spatial frequency of data (Chaloupka & Saffer, 1992; Farrelly et al., 2013; Farrelly, Pechacek, & Chaloupka, 2003; Orzechowski &

[1] As illustrated by Dhar, Chavas, and Gould (2003), unless properly addressed, endogenous regressors can lead to biased estimates of economic effects and erroneous policy recommendations.

Walker, 2015). This in turn can lead to imprecise estimates of the underlying model parameters with the inefficiency magnifying as the size of geographical units expands (Cramer, 1964).

We evaluate the effectiveness of smoke-free indoor air laws, tobacco control expenditures, and sin taxes while addressing all of the issues presented above. Specifically, our study has three distinguishing characteristics. **First**, tobacco control policies such as smoke-free indoor air laws and tobacco control expenditures are examined in a single framework, which addresses potential policy endogeneity resulting from analyzing policies in isolation whenever synergetic effects exist between the policies in question. **Second**, we adopt a Smoothed Instrumental Variables Quantile Regression (SIVQR) estimator developed by Kaplan and Sun (2017) and Kaplan (2022) that not only accounts for heterogenous effects of price on smoking, but also addresses the endogeneity of cigarette price and tobacco control policies considered.[2] The instruments used to address policy endogeneity measure citizen and government ideology across the states, thus reflecting the state political atmosphere. We believe the political ideology and affiliation of state political leaders, as well those of state citizens, and other idiosyncrasies constitute valid policy instruments as political views, affiliations, and public opinion have been found to have an important bearing on policies regulating the access to tobacco products, tobacco

[2] SIVQR implements the smoothed estimator of Kaplan and Sun (2017). Despite many similarities to other quantile regression estimators, some of the main advantages of SIVQR are the fast computation and allowance for multiple endogenous variables. For example, compared to Censored Quantile Instrumental Variables (CQIV) estimator derived by Chernozhukov, Fernández-Val, Han, and Kowalski (2019), SIVQR allows for multiple discrete and continuous endogenous variables while handling reverse causality and simultaneity. See Kaplan (2020) and Kaplan (2022) for more detail on how SIVQR compares to the remaining quantile regression estimators such as those implemented by Stata commands IVQREG, IVQREG2, and IVQTE.

advertising, and various anti-tobacco media campaigns (i.e., the relevance criterion) (e.g., Shete, Yu, & Shete, 2021; Jacobson, Wasserman, & Raube, 1993). Meanwhile, evidence suggests that individual political views are not related to smoking, given the addictive nature of tobacco, and the fact that a distinct set of factors affect tobacco initiation (e.g., Carroll, 2004). Therefore, we believe our instruments are excluded from the cigarette demand equation, and there is no reverse causality from cigarette consumption to the political atmosphere (the exogeneity criterion). **Third**, we base our empirical investigation on a most recent novel, nationally representative individual-level cigarette consumption data provided by the National Adult Tobacco Survey (NATS) (Centers for Disease Control and Prevention, 2015), tobacco-control policy data provided by the CDC's State Tobacco Activities Tracking and Evaluation (STATE) system (Centers for Disease Control and Prevention (CDC), 2021), as well as individual-level actual cigarette price data from NATS that allow for more precise estimation of price elasticities and policy effects vis-à-vis many past studies that rely on aggregate consumption and price data. To the best of our knowledge, this study presents the first attempt at combining all of these desirable features in a single empirical framework.

Our main findings indicate that ignoring price and policy endogeneity introduces biases into the estimates of price and policy effects. Further, tobacco expenditures are found to be effective only for relatively more addicted smokers, while smoke-free indoor laws lack efficacy. Based on the magnitude of price elasticity estimates, sin taxes appear to be most potent for smokers with lower degree of addiction. Therefore, optimal policy responses should combine tobacco expenditures with sin taxes.

2. TOBACCO CONTROL POLICIES AND SMOKING

There is a wide array of state- and federal-level public policy tools in the United States for tobacco control. Tobacco tax policy is perhaps the most well-known of these instruments, which is utilized at both federal and state levels, and aims at generating revenues while reducing tobacco consumption. In the US, the federal excise tax on cigarettes increased from $0.24 per pack in 1995 to $1.01 in 2009 and the average state excise tax rose from $0.33 per pack to $1.20 over the same period (Centers for Disease Control and Prevention (CDC), 2009). As of August 21, 2021, prices ranged considerably from $0.17 per pack in Missouri to $4.94 in Washington, DC ((Centers for Disease Control and Prevention (CDC), 2021).

Revenue generated from state tobacco taxes and tobacco industry legal settlements provides state governments with nearly $27 billion (FY2021) annually to fund tobacco prevention and cessation programs. Currently, no state fully funds their tobacco control programs at the CDC recommended levels (Campaign for Tobacco-Free Kids, 2021). In FY2021, states are predicted to spend less than 3% of the $27 billion that will be collected from tobacco taxes and legal settlements. Furthermore, an estimated $3.3 billion would provide sufficient funding to reach the CDC-recommended levels (Campaign for Tobacco-Free Kids, 2021); however the actual spending by the states in FY2021 was only $656 million. Alaska (89.7%) and Maine (87.4%) are the highest funders of the CDC recommended levels, whereas 29 states and the District of Columbia spend less than 20%, and Connecticut and Tennessee had no allocations to such efforts in FY2021 (Campaign for Tobacco-Free Kids, 2021).

Tobacco-free/smoke-free laws are regulated primarily at the state and local levels (Sanders & Slade, 2013). Arizona was the first to adopt "clean indoor air" laws in 1973, and a number of other states followed suit soon after (Chaloupka & Warner, 2000). Over time, many of these state and local laws and regulations became stricter, perhaps due to better knowledge of the health consequences of the tobacco use. Currently, 27 states have comprehensive ban on smoking at bars, restaurants and workspaces, 10 states have partial ban on smoking in one or two of these locations, and 14 states have no policies restricting smoking in any of these locations (Centers for Disease Control and Prevention (CDC), 2021). At the local-level, many governments have adopted their own tobacco-free or smoke-free regulations to supplement the state-level restrictions (Sanders & Slade, 2013).

The Social Ecological Model (SEM) (McLeroy, Bibeau, Steckler, & Glanz, 1988) is widely accepted as the key theoretical foundation for evaluating the impacts of most relevant factors on health behaviors, including tobacco use (Sorensen, Barbeau, Hunt, & Emmons, 2004; Zhang, Cowling, & Tang, 2010). The basic argument is that individual behavior is shaped not only at intrapersonal and interpersonal levels, but also at institutional, community, and policy levels. Specifically, taxes and other tobacco-control policies such as indoor air laws and tobacco-control expenditures affect smoking behavior cumulatively; hence, it is imperative to study the joint effects of these different tobacco control policies on individual smoking behavior. Further, omitting important variables from the model will wrongly attribute the effects of the excluded variables to the included covariates, hence, generating erroneous elasticity estimates and policy implications. Economic theory suggests that heavy smokers and low-income individuals are price-sensitive, given the disproportionately higher shares of income spent on cigarettes. Contrarily, heavy smokers are often thought to be price-insensitive due to nicotine-induced addiction (Chen, Chang, & Lin, 2013). As regards the effects of tobacco control expenditures and smoke-free indoor laws, there seems to be less ambiguity. For example, Farrelly et al. (2014) find that both policies are effective in reducing adult smoking.

Gaining a sound understanding of the effectiveness of these policies in curbing tobacco consumption remains an active area of research. Most studies in this strand of literature have largely been focused on the assessment of the tax effects (Callison & Kaestner, 2014; Evans, Ringel, & Stech, 1999), those of smoke-free laws (Chaloupka & Saffer, 1992; Larson, Bovbjerg, & Luck, 2016; McMullen, Brownson, Luke, & Chriqui, 2005; Song, Dutra, Neilands, & Glantz, 2015), or tobacco-control expenditures (Farrelly et al., 2013; Farrelly et al., 2003; Farrelly et al., 2008), thus examining each of these policies in isolation. This may be problematic in light of certain findings indicating that health behaviors are the outcome of the multidimensional and interactive effects of personal and environmental factors. Farrelly *et al.* (2014) and Nesson (2017) are the only known exceptions. Specifically, Farrelly et al. (2014) investigate the effects of smoke-free laws and tobacco-control expenditures jointly. On the other hand, Nesson (2017) studies the impacts of cigarrete taxes and smoke-free laws on smoking via a conditional quantile regression model that accounts for the inherent differences in smoking levels. Nevertheless, the common limitations plaguing these past studies are the lack of data on actual individual-level tobacco prices paid by the individuals, lack of information on individual characteristics, as well as the endogeneity of tobacco prices and various tobacco control policies.

Finally, previous cigarette demand studies have largely relied on conditional mean effects of prices and other demand determinants when estimating elasticities. This standard econometric technique is incapable of recognizing the heterogeneity across different consumption levels (quantiles) and is likely to result in biased elasticities and forecasts of future demand for cigarettes. In contrast, quantile regression (QR) approach allows for potential differential effects of public policies on cigarettes consumption by various groups with differing usage rate (i.e., heavy, average, and light smokers) (Goel and Ram, (2004); Maclean et al., (2014); and Nesson, (2017). The QR method has been utilized in various contexts; Manning *et al.* (1995) and Shrestha (2015) apply QR to the estimation of price elasticity of demand for alcohol; Bottai *et al.* (2014) estimate the longitudinal associations between physical activity and body mass index; Laporte *et al.* (2010) investigate whether the forward-looking behavior varies with the level of smoking; Goel and Ram (2004) estimate state-level price-elasticity of cigarette demand in the U.S; Nesson (2017) and Maclean *et al.* (2014) apply QR to the analysis of tax effects on cigarette demand. A detailed theoretical background on quantile regression is provided in Hao and Naiman (2007), Koenker (2005), and Koenker and Hallock (2001) and a thorough discussion of differences between OLS and QR is provided in Diana (2012).

To summarize, economic theory and existing applied research suggest that tobacco control policies (cigarette excise taxes, tobacco-free ordinances, etc.) nudge smokers towards reducing or quitting smoking. However, the overwhelming majority of existing literature either fails to recognize the heterogeneity in cigarette consumption, uses aggregate prices instead of individual-level prices, considers the effect of various tobacco-control policies in isolation, ignores the econometric issues of price and policy endogeneity, or lacks information on individual characteristics.

3. METHODS

To identify the effects of cigarette prices and tobacco control policies on individual smoking behavior, we adopt an instrumental variables quantile regression (IVQR) structural model. As discussed above, the standard econometric techniques (e.g., OLS) estimate the conditional mean effects of price, income, and other determinants on cigarette consumption, thus limiting our learning capacity to average consumer response (Koenker, 2005; Chernozhukov and Hansen, 2005). However, average consumer behavior may not provide an accurate reflection of the wide spectrum of smoking behavior in settings, where smoker reaction to economic incentives or disincentives (e.g., taxes) and public policies (e.g., smoke-free laws) vary considerably based on addiction level. Consequently, mean-effect estimation may not adequately inform of the effects of tobacco-control policies along the entire distribution (Bottai et al., 2014). The QR method offers a solution to this problem by allowing estimation of demand elasticities across different consumption levels, called quantiles, in a manner that uses the entire sample information without losing the degrees of freedom (Goel & Ram, 2004). Importantly, the IVQR framework exploited in this study further accounts for potential endogeneity of price and tobacco control policies, overlooking which results in inconsistent estimates of policy effects and erroneous policy implications.

Let *Q* denote cigarette consumption, *C* represent tobacco control policies, and *X* be other covariates. The structural model of primary interest in this study can then be represented by:

(1) $Q = C'\beta(U) + X'\alpha(U), \quad U \mid X, Z \sim \text{Uniform}(0,1)$,

(2) $C = \phi(X, Z, \Upsilon)$, where Υ is correlated with *U*,

(3) $\tau \mapsto C'\beta(\tau) + X'\alpha(\tau)$ is strictly monotonic and continuous in τ ,

where *U* is a scalar random variable representing unobserved determinants of cgarette consumption; Υ reflects unobserved price and policy determinants and renders *C* endogenous; *Z* denotes a vector of instrumental variables affecting price and policies and excluded from the outcome equation in (1); and $C'\beta(\tau) + X'\alpha(\tau)$ is the τ - quantile of Q conditional on *C* and *X*.

To identify the price and policy effects on smoking, we exploit a set of instrumental variables *Z*, which induce an exogenous variation in *C* unrelated to *U*. Specifically, the structural parameters in the outcome equation are estimated via the following moment conditions:

(4) $P\left[Q \leq S_Q\left(\tau \mid C, X\right) \mid Z, X\right] = \tau$.

To estimate price and policy elasticities of demand for cigarettes, we adopt the following structural empirical quantile regression model:

(5) $\log\left(Q_{ist}\right) = \beta_0\left(U\right) + \beta_1\left(U\right)\log\left(P_{ist}\right) + \beta_2\left(U\right)SIAL_{st} + \beta_3\left(U\right)TCX_{st} + X_{ist}^{'}\alpha\left(U\right)$,

where Q_{ist} and P_{ist} denote cigarette consumption and price paid by individual *i* in state *s* at time *t*, respectively; $SIAL_{st}$ and TCX_{st} represent the state-level smoke-free indoor air laws and tobacco control expenditures in state *s* in year *t*, respectively; X_{ist} is a vector of observed individual characteristics for *i* in state *s* at time *t*, $\beta\left(\bullet\right)$ is vector-valued random elasticity of cigarette demand with respect to cigarette price P_{ist}, and policies considered $(SIAL_{st}, TCX_{st})$; $\alpha\left(\bullet\right)$ reflects individuals' responses to changes in own characteristics; and *U* constitutes an unobserved characteristic affecting the level of demand, and is normalized to follow a standard uniform distribution, i.e., *U*(0,1). Given the addictive nature of cigarettes consumption, *U* can be viewed as individual degree of addiction to smoking, which accounts for heterogeneity in smoking among consumers having the same observed descriptors and facing the same policies and prices (see, for example, Chernozhukov and Hansen, 2005; Kaplan, 2022). Finally, in line with Chernozhukov and Hansen (2005) and Kaplan (2022), we assume a monotonicity property, implying that conditional on the observables $\log\left(P_{ist}\right)$, $SIAL_{st}$, TCX_{st}, and X, an individual with higher *U* (higher addiction level) has higher Q_{ist} (smokes more) relative to those with lower *U* (less addicted). Additionally, $\beta\left(0.5\right)$ can be interpreted as elasticity of demand with respect to price and policies at a median addiction level (50th percentile), while $\beta\left(0.1\right)$ and $\beta\left(0.9\right)$

represent the respective elasticities for relatively less (10^{th} percentile) and more addicted (90^{th} percentile) individuals (e.g., Kaplan, 2022).

It must be emphasized that the main contributions of the present study centers around intensive smoking margin, i.e., the number of cigarettes smoked conditional on non-zero cigarette consumption. Meanwhile, certain other studies examine whether an individual smokes (the extensive margin) separately from the decision of how much to smoke (e.g., Goldin and Homonoff, 2013). Our choice of the intensive margin is explained in part by ensuring tractability, and the finding that policy elasticities are generally smaller in magnitude and less precise when extensive and intensive margins are analyzed in a unified framework (see, for example, MacLean, Kessler, and Kenkel, 2016).

An important feature of our empirical framework is the allowance for more than one tobacco control policies such as the smoke-free indoor air laws $\left(SIAL_{st}\right)$ and tobacco control expenditures $\left(TCX_{st}\right)$ in a single framework. This accounts for potential policy endogeneity resulting from analyzing policies in isolation, when certain synergetic effects between the policies in question are present (i.e., omitted variable bias).

Even when prices and tobacco control policies are incorporated into a single framework and omitted variable bias is not a major concern, prices are endogenous because they comprise a tax component, which is determined by smoking levels to a certain extent (e.g., Evans, Ringel, and Stech, 1999; Sen and Fatima, 2011). Prices are also endogenous because of simultaneity between consumption $\left(Q_{ist}\right)$ and price $\left(P_{ist}\right)$ (i.e., reverse causality). The result is biased and inconsistent price elasticities of demand, and ultimately, erroneous policy implications. Price endogeneity may also stem from omitting important demand drivers from the analysis. For example, lack of data on cigarette advertising expenditures may result in the effect of this variable being attributed to other demand determinants (e.g., Duffy, 1996). The endogeneity of state tobacco control policies, on the other hand, may emanate from the reverse causality between cigarette consumption (Q_{ist}) and the control policies $(SIAL_{st}, TCX_{st})$, as the state regulations tend to be stricter in states plagued with heavier smoking and addiction (e.g., Sandford, 2003). Ignoring this source of endogeneity may further induce biases and inconsistencies into the estimated price and policy effects.

To address the endogeneity of cigarette price and tobacco control policies, we exploit instrumental variables reflecting the political climate surrounding tobacco use and efforts to regulate it across the US states. State political ideology reflects beliefs regarding the ultimate responsibility for health, which can lie with individuals or society, and the role of governments (right vs. responsibility) in regulating individual behavior (Cohen et al., 2000). Since legislators and commissioners are ultimately responsible for the types of polices enacted and maintained, political ideology is believed to be an important facilitator or barrier to effective tobacco control policies, given their beliefs and convictions on the optimal ways that public resources need to be distributed, beneficiaries of policies, ethics of smoking, etc. (Menashe, 1998; McKinlay and Marceau, 2000). Evidence also suggests that state tobacco control policies are shaped by the preferences of state residents (Pacheco, 2012). Therefore, we construct instruments reflecting the political affiliation and ideology of state governments and residents, to ensure relevance criterion of instruments is satisfied. The specific instruments utilized include dynamic measures of political ideology of state residents and political leaders measured based on a methodology proposed by Berry et al. (1998). These are constructed based on the outcomes of congressional elections, the political affiliation of the governor, the partisan composition of state legislatures, roll call scores of state congressional delegations, as well as other descriptors of state political elites and voters, which is presented in more detail in the data description.

There is also ample evidence on the tobacco lobby political influence on tobacco control policies (e.g., Givel and Glantz, 2001; Smith, Savell, and Gilmore, 2013; Bialous, and Glantz, 2018). Some of the major tobacco industry tactics have been publicity campaigns, direct lobbying, securing credible allies, and establishing “front groups” (i.e., organizations funded and directed by tobacco companies to influence policy makers and the public in favor of the tobacco industry) (e.g., Givel and Glantz, 2001). In the absence of data on these activities, we use state fixed effects to capture tobacco industry efforts to sway state-level tobacco control policy, that are relatively constant over our sample period.

The exogeneity of these instruments relies on the assumption that smoking is largely determined by socio-economic, psychological, behavioral and related factors, conditional on which political views and other state-level idiosyncrasies do not influence smoking. Specifically, smoking initiation is usually driven by psychosocial motives such as conveying messages about maturity and independence, as well as those emanating from emotional stability, bodyweight issues, poor performance at school, curiosity, etc. (Jarvis, 2004; Hsieh, and Van Kippersluis, 2018; Kim and Chun, 2018). Once initiated, smokers progress through the continuum and develop a physiological need for nicotine, which makes cessation increasingly difficult over time (US Department of Health and Human Services, 1994; Sylvestre et al., 2018; Pogun, and Rodopman, 2021). These facts, combined with the lack of a feedback effect from smoking to political views, point to individual political views and ideologies being properly excluded from the outcome equation relating smoking to socio-economic variables and various control policies (exogeneity requirement).

4. DATA

We perform our empirical price and policy analysis using data compiled from multiple sources. Specifically, individual-level cigarette consumption and price data were obtained from CDC's National Adult Tobacco Survey (NATS) (Centers for Disease Control and Prevention, 2015). Further, state-level data on the smoke-free indoor air laws and tobacco control expenditures were collected from the CDC's State Tobacco Activities Tracking and Evaluation System (STATES) (Centers for Disease Control and Prevention (CDC), 2021). Data on mean hourly wage, electricity prices from tobacco manufacturing industry and retail sectors, and gas prices were compiled from the US Bureau of Labor Statistics (U.S. Bureau of Labor Statistics, 2021) and the US Energy Information Administration (U.S. Energy Information Administration, 2021a, 2021b). Finally, information reflecting governor political affiliation and the partisan composition of state legislatures was collected from the State Partisan Composition dataset of the National Conference of State Legislatures (NCSL) (National Conference of State Legislatures, 2021).

National Adult Tobacco Survey

The NATS constitutes the single most comprehensive dataset on tobacco use and behavior in the United States and is representative and comparable at both national and state levels by its very design. The first NATS was conducted between October 2009 and February 2010, while the second and third surveys were implemented over October 2012 - July 2013 and October 2013 - October 2014, respectively.

Smoking Outcomes

The outcome variable of interest in this study is represented by monthly cigarette consumption among current smokers. In each cohort, the NATS asks respondents if they currently smoke every day, some days, or not at all. Subsequently, if the respondent indicates having smoked every day or some days, they are treated as current smokers and are asked about the number of days in the past 30 days they smoked along with the number of cigarettes smoked per day. We calculate monthly cigarette consumption as a product of the number of days smoked and the average number of cigarettes smoked per day.

Key Explanatory Variables

The NATS provides data on the purchase price for the last pack or carton of cigarettes collected from the current smokers, which we convert to a per pack basis assuming each carton contains ten packs of cigarettes. Prices are adjusted to 2009 dollars using the consumer price index.

State-Level Variables

Smoke-free Indoor Air Legislation variable reflects the presence of a state-level comprehensive ban on smoking at the private worksites, restaurants, and/or bars. It is coded as one if the state has all three locations 100% smoke-free (comprehensive ban) or zero otherwise. Further, we follow Farrelly *et al.* (2003) and Farrelly *et al.* (2013) to include a measure of *per capita cumulative tobacco control expenditures* for each state calculated by adding each year's annual funding to those from all previous years, which were discounted at a rate of 25% per year. This measure includes state expenditures (beginning 2008) and appropriations/grants (beginning 1991) on tobacco control programs, which are obtained from CDC's STATE system (Centers for Disease Control and Prevention (CDC), 2021). Interestingly, Farrelly *et al*. (2003) and Farrelly *et al.* (2008) found that state tobacco control programs were an effective policy tool.

Other Control Variables

Income and demographic characteristics are derived from the NATS. In modeling smoking behaviors, we use individuals' annual household income, age, level of educational attainment, marital status, race/ethnicity, and gender.

State-Level Data on Citizen and Government Ideology

Dynamic measures of political ideology of state residents and political leaders for our sample period are computed via a methodology proposed by Berry et al. (1998). Specifically, these variables reflect the outcomes of congressional elections, the political affiliation of the governor, the partisan composition of state legislatures, roll call scores of state congressional delegations, as well as other descriptors of state political elites and voters. *Citizen ideology* is computed as an index that takes into account the ideological position of each member of Congress in the respective years via interest group ratings, estimated citizen ideology in each district of a state based on the ideology score for the district's incumbent and that of their challenger, as well as election results that shed light on ideological divisions in the electorate. Specifically, citizen ideology represents an unweighted average of citizen ideology scores for all the districts in a state, while the final measure averages the ideology scores for major party candidates, using weights that are proportional to each candidate's share of support in the district. On the other hand, *government ideology* measurement relies on data on ideology scores for the governor and the major party delegations in each house of the state legislature. Using certain assumptions on the distribution of power among policymakers, these scores are then used to compute the government ideology index. For more information on the specific formulas and other relevant details used to calculate the citizen and government ideology, see Berry et al. (1998) (pages 330-334).

National Conference of State Legislatures Data

Data for state political environment comes from the State Partisan Composition dataset of the National Conference of State Legislatures (NCSL) (National Conference of State Legislatures, 2021). It uses the party control of the state legislative and executive branches to generate the profile of the political control in each state. Political control is divided into Republican controlled, Democrat controlled, or Split or Divided control. At any given year a state is considered to be controlled by one party if both the executive and legislative branches are held by the same party. They are designated as split or divided when no single party controls both branches.

Our sample comprises 24,421 observations with 15% having smoked cigarettes on a daily basis or less frequently. As can be observed from the empirical distribution of cigarette consumption, daily individual cigarette use is especially pronounced at 20 cigarettes (over 25%), while a majority of smokers reportedly smoked less (Figure 1). In line with Nesson (2017), individuals having self-reported as non-smokers were removed from this analysis. Further, current smokers in our sample smoked an average of 13.65 (SD=9.2) cigarettes per day (Table 1). The average cigarette price during the sample period is $4.84 (SD=1.60) per pack and only about 15% of the smokers have taken advantage of special offers for cigarette purchases. The average respondent was about 48 years of age, with females accounting for 54% of the sample. Further, average annual household income amounted to $49,670. Around 44%% of the respondents had high school diploma or less, 37% had some college or less than BS degree, 13% had a BS degree, and the rest of the individuals sampled had a MS or higher. As for the racial composition of our sample, non-Hispanic whites accounted for almost 76% of the respondents, followed by non-Hispanic blacks with a 9.5% share. As of 2015, 27 US states had comprehensive indoor smoking bans in restaurants, bars, and workspaces and in 2014 (last year of our study cohort) the average per capita expenditures on tobacco control were $18.36 (SD=16.05) ranging from $1.55 (Tennessee) to $76.24 (Alaska). Finally, citizen and government ideologies are estimated to be 50.58 and 45.79, respectively (i.e., these are computed as indices ranging from 0 to 100, with 0 representing the most conservative value, and 100 reflecting the most liberal position).

5. RESULTS

We estimate the complete model that incorporates both tobacco control policies and addresses price and policy endogeneity provided in equation [5] via the SIVQR estimator. Specifically, the quantile regression model of cigarette consumption is estimated for nine quantiles extending from the 10th to the 90th quantiles, the results of which are compared with those from the OLS and 2SLS regressions (Table 2). To examine the strength of our instruments, we estimate the first stage regression of policies on the respective instruments and find that the Cragg-Donald Wald F statistic is 106.6 with the respective *p-value* <0.00. Further, the Anderson-Rubin Wald test statistic is 197.7, and Stock-Wright LM S statistic is 196.1.[3] Therefore, the policy instruments utilized in this application meet the relevance criterion, and we dismiss concerns about weak instrument bias. Regarding the exogeneity of these instruments, the Sargan statistic for overidentification test of all instruments is 0.617 (*p-value* =0.73), which provides empirical evidence for instrument exogeneity.[4] Meanwhile, it deserves mentioning that despite the

---

[3] Parameter estimates from the first-stage regressions are not presented because of limited space; however, they are available upon request.

[4] A potential concern regarding the exogeneity of the ideology instruments is that more rural areas tend to smoke more (or less) and vote Republican more (or less). Therefore, we examined the possible correlation between smoking and ideology instruments for subsets of states variously defined (i.e., rural vs urban states, states based on geographic location, and degree of religiosity), and find negligible correlation (the highest correlation coefficient is 0.03). We take

popularity of this test in the empirical literature, overidentifying restrictions provide little information on the validity of instruments (e.g., Parente and Silva, 2012). Instead, the validity of instruments should be based on the underlying economic model and the causal mechanism (in the methodology section, we presented one such mechanism). Further, in empirical applications with considerable parameter heterogeneity, overidentifying restriction tends to be rejected.

Our findings reveal considerable inelasticity and heterogeneity in smoker price sensitivity across the conditional quantiles, with all the estimates being statistically significant for all the quantiles considered. Specifically, own-price elasticity of demand for cigarettes initially increases in magnitude from -0.509 at the 10th quantile to -0.515 at the 20th quantile, while undergoing a steady decline for relatively larger quantiles of consumption distribution, reaching its smallest magnitude of -0.128 at the 80th quantile. Afterwards, it bounces back to -0.133 at the 90th quantile. In contrast, the OLS and 2SLS parameters are estimated to be -0.329 and -0.281, respectively, which significantly underestimates the smoker price responsiveness for the relatively less addicted smokers, while overestimating it for smokers with higher degree of addiction.

To put these estimates into perspective, imposing a $1.00 tax on cigarettes (i.e., 20.5% of the average sample price) results in a 10.6% reduction in smoking for individuals at the 20th quantile, and only 2.6% reduction for smokers at the 80th quantile. This reaction is most

---

comfort in this finding, in that it lends support to our exogeneity argument discussed above (smoking initiation is driven by factors distinct from political ideology, starts at a relatively young age, and cessation is increasingly difficult because of addictive nature of cigarettes, irrespective of individual political views and affiliations).

consistent with less nicotine dependent smokers being less price-responsive, which makes it easier for them to cut back on cigarette use when prices rise (e.g., Yu et al., 2020). Meanwhile, our results indicate that smokers in the upper tail of the conditional distribution become relatively less responsive to a price change beyond a certain threshold (i.e., 20th quantile), which also may reflect tobacco addiction (e.g., Maclean, Webber, and Marti, 2014). These findings are partially in line with those from a number of studies that report a U-shaped relationship between price and quantity consumed (see, for example, Johanna Catherine Maclean et al., 2014; Ronning and Schulz, 2004; Wilkins et al., 2013), most of which ignore price endogeneity, and/or omit the policy variables from the empirical analysis. It is also important to note that, despite the inelastic nature of smoker price responsiveness, Glantz (2019) finds that even a 1% reduction in smoking among Medicaid participants in each of the states generates $2.6 billion in total savings due to improved health conditions, with average state savings equaling $25 million.

As regards policy impacts, tobacco control expenditures are found to be effective only for relatively more addicted individuals at the 80th and 90th quantiles, with the respective estimates of -0.006 and -0.014. This finding is somewhat consistent with Farrelly *et al.* (2008), who find that expenditures within the framework of this program reduced smoking prevalence among individuals aged 25 or older. On the other hand, we find that comprehensive smoke-free indoor air laws have mostly negative but statistically insignificant estimates. These findings are largely consistent with Nesson (2017). We are also careful when comparing these past studies to the current analysis, given that they suffer from several data limitations and econometric issues, which could have affected some of their main findings. For example, omitting smoke-free indoor air policies could potentially result in its effects being attributed to the tobacco control expenditures. Further, ignoring price and policy endogeneity may as well contaminate the parameter estimates of the demand model, as well as those of policy impacts. Finally, to our knowledge, this is one of the very few studies examining the effects of smoke-free indoor air laws on smoking, while most previous studies confined their focus to the impact of this policy on indoor air pollution.[5]

We also investigate the impact of individual demographic characteristics on cigarette consumption. Specifically, smoker income is found to have a negative and statistically significant impact on cigarette consumption only between the 10^{th} and 40^{th} quantiles, with the magnitude decreasing across the higher quantiles (i.e., from -0.154 at the 10^{th} quantile to -0.019 at the 40^{th} quantile). Further, smoking is estimated to go hand-in-hand with smoker age across the quantiles considered, with the magnitude decreasing at the relatively higher quantiles (i.e., from 0.187 at the 10^{th} quantile to 0.055 at the 80^{th} quantile, before bouncing back to 0.075 at the 90^{th} quantile). As regards smoker education, we find that individuals with less than high school, high school, and some college education smoke more cigarettes vis-à-vis those with college and higher level of education. This result is consistent across all the quantiles considered; moreover, the effect diminishes for higher quantiles. Interestingly, married individuals over the 10^{th}-40^{th} quantiles smoke relatively more as compared to unmarried individuals, while marital status does not appear to be an important factor at higher quantiles. With respect to gender differences in cigarette consumption, men are found to smoke more relative to women based on both the quantile regression and OLS estimates. Finally, African Americans, Asians, Hispanics, and

[5] To our knowledge, this constitutes the first study examining tobacco control expenditures and smoke-free indoor air laws in a single empirical framework.

remaining non-White individuals are estimated to be smoking statistically significantly less than Whites, with the difference becoming less important for higher quantiles.

To shed light on the magnitude and direction of the bias in our parameter and elasticity estimates caused by the endogeneity of cigarette prices and the tobacco control polices considered, we treat the difference between the parameter estimates from the models with exogenous and endogenous price and policies as random variables, whose standard errors are computed taking into account correlations thereof, as per Turner and Rockel (1988). As can be observed from Table 3, the great majority of parameter estimates from the SIVQR and standard quantile regression model ignoring price and policy endogeneity are statistically significantly different. We further contrast the parameter estimates from the models ignoring and addressing policy endogeneity by juxtaposing the respective results in Figures 2-4. It can be seen that price elasticity estimates are the most impacted of all the elasticities (Figure 2), and that addressing endogeneity via the IV approach results in wider confidence intervals (e.g., Semadeni, Withers, and Trevis Certo, 2014).

Importantly, our findings indicate that ignoring price endogeneity results in sizable biases in own-price elasticity estimates, with the magnitude of the bias reaching -0.043 (equivalent to a 32% change in the price elasticity estimate) at the 90^{th} quantile. In the same vein, ignoring policy endogeneity introduces considerable biases into the estimated effects of tobacco control expenditures, the size and sign of which varies by quantile. In contrast, standard quantile regression models are found to induce downward bias into the effects of tobacco control expenditures on cigarette consumption for the quantiles between 70^{th} and 90^{th}. Finally, we express the magnitude of the bias in percentage terms, as the small magnitude of many coefficients may not allow for a meaningful comparison across the different models (Table 4).

As it appears, the price elasticity bias ranges from -6.73% to 32.25%, while that for policies reaches up to a 4-fold. The main implication of these findings is that cigarette tax policy may be more effective in reducing smoking prevalence, especially for the relatively heavier smokers, than the standard econometric techniques would suggest. Further, tobacco control expenditures emerge as a potent policy tool for smokers with high levels of addiction, while smoke-free indoor air laws are not as effective as more restrictive models imply. Therefore, optimal policy responses should combine sin taxes with tobacco control expenditures that aim at enhancing smoker knowledge of tobacco harms.

Finally, we perform a number of robustness checks to test the stability of our results. First, we include a dummy variable indicating individual smokers' health condition as an additional covariate, however, the main results from this empirical specification are virtually identical (we are aware that health condition is potentially endogenous because of simultaneity between smoking and thereof). Second, we account for the sexual orientation of the individuals, given that sexual-minority smokers have been found to smoke more cigarettes and score higher on nicotine dependence relative to heterosexual users (e.g., Corliss et al., 2012). Once again, the results from this model are indistinguishable from our base model. Third, we include a variable indicating whether cigarettes were purchased at a discounted price and find that the main parameters of interest change negligibly. Finally, a potential concern is that rising cigarette tax effects may be overestimated, if cigarette and alcohol taxes are raised simultaneously in certain states, and assuming that cigarettes and alcohol are complementary goods. However, the raw correlation between coefficient between cigarette and alcohol taxes was -0.013 during our sample period, indicating that alcohol taxes could not have played a role in cigarette consumption, and we may dismiss the possibility of this omission.

6. CONCLUSIONS

This study adopts a Smoothed Instrumental Variables Quantile Regression (SIVQR) estimator to investigate the impact of various tobacco control policies on cigarette consumption while addressing some of the fundamental issues plaguing the previous literature. Specifically, the effectiveness of smoke-free indoor air laws, tobacco control expenditures, and cigarette taxes are examined in a single framework, which not only allows for potential synergies among these policies, but also addresses the endogeneity of price and tobacco control policies. Our identification strategy exploits a unique set of instruments while allowing for differential impacts across the conditional distribution of cigarette consumption. The price instruments constructed reflect the supply side of the price determination mechanism, and the policy instruments capture the state political atmosphere. Finally, our use of the most recent nationally representative individual-level price and consumption data is essential to precise estimation of price elasticities and policy effects.

Our results indicate that ignoring price and policy endogeneity leads to inconsistent price elasticity estimates and those of policy impacts the main implication of which is that cigarette tax policy may be more effective in reducing smoking prevalence, than the standard econometric techniques would suggest. Further, tobacco control expenditures emerge as a potent policy tool for more addicted smokers, while smoke-free indoor air laws are not as effective as more restrictive models imply. Therefore, optimal policy responses should combine sin taxes with tobacco control expenditures that aim at enhancing smoker knowledge of tobacco harms. The finding that state-level tobacco control policies are ineffective in preventing and reducing cigarette consumption may not come as a huge surprise, given that local-level tobacco control policies (e.g., county or city/municipality-level smoke-free ordinances, tobacco-free campus policies, and efforts towards building tobacco-free communities) may be more relevant policy instruments.

A few recommendations for future research are worth noting. First, future studies would benefit from incorporating local (e.g., county and/or city) policy variables once such data become available. Unveiling the impact of these tools is key to designing an optimal combination of various federal, state, and local level tobacco control policies. Second, future research should incorporate more recent data, as the CDC, other agencies, and researchers compile such data. Finally, future research would benefit significantly from more disaggregate cigarette data containing information on brand, nicotine content, and other characteristics, assuming such information becomes publicly available.

REFERENCES

Bialous, S.A. & Glantz, S.A. 2018. Heated tobacco products: another tobacco industry global strategy to slow progress in tobacco control. *Tobacco control*, 27(Suppl 1):s111-s117.

Bottai, M., Frongillo, E. A., Sui, X., O'Neill, J. R., McKeown, R. E., Burns, T. L., . . . Pate, R. R. (2014). Use of quantile regression to investigate the longitudinal association between physical activity and body mass index. *Obesity (Silver Spring), 22*(5), E149-156. doi:10.1002/oby.20618

Callison, K., & Kaestner, R. (2014). Do higher tobacco taxes reduce adult smoking? New evidence of the effect of recent cigarette tax increases on adult smoking. *Economic Inquiry, 52*(1), 155-172. doi:https://doi.org/10.1111/ecin.12027

Campaign for Tobacco-Free Kids. (2021). Broken Promises to Our Children: A State-by-State Look at the 1998 Tobacco Settlement 22 Years Later. Retrieved from https://www.tobaccofreekids.org/what-we-do/us/statereport

Carroll, J. 2004. GALLUP. Americans' Opinions About Smoking. Retrieved from https://news.gallup.com/poll/14257/smoking.aspx

Centers for Disease Control and Prevention. (2015). National Adult Tobacco Survey. Retrieved from http://www.cdc.gov/tobacco/data_statistics/surveys/nats/

Centers for Disease Control and Prevention (CDC). (2009). Federal and state cigarette excise taxes - United States, 1995-2009. *Morbidity and Mortality Weekly Report (MMWR), 58*(19), 524-527.

Centers for Disease Control and Prevention (CDC). (2021). State Tobacco Activities Tracking and Evaluation (STATE) System. Retrieved from http://www.cdc.gov/statesystem/

Chaloupka, F. (1991). Rational Addictive Behavior and Cigarette Smoking. *Journal of Political Economy, 99*(4), 722-742. doi:10.1086/261776

Chaloupka, F., & Saffer, H. (1992). Clean Indoor Air Laws and the Demand for Cigarettes. *Contemporary Economic Policy, 10*(2), 72-83. doi:doi:10.1111/j.1465-7287.1992.tb00227.x

Chaloupka, F., & Warner, K. (2000). Chapter 29 The economics of smoking. In *Handbook of Health Economics* (Vol. 1, pp. 1539-1627): Elsevier.

Chaloupka, F., & Wechsler, H. (1997). Price, tobacco control policies and smoking among young adults. *J Health Econ, 16*(3), 359-373.

Chen, C. M., Chang, K. L., & Lin, L. (2013). Re-examining the price sensitivity of demand for cigarettes with quantile regression. *Addict Behav, 38*(12), 2801-2804. doi:10.1016/j.addbeh.2013.07.003

Chernozhukov, V., and C. Hansen.2005. An IV model of quantile treatment effects. *Econometrica* 73, no. 1:245-261.

Chernozhukov, V., Fernández-Val, I., Han, S., & Kowalski, A. (2019). Censored quantile instrumental-variable estimation with Stata. *The Stata Journal, 19*(4), 768-781. doi:10.1177/1536867x19893615

Cohen, J.E., Milio, N., Rozier, R.G., Ferrence, R., Ashley, M.J. and Goldstein, A.O., 2000. Political ideology and tobacco control. Tobacco control, 9(3):263-267.

Colman, G. J., & Remler, D. K. (2008). Vertical equity consequences of very high cigarette tax increases: If the poor are the ones smoking, how could cigarette tax increases be progressive? *Journal of Policy Analysis and Management, 27*(2), 376-400. doi:doi:10.1002/pam.20329

Corliss, H.L., Wadler, B.M., Jun, H.J., Rosario, M., Wypij, D., Frazier, A.L. and Austin, S.B. 2012. Sexual-orientation disparities in cigarette smoking in a longitudinal cohort study of adolescents. *Nicotine & Tobacco Research*, 15(1):213-222.

Cramer, J. S. (1964). Efficient Grouping, Regression and Correlation in Engel Curve Analysis. *Journal of the American Statistical Association, 59*(305), 233-250. doi:10.2307/2282872

DeCicca, P., & McLeod, L. (2008). Cigarette taxes and older adult smoking: evidence from recent large tax increases. *J Health Econ, 27*(4), 918-929. doi:10.1016/j.jhealeco.2007.11.005

Diana, T. (2012). Predicting Block Time: An Application of Quantile Regression. In T. Magister (Ed.), *Advances in Air Navigation Services* (Vol. Chapter 4): IntechOpen.

Duffy, M. (1996). Econometric Studies of Advertising, Advertising Restrictions and Cigarette Demand: A Survey. *International Journal of Advertising, 15*(1), 1-23. doi:10.1080/02650487.1996.11104630

Evans, W. N., Ringel, J. S., & Stech, D. 1999. Tobacco Taxes and Public Policy to Discourage Smoking. In J. Poterba (Ed.), *Tax Policy and the Economy, Volume 13*. Cambridge, MA: National Bureau of Economic Research.

Farrelly, M. C., Loomis, B. R., Han, B., Gfroerer, J., Kuiper, N., Couzens, G. L., . . . Caraballo, R. S. (2013). A comprehensive examination of the influence of state tobacco control programs and policies on youth smoking. *Am J Public Health, 103*(3), 549-555. doi:10.2105/ajph.2012.300948

Farrelly, M. C., Loomis, B. R., Kuiper, N., Han, B., Gfroerer, J., Caraballo, R. S., . . . Couzens, G. L. (2014). Are tobacco control policies effective in reducing young adult smoking? *J Adolesc Health, 54*(4), 481-486. doi:10.1016/j.jadohealth.2013.09.015

Farrelly, M. C., Pechacek, T. F., & Chaloupka, F. J. (2003). The impact of tobacco control program expenditures on aggregate cigarette sales: 1981-2000. *J Health Econ, 22*(5), 843-859. doi:10.1016/s0167-6296(03)00057-2

Farrelly, M. C., Pechacek, T. F., Thomas, K. Y., & Nelson, D. (2008). The impact of tobacco control programs on adult smoking. *Am J Public Health, 98*(2), 304-309. doi:10.2105/ajph.2006.106377

Gale, F., Foreman, L., & Capehart, T. (2000). *Tobacco And The Economy: Farms, Jobs, And Communities*. Retrieved from https://www.ers.usda.gov/publications/pub-details/?pubid=41167

Givel, M.S., & Glantz, S.A. 2001. Tobacco lobby political influence on US state legislatures in the 1990s. *Tobacco control*, 10(2):124-134.

Glantz, S.A. 2019. Estimation of 1-year changes in Medicaid expenditures associated with reducing cigarette smoking prevalence by 1%. JAMA network open, 2(4), pp.e192307-e192307.

Glynn, T. J. (2014). E-cigarettes and the future of tobacco control. *CA Cancer J Clin, 64*(3), 164-168. doi:10.3322/caac.21226

Goel, R. K., & Ram, R. (2004). Quantile-regression estimates of cigarette demand elasticities for the United States. *Journal of Economics and Finance, 28*(3), 413-421. doi:10.1007/bf02751743

Goldin, J. and Homonoff, T. 2013. Smoke gets in your eyes: cigarette tax salience and regressivity. *American Economic Journal: Economic Policy*, 5(1):302-36.

Hahn, E. J. (2010). Smokefree legislation: a review of health and economic outcomes research. *Am J Prev Med, 39*(6 Suppl 1), S66-76. doi:10.1016/j.amepre.2010.08.013

Hao, L., & Naiman, D. Q. (2007). *Quantile Regression*. Thousand Oaks, CA: Sage Publications.
Hayashi, F. (2001). *Econometrics*: Princeton University Press.
Hsieh, C.S. and Van Kippersluis, H., 2018. Smoking initiation: Peers and personality. *Quantitative Economics*, 9(2):825-863.
Jacobson, P.D., Wasserman, J. and Raube, K., 1993. The politics of antismoking legislation. *Journal of Health Politics, Policy and Law*, 18(4), 789-819.
Jarvis, M.J. 2004. Why people smoke. *BMJ*, 328(7434):277-279.
Kaplan, D. M. 2020. *sivqr: Smoothed IV quantile regression*. Retrieved from https://ideas.repec.org/p/umc/wpaper/2009.html
Kaplan, D.M. and Sun, Y., 2017. Smoothed estimating equations for instrumental variables quantile regression. *Econometric Theory*, 33(1):105-157. doi:10.1017/S0266466615000407
Kaplan, D.M. 2022. Smoothed instrumental variables quantile regression. *The Stata Journal*, 22(2):379-403.
Kim, H.H.S. and Chun, J. 2018. Analyzing multilevel factors underlying adolescent smoking behaviors: the roles of friendship network, family relations, and school environment. *Journal of School Health*, 88(6):434-443.
Koenker, R. (2005). *Quantile Regression*. Cambridge, UK: Cambridge University Press.
Koenker, R., & Hallock, K. F. (2001). Quantile Regression. *Journal of Economic Perspectives, 15*(4), 143-156. doi:doi: 10.1257/jep.15.4.143
Kowalski, A. (2016). Censored Quantile Instrumental Variable Estimates of the Price Elasticity of Expenditure on Medical Care. *Journal of Business & Economic Statistics, 34*(1), 107-117. doi:10.1080/07350015.2015.1004072
Laporte, A., Karimova, A., & Ferguson, B. (2010). Quantile regression analysis of the rational addiction model: investigating heterogeneity in forward-looking behavior. *Health Econ, 19*(9), 1063-1074. doi:10.1002/hec.1647
Larson, A., Bovbjerg, V., & Luck, J. (2016). State Clean Indoor Air Laws and smoking among adults with poor mental health. *J Public Health Policy, 37*(4), 453-466. doi:10.1057/jphp.2016.17
Liang, L., Chaloupka, F., Nichter, M., & Clayton, R. (2003). Prices, policies and youth smoking, May 2001. *Addiction, 98 Suppl 1*, 105-122.
Maclean, J. C., Kessler, A. S., & Kenkel, D. S. (2016). Cigarette Taxes and Older Adult Smoking: Evidence from the Health and Retirement Study. *Health Econ, 25*(4), 424-438. doi:10.1002/hec.3161
Maclean, J. C., Webber, D. A., & Marti, J. 2014. An Application of Unconditional Quantile Regression to Cigarette Taxes. *Journal of Policy Analysis and Management, 33*(1), 188-210. doi:doi:10.1002/pam.21724
MacLean, J.C., Kessler, A.S. and Kenkel, D.S. 2016. Cigarette taxes and older adult smoking: evidence from the health and retirement study. *Health Economics*, 25(4):424-438.
Manning, W. G., Blumberg, L., & Moulton, L. H. (1995). The demand for alcohol: the differential response to price. *J Health Econ, 14*(2), 123-148.
Menashe, C.L. 1998. The power of a frame: an analysis of newspaper coverage of tobacco issues-United States, 1985-1996. *Journal of health communication*, 3(4):307-325.
McKinlay, J.B. and Marceau, L.D., 2000. To boldly go.... *American Journal of Public Health*, 90(1):25.

McLellan, D. L., Hodgkin, D., Fagan, P., Reif, S., & Horgan, C. M. (2012). Unintended consequences of cigarette price changes for alcohol drinking behaviors across age groups: evidence from pooled cross sections. *Substance Abuse Treatment, Prevention, and Policy, 7*(1), 28. doi:10.1186/1747-597X-7-28

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Educ Q, 15*(4), 351-377.

McMullen, K. M., Brownson, R. C., Luke, D., & Chriqui, J. (2005). Strength of clean indoor air laws and smoking related outcomes in the USA. *Tobacco Control, 14*(1), 43-48. doi:10.1136/tc.2004.007880

Mokdad, A. H., Marks, J. S., Stroup, D. F., & Gerberding, J. L. (2004). Actual causes of death in the United States, 2000. *Jama, 291*(10), 1238-1245.

National Conference of State Legislatures. (2021). State Partisan Composition. Retrieved from https://www.ncsl.org/research/about-state-legislatures/partisan-composition.aspx

Nesson, E. (2017). Heterogeneity in Smokers' Responses to Tobacco Control Policies. *Health economics, 26*(2), 206-225. doi:doi:10.1002/hec.3289

Orzechowski, & Walker. (2015). *The Tax Burden on Tobacco, Volume 49, 1970-2014*. Retrieved from

Pacheco, J. 2012. The social contagion model: Exploring the role of public opinion on the diffusion of antismoking legislation across the American states. *The Journal of Politics*, 74(1):187-202.

Parente, P. M. D. C., & Santos Silva, J. M. C. (2012). A cautionary note on tests of overidentifying restrictions. *Economics Letters, 115*(2), 314-317. doi:https://doi.org/10.1016/j.econlet.2011.12.047

Peterson, D. E., Zeger, S. L., Remington, P. L., & Anderson, H. A. (1992). The effect of state cigarette tax increases on cigarette sales, 1955 to 1988. *Am J Public Health, 82*(1), 94-96.

Pogun, S. and Rodopman Arman, A. 2021. Understanding nicotine addiction and the health effects of nicotine use. ERS Monograph: Supporting Tobacco Cessation. *European Respiratory Society*, 18-32.

Ronning, G., & Schulz, N. (2004). A Microeconometric characterization of household consumption using quantile regression. *Applied Economics Quarterly, 50*(2), 183-208.

Sanders, A., & Slade, G. (2013). State cigarette excise tax, secondhand smoke exposure, and periodontitis in US nonsmokers. *Am J Public Health, 103*(4), 740-746. doi:10.2105/ajph.2011.300579

Sandford, A. (2003). Government action to reduce smoking. *Respirology, 8*(1), 7-16. doi:https://doi.org/10.1046/j.1440-1843.2003.00436.x

Shete, S.S., Yu, R. and Shete, S., 2021. Political Ideology and the Support or Opposition to United States Tobacco Control Policies. *JAMA Network Open*, 4(9), e2125385-e2125385.

Semadeni, M., Withers, M.C. and Trevis Certo, S. 2014. The perils of endogeneity and instrumental variables in strategy research: Understanding through simulations. *Strategic Management Journal*, 35(7):1070-1079.

Sen, A. and Fatima, N. 2011. Do Lower Cigarette Taxes Increase Smoking: Evidence from the Canadian National Experiment. *Canadian Tax Journal*, 59:221.

Shrestha, V. (2015). Estimating the Price Elasticity of Demand for Different Levels of Alcohol Consumption among Young Adults. *American Journal of Health Economics, 1*(2), 224-254. doi:10.1162/AJHE_a_00013

Smith, K.E., Savell, E. & Gilmore, A.B. 2013. What is known about tobacco industry efforts to influence tobacco tax? A systematic review of empirical studies. *Tobacco control*, 22(2), pp.e1-e1.
Song, A. V., Dutra, L. M., Neilands, T. B., & Glantz, S. A. (2015). Association of Smoke-Free Laws With Lower Percentages of New and Current Smokers Among Adolescents and Young Adults: An 11-Year Longitudinal Study. *JAMA Pediatr, 169*(9), e152285. doi:10.1001/jamapediatrics.2015.2285
Sorensen, G., Barbeau, E., Hunt, M. K., & Emmons, K. (2004). Reducing Social Disparities in Tobacco Use: A Social-Contextual Model for Reducing Tobacco Use Among Blue-Collar Workers. *Am J Public Health, 94*(2), 230-239. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1448233/
Sylvestre, M.P., Hanusaik, N., Berger, D., Dugas, E., Pbert, L., Winickoff, J. and O'Loughlin, J.L. 2018. A tool to identify adolescents at risk of cigarette smoking initiation. *Pediatrics*, 142(5).
Turner, R.W., & Rockel, M.L. 1988. Estimating covariances of parameter estimates from different models. *Economics Letters*, 26(2):137-140.
U.S. Bureau of Labor Statistics. (2021). Occupational Employment and Wage Statistics. Retrieved from https://www.bls.gov/oes/tables.htm
US Department of Health and Human Services. 1994. Preventing tobacco use among young people: a report of the Surgeon General. Atlanta, Georgia: US Department of Health and Human Services, Public Health Service, CDC, 1994.
U.S. Department of Health and Human Services. (2014). *The Health Consequences of Smoking-50 Years of Progress. A Report of the Surgeon General*. Retrieved from Atlanta, GA:
U.S. Energy Information Administration. (2021a). Elecrticity Data Browser. Retrieved from https://www.eia.gov/electricity/data/browser/
U.S. Energy Information Administration. (2021b). Weekly Retail Gasoline and Diesel Prices. Retrieved from https://www.eia.gov/dnav/pet/pet_pri_gnd_a_epmr_pte_dpgal_a.htm
Wamamili, B. M., & Garrow, A. P. (2017). Have higher cigarette taxes in the United States discouraged smoking? A review of data from 1999-2013. *Tob Prev Cessat, 3*, 15. doi:10.18332/tpc/70561
Wilkins, N., Yurekli, A., & Hu, T.-w. (2013). *Economics of Tobacco Toolkit, Tool 3: Economic Analysis of Tobacco Demand*. Retrieved from Washington, DC: https://openknowledge.worldbank.org/handle/10986/16269
Xu, X., Bishop, E. E., Kennedy, S. M., Simpson, S. A., & Pechacek, T. F. (2015). Annual healthcare spending attributable to cigarette smoking: an update. *Am J Prev Med, 48*(3), 326-333.
Yu, L., Cohen, J.E., Hoe, C., Yang, T. and Wu, D. 2020. Male smoking reduction behaviour in response to China's 2015 cigarette tax increase. *Tobacco control*, 29(4):405-411.
Zhang, X., Cowling, D. W., & Tang, H. (2010). The impact of social norm change strategies on smokers' quitting behaviours. *Tobacco Control, 19 Suppl 1*, i51-55. doi:10.1136/tc.2008.029447

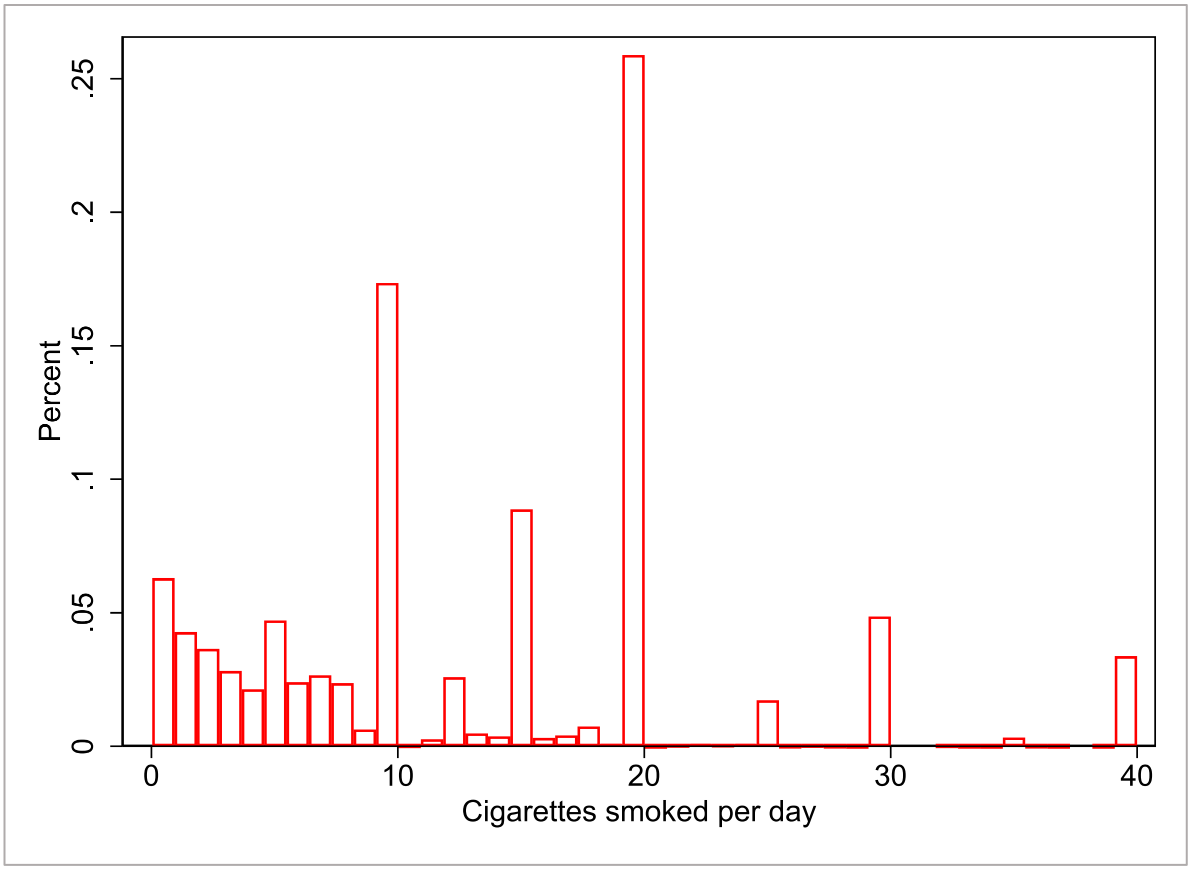


FIGURE 1. Empirical distribution of cigarettes smoked per day.

Note: Adult self-reported smoking based on NATS data.

TABLE 1. Descriptive Statistics of the Main Variables

Continuous variables	**Mean**	**Std. Dev.**
Cigarettes per day	13.65	9.42
Cigarette price (individual level, real $US)	4.84	1.60
Cumulative per capita tobacco control expenditures ($US)	13.24	12.00
Income (1,000 $US)	49.67	36.51
Age	47.88	15.25
Categorical variables	**Frequency**	**%**
Education		
Less than high school diploma, GED, or	3,021	12.37
High school diploma, GED, or equivalent	7,814	32.02
Some college or less than BS degree	8,953	36.67
BS degree	3,150	12.91
MS or higher	1,465	6.03
Marital status		
Not married	12,675	51.90
Married/Partnered	11746	48.20
Race and ethnicity		
White only, non-Hispanic	18,511	75.80
Black only, non-Hispanic	2,308	9.45
Asian only, non-Hispanic	252	1.03
Other, non-Hispanic	1,978	8.10
Hispanic	1,360	5.57
Gender		
Male	11,324	46.37
Female	13,097	53.63
Smoke-free policy (in 50 states and DC; 2015)		
No comprehensive ban or policy	24	47.06
Comprehensive ban	27	52.94
	Mean	**Std. Dev.**
Instruments		
Citizen ideology	50.58	14.45
Government ideology	45.79	17.26
Governor political affiliation (democrat)	0.49	0.50
Partisan composition of state legislature (democrat)	0.43	0.49
Partisan composition of state legislature (split)	0.13	0.33

***Note 1**:* The total number of observations is 24,421.

***Note 2**:* Citizen and government ideologies are measured as indices, and fall in the range 0-100, with 0 representing the most conservative value, and 100 reflecting the most liberal position.

TABLE 2. Estimation Results from the OLS, 2SLS, and SIVQR Estimators

Explanatory variables	OLS	2SLS	**Quantiles**								
			10th	20th	30th	40th	50th	60th	70th	80th	90th
Log (Cigarette price)	-0.329***	-0.281***	-0.509***	-0.515***	-0.337***	-0.322***	-0.289***	-0.225***	-0.160***	-0.128***	-0.133***
	(0.022)	*(0.050)*	*(0.137)*	*(0.107)*	*(0.057)*	*(0.043)*	*(0.031)*	*(0.026)*	*(0.024)*	*(0.019)*	*(0.044)*
Smokefree indoor air laws	0.001	-0.009	0.055	-0.034	-0.020	-0.006	-0.020	-0.012	-0.004	0.002	-0.013
	(0.016)	*(0.020)*	*(0.069)*	*(0.046)*	*(0.028)*	*(0.019)*	*(0.014)*	*(0.010)*	*(0.010)*	*(0.007)*	*(0.017)*
Tobacco control expenditures	-0.005	-0.005	-0.001	-0.013	-0.009	-0.005	0.001	-0.001	-0.004*	-0.006**	-0.014***
	(0.008)	*(0.009)*	*(0.028)*	*(0.013)*	*(0.011)*	*(0.009)*	*(0.006)*	*(0.005)*	*(0.002)*	*(0.003)*	*(0.004)*
Log (Income)	-0.041***	-0.044***	-0.154***	-0.071***	-0.028**	-0.019***	-0.011	-0.007	-0.005	-0.003	-0.010
	(0.008)	*(0.009)*	*(0.026)*	*(0.013)*	*(0.011)*	*(0.008)*	*(0.007)*	*(0.007)*	*(0.005)*	*(0.004)*	*(0.006)*
Age	0.135***	0.139***	0.187***	0.170***	0.132***	0.111***	0.110***	0.093***	0.067***	0.055***	0.075***
	(0.007)	*(0.008)*	*(0.025)*	*(0.017)*	*(0.012)*	*(0.009)*	*(0.006)*	*(0.005)*	*(0.004)*	*(0.003)*	*(0.005)*
Less than high school	0.388***	0.393***	0.869***	0.664***	0.459***	0.325***	0.277***	0.236***	0.161***	0.136***	0.176***
	(0.028)	*(0.028)*	*(0.084)*	*(0.057)*	*(0.029)*	*(0.022)*	*(0.017)*	*(0.015)*	*(0.011)*	*(0.012)*	*(0.019)*
High school	0.333***	0.337***	0.787***	0.622***	0.407***	0.248***	0.228***	0.198***	0.126***	0.091***	0.105***
	(0.021)	*(0.021)*	*(0.066)*	*(0.042)*	*(0.029)*	*(0.022)*	*(0.015)*	*(0.017)*	*(0.011)*	*(0.010)*	*(0.014)*
Some college	0.255***	0.259***	0.628***	0.503***	0.330***	0.187***	0.166***	0.155***	0.093***	0.068***	0.075***
	(0.020)	*(0.020)*	*(0.071)*	*(0.049)*	*(0.033)*	*(0.019)*	*(0.018)*	*(0.019)*	*(0.013)*	*(0.012)*	*(0.012)*
Married	0.043***	0.047***	0.171***	0.107***	0.072***	0.040***	0.017	0.001	-0.003	-0.006	-0.011
	(0.015)	*(0.015)*	*(0.042)*	*(0.031)*	*(0.016)*	*(0.011)*	*(0.014)*	*(0.010)*	*(0.007)*	*(0.008)*	*(0.009)*
Male	0.165***	0.165***	0.100**	0.126***	0.167***	0.195***	0.205***	0.179***	0.141***	0.123***	0.187***
	(0.014)	*(0.014)*	*(0.049)*	*(0.030)*	*(0.023)*	*(0.013)*	*(0.014)*	*(0.008)*	*(0.006)*	*(0.007)*	*(0.008)*
African American	-0.430***	-0.440***	-0.633***	-0.619***	-0.555***	-0.504***	-0.448***	-0.451***	-0.423***	-0.244***	-0.245***
	(0.024)	*(0.025)*	*(0.077)*	*(0.056)*	*(0.037)*	*(0.037)*	*(0.030)*	*(0.020)*	*(0.025)*	*(0.018)*	*(0.016)*
Asian	-0.458***	-0.469***	-0.642***	-0.667***	-0.615***	-0.572***	-0.485***	-0.419***	-0.443***	-0.265***	-0.219***
	(0.071	*(0.072)*	*(0.227)*	*(0.081)*	*(0.128)*	*(0.078)*	*(0.104)*	*(0.064*	*(0.057)*	*(0.082)*	*(0.050)*
Hispanic	-0.176***	-0.178***	-0.371***	-0.221***	-0.240***	-0.182***	-0.166***	-0.144***	-0.093***	-0.060***	-0.054***
	(0.027)	*(0.027)*	*(0.128)*	*(0.047)*	*(0.041)*	*(0.034)*	*(0.027)*	*(0.023)*	*(0.015)*	*(0.010)*	*(0.014)*
Other (non-White)	-0.581***	-0.588***	-1.138***	-0.972***	-0.786***	-0.624***	-0.513***	-0.460***	-0.418***	-0.239***	-0.193***
	(0.032)	*(0.032)*	*(0.184)*	*(0.108)*	*(0.072)*	*(0.039)*	*(0.035)*	*(0.030)*	*(0.044)*	*(0.032)*	*(0.018)*

Health condition	0.156***	0.157***	0.231***	0.189***	0.166***	0.159***	0.138***	0.116***	0.096***	0.099***	0.155***
	(0.017)	*(0.017)*	*(0.073)*	*(0.041)*	*(0.022)*	*(0.022)*	*(0.018)*	*(0.013)*	*(0.010)*	*(0.010)*	*(0.018)*
Dummy variable (2009)	-0.044***	-0.049***	-0.399***	-0.096***	0.005	0.050***	0.074***	0.068***	0.051***	0.042***	0.052***
	(0.018)	*(0.018)*	*(0.050)*	*(0.037*	*(0.018)*	*(0.014)*	*(0.012)*	*(0.010)*	*(0.009)*	*(0.006)*	*(0.008)*
Dummy variable (2010)	-0.032	-0.032	-0.092*	-0.080***	-0.033	-0.004	0.005	0.004	0.000	0.000	0.007
	(0.021)	*(0.021)*	*(0.055)*	*(0.031)*	*(0.024)*	*(0.019)*	*(0.018)*	*(0.012)*	*(0.008)*	*(0.009)*	*(0.015)*

***Note**:* Values in the parentheses are the standard errors. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level, respectively. The total number of observations is 24,421.

TABLE 3. Difference between Parameter Estimates from the Models with Exogenous and Endogenous Price and Policies

Explanatory variables	Quantiles								
	10th	20th	30th	40th	50th	60th	70th	80th	90th
Log (Cigarette price) $(\delta_{1\tau})$	-0.023***	0.017***	-0.041***	-0.011***	0.019***	0.010***	-0.005***	-0.014***	-0.043***
	(0.001)	*(0.001)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.001)*	*(0.000)*
Smoke-free indoor air laws $(\delta_{2\tau})$	-0.013***	-0.008***	0.007***	0.005***	0.001***	0.001***	0.004***	0.004***	0.013***
	(0.001)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Tobacco control expenditures $(\delta_{3\tau})$	-0.005***	-0.002***	0.001***	-0.001***	-0.002***	-0.001***	0.000	0.001***	0.001***
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Log (Income)	0.0053***	0.0027***	0.0054***	0.0029***	-0.0001	-0.0001	0.0003***	0.0010***	0.0009***
	(0.0002)	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0000)*	*(0.0000)*	*(0.0001)*
Age	-0.0046***	-0.0024***	-0.0045***	-0.0045***	0.0001	0.0000	-0.0003***	-0.0005***	-0.0023***
	(0.0002)	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0000)*	*(0.0000)*	*(0.0000)*	*(0.0000)*
Less than high school	-0.0107***	-0.0061***	-0.0061***	-0.0042***	0.0006***	0.0004***	0.0000	0.0002**	-0.0021***
	(0.0008)	*(0.0005)*	*(0.0002)*	*(0.0002)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0002)*
High school	-0.0044***	-0.0037***	-0.0034***	-0.0015***	0.0003***	0.0002***	0.0001	0.0006***	-0.0013***
	(0.0006)	*(0.0003)*	*(0.0002)*	*(0.0002)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*
Some college	-0.0069***	-0.0026***	-0.0048***	-0.0007***	0.0002	0.0002	0.0000	0.0002**	-0.0008***
	(0.0006)	*(0.0004)*	*(0.0003)*	*(0.0002)*	*(0.0002)*	*(0.0002)*	*(0.0001)*	*(0.0001)*	*(0.0001)*
Married	-0.0063***	-0.0019***	-0.0061***	-0.0021***	0.0002**	0.0000	-0.0004***	-0.0012***	-0.0014***
	(0.0004)	*(0.0002)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*
Male	-0.0011***	-0.0019***	-0.0017***	-0.0017***	0.0002**	-0.0002**	0.0005***	0.0013***	-0.0022***
	(0.0004)	*(0.0003)*	*(0.0002)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*
African American	-0.6714***	-0.6427***	-0.5613***	-0.5065***	-0.4624***	-0.4599***	-0.4282***	-0.2504***	-0.2495***
	(0.0006)	*(0.0004)*	*(0.0003)*	*(0.0003)*	*(0.0003)*	*(0.0002)*	*(0.0002)*	*(0.0002)*	*(0.0001)*
Asian	0.0120***	0.0085***	0.0055***	0.0188***	-0.0001	-0.0005	0.0006	0.0019***	0.0060***
	(0.0020)	*(0.0007)*	*(0.0011)*	*(0.0007)*	*(0.0009)*	*(0.0006)*	*(0.0005)*	*(0.0007)*	*(0.0005)*
Hispanic	0.0063***	0.0032***	0.0082***	0.0057***	0.0005**	0.0005**	-0.0003***	-0.0009***	-0.0004***
	(0.0011)	*(0.0004)*	*(0.0004)*	*(0.0003)*	*(0.0002)*	*(0.0002)*	*(0.0001)*	*(0.0001)*	*(0.0001)*
Other (non-White)	-0.0050***	0.0053***	0.0150***	0.0118***	0.0000	-0.0008***	0.0013**	-0.0010***	0.0033***
	(0.0016)	*(0.0010)*	*(0.0007)*	*(0.0003)*	*(0.0003)*	*(0.0003)*	*(0.0004)*	*(0.0003)*	*(0.0002)*

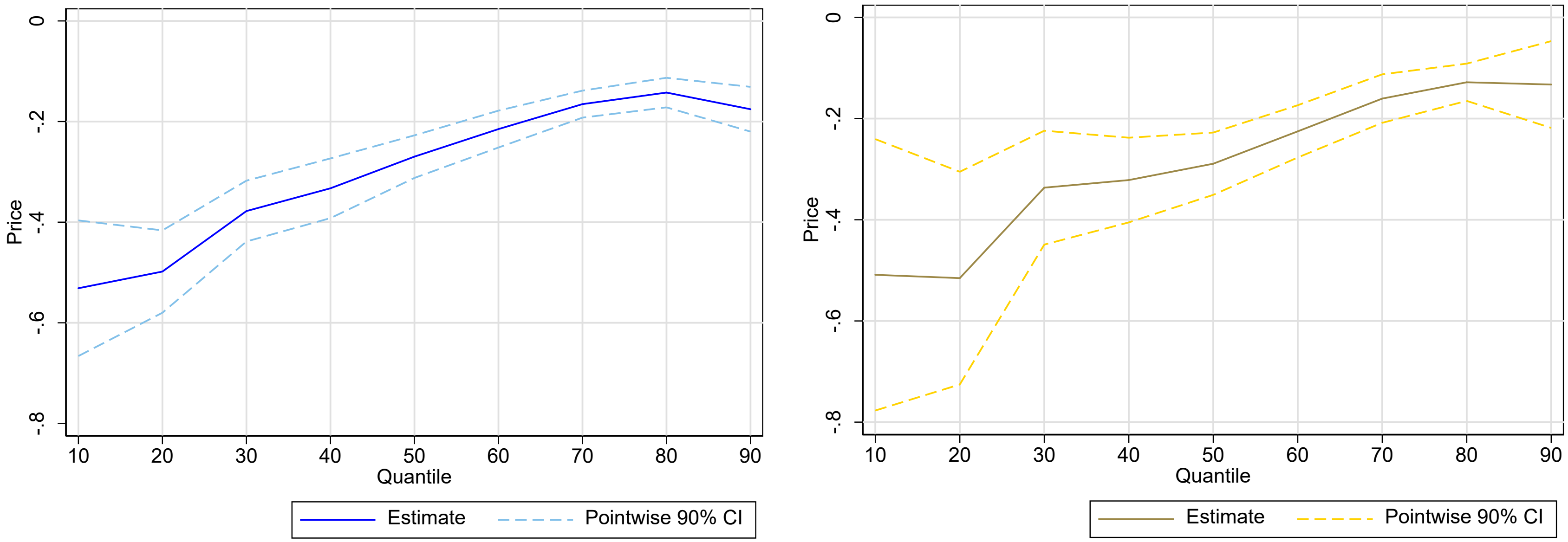
Health condition	-0.0107***	-0.0010**	0.0015***	-0.0046***	0.0001	0.0001	0.0004***	0.0003***	-0.0019***
	(0.0006)	*(0.0004)*	*(0.0002)*	*(0.0002)*	*(0.0002)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0002)*
Dummy variable (2009)	0.0074***	0.0012***	0.0060***	0.0072***	0.0007***	0.0009***	0.0013***	0.0025***	0.0023***
	(0.0004)	*(0.0003)*	*(0.0002)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*
Dummy variable (2010)	0.0052***	-0.0002	-0.0031***	-0.0011***	0.0000	0.0001	0.0003***	0.0001	0.0011***
	(0.0005)	*(0.0003)*	*(0.0002)*	*(0.0002)*	*(0.0002)*	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*

***Note**:* Values in the parentheses are the standard errors. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level, respectively. The standard errors are computed considering correlations between the respective parameter estimates, as per Turner and Rockel (1988). The total number of observations is 24,421.

TABLE 4. Percentage Difference between Parameter Estimates from the Models with Exogenous and Endogenous Price and Policies

Explanatory variables	**Quantiles**								
	10th	20th	30th	40th	50th	60th	70th	80th	90th
Log (Cigarette price) $(\delta_{1\tau})$	4.424	-3.335	12.311	3.466	-6.734	-4.567	3.062	11.036	32.250
Smoke-free indoor air laws $(\delta_{2\tau})$	-24.149	22.914	-33.492	-74.557	-7.354	-11.794	-90.216	185.500	-99.278
Tobacco control expenditures $(\delta_{3\tau})$	435.435	19.290	-8.819	26.828	-195.975	46.125	-1.420	-10.027	-9.379
Log (Income)	-3.587	-3.992	-23.690	-17.879	1.205	0.826	-6.619	-57.822	-10.404
Age	-2.552	-1.452	-3.530	-4.222	0.067	-0.034	-0.490	-0.933	-3.202
Less than high school	-1.249	-0.927	-1.341	-1.316	0.207	0.174	-0.028	0.151	-1.198
High school	-0.562	-0.594	-0.848	-0.592	0.122	0.096	0.078	0.642	-1.225
Some college	-1.113	-0.523	-1.465	-0.401	0.126	0.145	0.003	0.243	-1.125
Married	-3.828	-1.807	-9.332	-5.599	1.231	-4.412	10.912	15.355	11.030
Male	-1.122	-1.569	-1.045	-0.876	0.087	-0.087	0.345	1.084	-1.167
African American	-1.741	-1.061	-3.181	-2.042	0.077	0.068	-0.252	-0.264	-1.574
Asian	-1.896	-1.294	-0.894	-3.402	0.027	0.109	-0.142	-0.732	-2.843
Hispanic	-1.723	-1.462	-3.549	-3.245	-0.316	-0.355	0.298	1.399	0.768
Other (non-White)	0.438	-0.551	-1.945	-1.932	-0.003	0.164	-0.323	0.407	-1.717
Health condition	-4.872	-0.535	0.912	-2.979	0.083	0.073	0.371	0.267	-1.240
Dummy variable (2009)	-1.882	-1.246	55.716	12.587	0.872	1.239	2.596	5.719	4.221
Dummy variable (2010)	-5.928	0.190	8.622	23.721	0.902	1.951	65.259	18.278	14.938

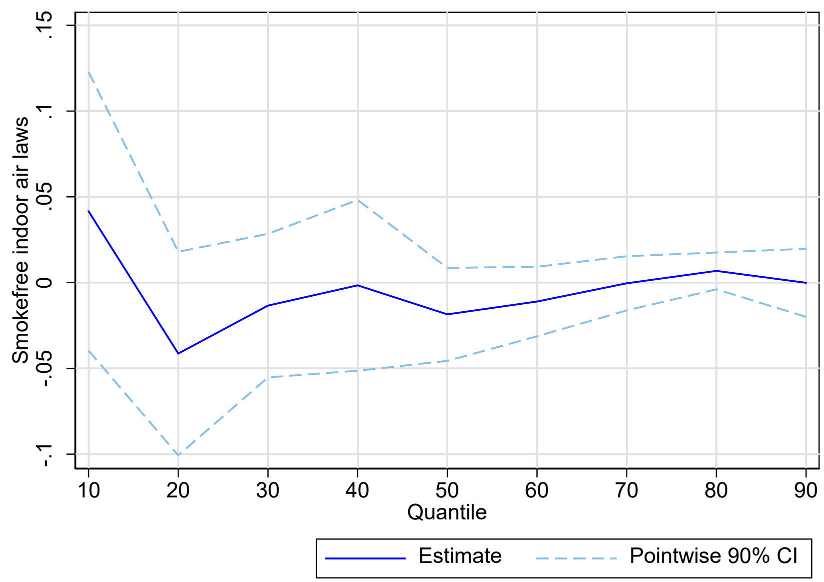
Note*:* Values in the parentheses are the standard errors. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level, respectively.



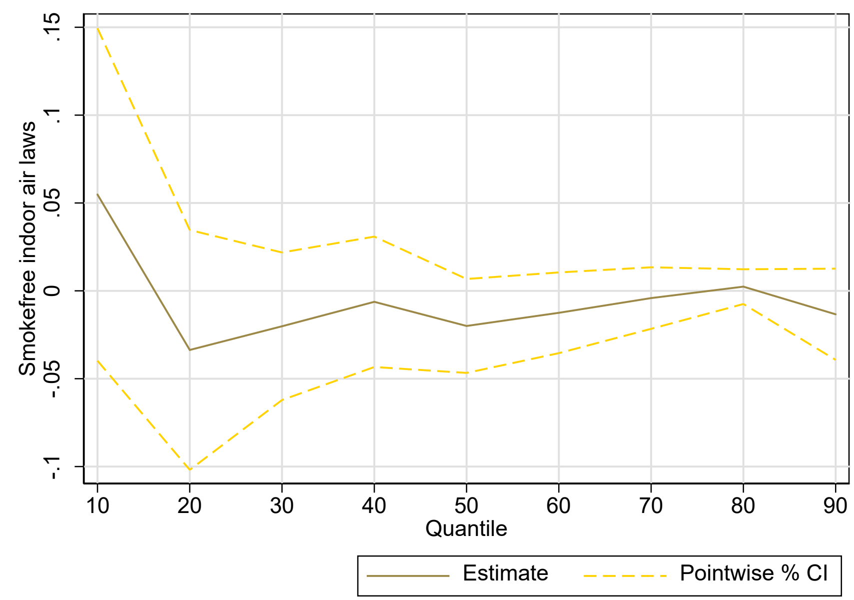
Panel A. Results from the Quantile regression ignoring endogeneity **Panel B.** Results from the IV Quantile regression

FIGURE 2. Price estimates and confidence intervals at different quantiles.

Note: IV quantile regression addresses endogeneity of cigarette price, tobacco expenditures, and smoke-free indoor air laws (SIVQR).



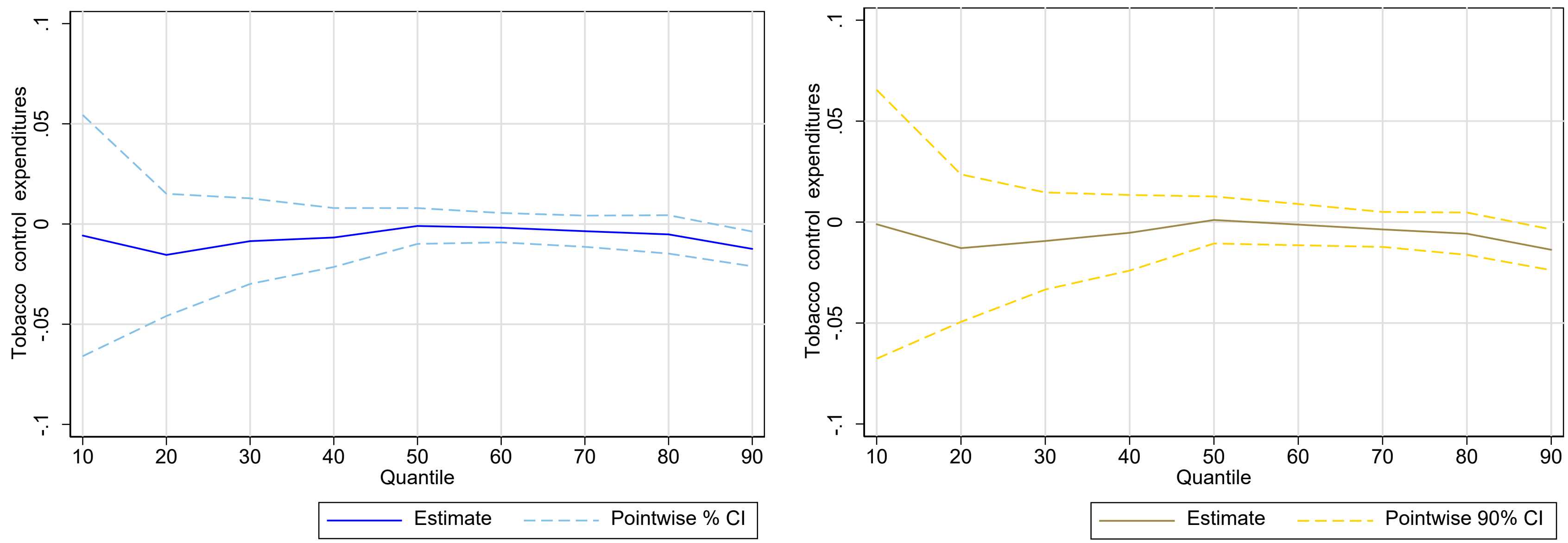
Panel A. Results from the Quantile regression ignoring endogeneity



Panel B. Results from the IV Quantile regression

FIGURE 3. Smokefree indoor air laws estimates and confidence intervals at different quantiles.

Note: IV quantile regression addressed endogeneity of cigarette price, tobacco expenditures, and smoke-free indoor air laws (SIVQR).



Panel A. Results from the Quantile regression ignoring endogeneity **Panel B.** Results from the IV Quantile regression

FIGURE 4. Tobacco control expenditure estimates and confidence intervals at different quantiles.

Note: IV quantile regression addressed endogeneity of cigarette price, tobacco expenditures, and smoke-free indoor air laws (SIVQR).