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Original investigation

The Association Between State Value-Added Taxes and Tobacco Use in India—Evidence From GATS and TCP India Survey

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Abstract

Introduction: State value-added taxes (VAT) on tobacco products have been increased significantly in recent years in India. Evidence on how these VATs were associated with smoking is highly needed.

Methods: State bidi and cigarette VAT rates were linked to Global Adult Tobacco Survey (GATS) India 2009–2010 and Tobacco Control Policy (TCP) India Survey waves 1 (2010–2011) and 2 (2012–2013), respectively. These linked data were used to analyze the associations between bidi VAT rates and bidi smoking, between cigarette VAT rates and cigarette smoking, and between the two VAT rates and dual use of bidis and cigarettes. Weighted logistic regressions were employed to examine GATS cross-sectional data, whereas generalized estimating equations (GEE) were employed to examine longitudinal TCP data. We further stratified the analyses by gender.

Results: A 10% increase in cigarette VAT rates was associated with a 6.5% ($p < .001$) decrease in dual use of cigarettes and bidis among adults and a 0.9% decrease ($p < .05$) in cigarette smoking among males in TCP; and with a 21.6% decrease ($p < .05$) in dual use among adults and a 17.2% decrease ($p < .001$) in cigarette smoking among males in GATS. TCP analyses controlling for state fixed effects are less likely to be biased and indicate a cigarette price elasticity of –0.44. As female smoking prevalence was extremely low, these associations were nonsignificant for females.

Conclusions: Higher state cigarette VAT rates in India were significantly associated with lower cigarette smoking and lower dual use of cigarettes and bidis. Increasing state VAT rates may significantly reduce smoking in India.

Implications: Both Global Adult Tobacco Survey and Tobacco Control Policy (TCP) India datasets suggest that higher state cigarette value-added tax rates were significantly associated with lower male cigarette smoking and lower dual use of cigarettes and bidis among all adults in India. TCP analyses indicate a cigarette price elasticity of –0.44. As shown in this study, state tobacco taxes in the current taxation system are likely effective in reducing smoking. Given this, a future central goods and service tax (GST) system could consider keeping states' authority in implementing local tobacco taxes or designing a GST system that is equally or more effective in reducing tobacco use.

Introduction

Tobacco use results in considerable public health and medical care costs in India.[1,2] As shown in the 2009–2010 Global Adult Tobacco Survey (GATS), 24.3% of Indian male adults and 2.9% of female adults were current tobacco users, and the prevalence of use was higher among older people[3,4] In addition, the form of tobacco use varies by demographic characteristics—bidi smoking prevalence in rural regions is nearly twice as high as in urban regions.[5] In fact, cigarette smoking is positively associated with wealth and education, while bidi smoking and dual use of bidis and cigarettes are negatively associated with wealth.[6] As the affordability of tobacco as a category continues to grow, the more expensive form—cigarettes have been gradually gaining popularity and younger and illiterate smokers have been shifting from bidi to cigarette smoking.[7,8]

Despite tax and price increases being arguably the single most effective policy in tobacco control,[9] evidence of their effectiveness in India is mixed. John[10] estimated price elasticity for tobacco to range from −0.4 to −0.9, with a larger impact seen for bidis and leaf tobaccos than for cigarettes. Guindon et al.[11] found that the price elasticity for bidis range from −0.60 to −0.95 and those for cigarettes range from −0.8 to −1.3. Joseph and Chaloupka[12] used the Global Youth Tobacco Survey of India and estimated a high price elasticity of −2.7 for bidis and a moderate price elasticity of −0.4 for cigarettes, suggesting youth are more sensitive to bidi price increases than adults. Selvaraj et al.[13] examined tobacco price elasticity by economic status and found that bidi price elasticity ranges from −0.43 to −0.08 and cigarette price elasticity ranges from −0.83 to −0.26, with larger price effects seen in poorer groups. In contrast, using GATS India data, Shang et al.[14] found that there was no significant association between tobacco prices and quitting smoking. Similarly, from analyses of the first wave of Tobacco Control Policy (TCP) India data, Pawar et al.[15] found no significant association between prices of smoked tobacco products and consumption.

Tobacco taxes in India also are very complicated with respect to their structures. Both central and state governments levy taxes on tobacco products, with lower rates for bidis than for cigarettes.[8,16–19] At the central level, quantity-based or specific taxes are imposed on both bidis and cigarettes. However, this specific rate varies by whether it is machine- or hand-made for bidis, by whether it has a filter or not, and by stick length for cigarettes. Significantly, bidi taxes are much lower than cigarette taxes.[8,16–19] As a result, tax rates vary considerably by product characteristics. Given that the more complicated a tax system is, the more opportunities for smokers to switch down to cheaper products, this complicated tax system in India may render increasing taxes a less effective policy for tobacco control.[8,16–19]

State governments in India have also been granted the authority to impose value-added taxes (VAT) on tobacco products in the last decade, resulting in different tax rates across states.[8] However, many states did not significantly raise their tobacco VAT rates until 2010, when they began to increase the VAT rates on bidis, cigarettes, and smokeless tobacco.[8,20] Recently, India has been considering a reform of their tax system to a central goods and service tax (GST) system, which may return the power of levying taxes from state to central governments.[13] Therefore, understanding whether state VATs have significantly raised prices and reduced smoking is much needed evidence for their effectiveness as a TCP and for policy makers' decisions about whether or not to keep state authorities over tobacco VATs in the new system. However, to the best of our knowledge, there have not been any studies investigating this issue.

Even with rising tax rates, whether or not these tax increases sufficiently reduced the affordability of tobacco products is key to understand their impact on tobacco use. Studies show that cigarettes and bidis have been growing more affordable and that bidis are much more affordable than cigarettes.[8,21,22] Kostova et al.[21] showed that prices paid for 2000 sticks of bidis are barely 1% of India's per capita gross domestic income, compared to 8% paid for the same number of cigarette sticks. As state VATs further increase tobacco prices on top of central excises, examining the association between VAT rates and tobacco use will also shed light on their role in reducing tobacco affordability.

Our study contributes to the existing literature in several aspects. First, this is the first study to analyze the association between state cigarette and bidi VAT rates and tobacco use, and thus provides important and timely evidence on the effectiveness of raising state VAT rates for tobacco control. Second, since the evidence of the association between prices and tobacco use is mixed, our analyses also add evidence on the estimates of such associations. Third, this study is the first to examine how bidi and cigarette taxes may influence dual use, which has not been studied before. Last, but not least, this study utilizes both GATS and TCP India data, two large-scale surveys that complement each other in sampling design and survey methods, making it a unique contribution to the literature.

Data

This study utilizes two large scale datasets (GATS and TCP India) with different sampling designs and measures of sociodemographic and policy environment information. GATS is nationally representative household survey, whereas TCP India is longitudinal cohort survey of population in four states (Maharashtra, Madhya Pradesh, Bihar, and West Bengal) with a probability sampling design. Therefore, we created a flow chart (Figure 1) to summarize and exhibit these two datasets and their corresponding variable

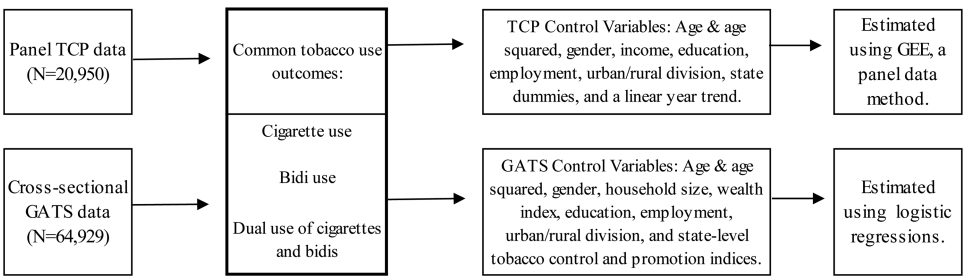

Figure 1. Models and data sources for analyzing association between VATs and tobacco use.

constructs and analytical methods. Despite the differences in survey and analytical methodologies, both surveys provide similar or comparable information on tobacco use and sociodemographic characteristics. In addition, because same relationships between state VAT rates and smoking were studied, we anticipated similar findings from the two surveys and presented corresponding results together.

Global Tobacco Adult Survey

GATS India is a nationally representative survey of tobacco use among adults aged 15 years or older. Designed to monitor tobacco use and evaluate the effectiveness of tobacco control policies, GATS contains rich information on tobacco use behaviors, attitudes, exposure to tobacco company marketing, and the tobacco control environment.[22,23] GATS India was conducted during 2009–2010, covering 31 states and territories and 99% of the total adult population of India.[24] Among the surveyed population, 51.7% were male and 70.8% lived in rural areas.[5] As a nationally representative survey with a large sample size and a sampling design that provides national, regional, and state estimates, GATS India provides unique opportunities to understand how state tobacco control interventions as well as national policies are associated with tobacco use behavior.[24]

Several standard questions from the GATS survey were used to measure tobacco use behaviors and related factors. Specific questions include: "On average, how many manufactured cigarettes/rolled tobacco in paper leaf/bidis do you currently smoke per day/per week?" and "How many manufactured cigarettes/rolled tobacco in paper leaf/bidis do you currently smoke during a usual week?" These questions were used to construct three tobacco use outcomes, which are: currently smoke cigarettes (noncigarette users are coded with 0 and cigarette current users are coded with 1), currently smoke bidis (nonbidi users are coded with 0 and bidi current users are coded with 1), and currently smoke both bidis and cigarettes (dual use of bidis and cigarettes are coded as 1 and other responses are coded as 0). Cigarette users include those who consume manufactured cigarettes or hand-rolled tobacco paper.

Following the previous literature and the GATS economic analysis toolkit,[14,25] we used a series of questions regarding assets and exposure to tobacco control policies as well as to tobacco marketing to create indices for each domain. In order to control for the influence of wealth on tobacco use,[6] wealth index for each individual was constructed as the fraction of a list of assets owned by the respondent. Furthermore, state-level indices were constructed using self-reported exposure to control for the common tobacco control and marketing environments. These state-level indices also have advantages over corresponding individual-level exposure measures because they are less likely to be influenced by individuals' tobacco use status and thus are less likely to be endogenous. Because marketing of alternative tobacco products may be different,[26] state-level tobacco control indices were constructed separately for bidis and cigarettes using self-reported exposure to worksite smoking bans and anti-smoking information with regard to each product. State-level tobacco promotion indices were constructed using self-reports of exposure to advertising and other forms of promotion, for bidis and cigarettes, respectively. The averages of the bidi and cigarette indices were also constructed and used to control for the average tobacco-related environment when estimating the dual use of cigarettes and bidis. Detailed methods can be found in Supplementary Table 1.

In addition to the wealth index, a variety of socioeconomic and demographic variables at the individual level, including gender (an indicator of being male), age, household size, being employed, residing in urban area and education (primary, secondary, high school, college or higher, with no education/less than primary as the omitted variable), were constructed and controlled for in the empirical analyses.

TCP India Survey

The International Tobacco Control Policy Evaluation Project (the ITC Project) partnered with the Healis-Sekhsaria Institute for Public Health to conduct the Tobacco Control Policy India Survey (TCP India).[15,27] In order to avoid confusion with the India Tobacco Company, the ITC Project is known as the TCP Project. TCP India was conducted in four states: Maharashtra, Madhya Pradesh, Bihar, and West Bengal. TCP India is a prospective cohort survey of adults aged 15 years or older, including both tobacco users and nonusers.[27] The first wave of TCP India was conducted between August 2010 and October 2011, and the second wave was conducted between October 2012 and September 2013. Both waves were used in the analyses.

TCP India allows us to construct tobacco use variables that are identical to those in GATS, including currently smoking cigarettes, currently smoking bidis, and dual use of bidis and cigarettes. In addition, socioeconomic and demographic variables at the individual level, including gender, age, being employed, residing in urban area, education (primary, secondary, college or higher, with no education/less than primary as the omitted variable), and monthly household income (low: <5000 rupees, moderate: 5000–15 000 rupees, and high: ≥15 000 rupees), were also available and controlled for in the regression.

State VAT Rates

We obtained annual state-level VAT rates starting from 2010 for cigarettes and bidis from data collected by the Campaign for Tobacco-Free Kids India team and VAT rates in 2009–2010 from ERC report of tobacco market in India. These VAT data are available on request. Between 2010 and 2013, the average state VAT on bidis increased from 5.5% to 14% and that on cigarettes increased from 15% to 25%. Among the four TCP India states, Maharashtra's bidi VAT rate increased from 0% to 5% in fiscal year 2012 and further to 12.5% in 2013, while its cigarette VAT rate increased from 20% to 25% in 2013. In Madhya Pradesh, the bidi VAT rate increased from 12.5% to 23% in 2012, whereas the cigarette VAT rate did not change. In Bihar, the cigarette VAT rate increased gradually from 13.5% in 2011 to 30% in 2013, with the bidi rate increasing from 0% to 13.5% in 2013. In West Bengal, the cigarette VAT rate increased from 13.5% to 20% in 2011 and further to 30% in 2013, whereas no bidi VAT was imposed.

Methods and Analyses

We utilized both GATS and TCP India data to analyze the associations between VAT rates and tobacco use. Given that the two surveys are different in their survey methodology and sampling,[27] we conducted separate, but similar regressions using each. Despite the difference in data, we intended to analyze same tobacco use outcomes and test the hypothesis that higher VAT rates are associated with lower tobacco use.

In the first step, we linked GATS and TCP India with state VAT rates using state and year identifiers. Changes in VAT rates occur at the start of the fiscal year (April 1). Therefore, we matched each TCP respondent to the fiscal year of his/her responses. The GATS India

survey was conducted entirely within fiscal 2009—from August 2009 through January 2010.[3]

One unique advantage of using both surveys is their complementarity. GATS was a nationally representative survey that covers nearly all states and territories, but a single cross-section lacks a time dimension. In contrast, TCP India was a longitudinal survey that follows a group of people over time, but that only surveyed people from four states and thus is not as comprehensive or representative as GATS survey. Examining data from both surveys provides a more complete picture than analyzing either alone. The models used in the analyses can be summarized by the following equations.

$$Y_i = \alpha \mathrm{VAT}_j + \beta X_i + \rho Z_j + \varepsilon_i \,(\mathrm{GATS\ equation})$$

$$Y_{it} = \alpha \mathrm{VAT}_{jt} + \beta X_{it} + \rho Z_j + \varepsilon_{it} \,(\mathrm{TCP\ India\ equation})$$

The distinction between the two equations is the presence of the subscript t in the TCP India equation, denoting its longitudinal design. Y_i/Y_{it} is one of three tobacco use outcomes and X_i/X_{it} is a vector of sociodemographic variables. In the GATS data, these X variables are gender, age, household size, employment status, residing in urban area, education, and wealth index. In the TCP India data, these X variables are gender, age, being employed, residing in urban area, education, and monthly household income. Z_j is a vector of state-specific controls. In the GATS data, these are the state tobacco control and marketing composite indices; in the TCP India analyses, these are state fixed effects. Because two waves of TCP India data were utilized, the regressions also included a linear year trend to capture the common time-varying factors such as an increase in national tobacco taxes. Year trend and state fixed effects were not included in the GATS analyses because it is a one-time cross-sectional survey.

A handful of previous studies have shown that bidis and cigarettes have distinct markets and that there is a sociodemographic division between bidi and cigarette users.[6,19] Wealthier and more educated tobacco users tend to use cigarettes.[6] Guindon et al.[11] employed a two-equation budgeting or Deaton Method to analyze the cross-price elasticity among tobacco and alcohol products and did not find conclusive substitution or complementary relationships between cigarettes and bidis. Using GATS data, we estimated the impact of cigarette on bidi use and vice versa using a two-stage least square method with corresponding VAT rate s as instruments (state-level bidi promotion was also used as instruments for bidi use to address the weak instrument problem), and did not find significant impact of cigarette on bidi use or vice versa. As a result, we decided to estimate cigarette, bidi, and dual use separately, with cigarette VAT rates, bidi VAT rates, and cigarette and bidi VAT rates entered to the three separate equations, respectively.

Weighted logistic regression methods were used to analyze the GATS data, with standard errors clustered at the state level. Following previous studies using ITC Project data from other countries,[18,28,29] generalized estimating equations (GEE) models with a logistic link, a binomial family and exchangeable correlation were used to analyze the TCP India data. GEE models extend generalized linear models by adjusting for correlated data and have been applied to analyze ITC Project panel data in many studies. Two sets of sensitivity analyses were conducted to examine the validity of estimates. First, we dropped the year trend in the TCP analyses and utilized additional variation of VAT rates over time that was common to all states in the analyses. Second, we did not control for tobacco control index in GATS analyses that were potentially correlated with VAT rates. Third, bidi and cigarette equations were estimated jointly using GATS data by assuming that the error terms of the two equations are correlated. All analyses were conducted using Stata 14.

Results

Weighted summary statistics are shown in Table 1. After dropping observations with missing data for outcome variables and covariates, the sample sizes are 20 950 for TCP India and 64 929 for GATS India. GATS final weights and TCP India longitudinal weights were used in the summary statistics and regressions. TCP India data shows that the prevalence of cigarette smoking, bidi smoking, and dual use were 11.5%, 10.7%, and 3.7%, respectively. The corresponding estimates from the GATS 2009–2010 data were 5.8%, 9.2%, and 2.2%, respectively. The average bidi VAT rate was 6.3% for the TCP India data and 5.6% for the GATS data, whereas the average cigarette VAT rate was 21.2% for TCP India and 14.6% for GATS. The higher rates for the TCP sample resulted from Madhya Pradesh and Maharashtra having among the highest state VAT rates in India, and the significant increases in these rates after 2010.[8]

Education profile shows that respondents in TCP survey were better educated compared with those in GATS survey: percentages of no formal education, primary, secondary/high school, and college education or above were 23.8%, 29.6%, 32.2%, and 14.3% in TCP survey, comparing to 31%, 24%, 36.7%, and 8.3% in GATS. Other summary statistics are relatively comparable across datasets. The average age was 40.5 in TCP and 35.9 in GATS and the percentage of males was 60% in TCP and 52% in GATS. In addition, 53% were employed at the time of survey and 71% lived in urban area in GATS, very similar to the corresponding estimates (49% employed and 67% in urban area) in the TCP data. Gender-specific summary statistics are reported in Supplementary Tables 1 and 2.

Results of the association between VAT rates and smoking outcomes are presented in Table 2, with the first three columns showing TCP analyses and the last three showing GATS analyses. Despite their different sampling designs and the methods used, results generally suggest a negative association between higher cigarette VAT rates and lower cigarette smoking prevalence. Specifically, higher cigarette VAT rates were significantly associated with lower dual-use of cigarettes and bidis ($p < .001$ in TCP and $p < .05$ in GATS). In addition, based on the GATS analyses, higher cigarette VAT rates were significantly associated with lower cigarette smoking among adults ($p < .001$). The corresponding elasticity estimates show that a 10% increase in cigarette VAT rates was associated with a 6.5% decrease in dual use in the TCP data and a 21.6% decrease in the GATS data. GATS results also indicate that a 10% increase in cigarette VAT rates was associated with a 17.2% decrease in cigarette smoking.

Results for males are shown in Table 3 and those for females are shown in Table 4. For males, analyses using both datasets produce similar conclusions. Higher cigarette VAT rates were significantly associated with lower cigarette smoking ($p < .05$ in TCP and $p < .001$ in GATS) and dual use ($p < .001$ in TCP and $p < .05$ in GATS). These estimates indicate that a 10% increase in cigarette VAT rates was associated with a 0.9% decrease in cigarette smoking and a 4.9% decrease in dual use among ITC male population, as well as a 16.9% decrease in cigarette smoking and a 21.3% decrease in dual use among GATS male population. Sensitivity analyses show very similar results (Supplementary Tables 3 and 4).

To make these VAT estimates more comparable to previous estimates of price elasticities from India, we further adjusted them to account for the differences in the base on which the VAT was applied. For example, a 10% increase in price is equivalent to a "10% × price

Table 1. Weighted Summary Statistics

	TCP		GATS	
Variables	Mean	SD	Mean	SD
Tobacco use				
Dual (bidi and cigarette)	0.037	0.189	0.022	0.147
Bidi	0.107	0.309	0.092	0.289
Cigarette	0.115	0.319	0.058	0.234
State VAT rates				
Bidi	0.063	0.083	0.056	0.075
Cigarette	0.212	0.054	0.146	0.030
State-level indices				
Average tobacco control	—	—	0.343	0.083
Average tobacco promotion	—	—	0.035	0.023
Cigarette tobacco control	—	—	0.427	0.089
Cigarette tobacco promotion	—	—	0.042	0.024
Bidi tobacco control	—	—	0.395	0.091
Bidi tobacco promotion	—	—	0.029	0.023
State dummies				
Bihar	0.206	0.404	—	—
West Bengal	0.267	0.443	—	—
Madhya Pradesh	0.262	0.440	—	—
Maharashtra	0.265	0.441	—	—
Age	40.476	15.722	35.934	15.896
Age squared	1885.487	1430.722	1543.934	1387.754
Male	0.597	0.490	0.517	0.50
Household size	—	—	6.069	3.315
Wealth index	—	—	0.332	0.234
Income				
Low	0.205	0.404	—	—
Middle	0.577	0.494	—	—
High	0.189	0.391	—	—
Missing	0.029	0.167	—	—
Education	—	—		
None	0.238	0.426	0.310	0.463
Primary	0.296	0.457	0.240	0.427
Secondary (high school not included in GATS)	0.322	0.467	0.287	0.452
High school	—	—	0.080	0.271
≥College	0.143	0.350	0.083	0.276
Employed	0.486	0.500	0.528	0.499
Urban	0.666	0.472	0.708	0.455
N	20 950		64 929	

Note: GATS final weights and TCP longitudinal weights were used.

Table 2. The association between bidi and cigarette VAT rates and smoking outcomes

	TCP (*N* = 20 950)			GATS (*N* = 64 929)		
	Bidi	Cigarette	Dual	Bidi	Cigarette	Dual
Bidi VAT rate	−0.240	—	1.135	1.096	—	−0.854
	(0.452)	—	(0.823)	(1.812)	—	(2.566)
Cigarette VAT rate	—	−0.368	−3.176***	—	−12.452***	−15.061*
	—	(0.241)	(0.440)	—	(2.794)	(7.290)
Elasticity estimates						
Bidi VAT rate	−0.013	—	0.070	0.055	—	−0.047
	(0.025)	—	(0.052)	(0.090)	—	(0.141)
Cigarette VAT rate	—	−0.069	−0.650***	—	−1.722***	−2.161*
	—	(0.045)	(0.090)	—	(0.380)	(1.045)

Note: TCP bidi analysis (Column 1) was estimated using random effect model because GEE model did not converge. Standard errors in parentheses.
$^{+}p < .1$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Table 3. The association between Bidi and Cigarette VAT Rates and Smoking outcomes, male

	TCP (N = 12,425)			GATS (N = 31,613)		
	Bidi	Cigarette	Dual	Bidi	Cigarette	Dual
Bidi VAT rate	−0.168	—	1.234	0.859	—	−1.475
	(0.431)	—	(0.837)	(1.884)	—	(2.553)
Cigarette VAT rate	—	−0.506*	−2.438***	—	−12.818***	−15.054*
	—	(0.248)	(0.458)	—	(2.877)	(7.226)
Elasticity Estimates						
Bidi VAT rate	−0.009	—	0.081	0.040	—	−0.081
	(0.024)	—	(0.055)	(0.087)	—	(0.140)
Cigarette VAT rate	—	−0.088*	−0.489***	—	−1.692***	−2.128*
	—	(0.043)	(0.092)	—	(0.366)	(1.012)

Note: standard errors in parentheses, $+p < 0.1$ $*p < 0.05$, $**p < 0.01$, $***p < 0.001$

Table 4. The association between Bidi and Cigarette VAT Rates and Smoking outcomes, female

	TCP (N = 7,562)			GATS (N = 33,316)		
	Bidi	Cigarette	Dual	Bidi	Cigarette	Dual
Bidi VAT rate	0.008	—	—	2.925	—	6.010
	(1.912)	—	—	(2.785)	—	(3.886)
Cigarette VAT rate	—	0.626	—	—	−9.298	−18.017
	—	(6.553)	—	—	(8.236)	(11.490)
Elasticity estimates						
Bidi VAT rate	0.0005	—	—	0.157	—	0.330
	(0.104)	—	—	(0.149)	—	(0.213)
Cigarette VAT rate	—	0.125	—	—	−1.349	−2.626
	—	(1.310)	—	—	(1.196)	(1.673)

Note: standard errors in parentheses.
$+p < .1$, $*p < .05$, $**p < .01$, $***p < .001$.

base" increase in the absolute value, whereas a 10% increase in VAT rates is equivalent to a "10% × VAT rates × tax base" increase in the absolute value. Conditional on the same tax or price base, a 10% increase in VAT rates will be smaller than a 10% increase in the rupee amount of prices. To make our estimates directly comparable with previous price elasticity estimates, we multiplied our VAT elasticity estimate by a factor of 5, a number rescaling the average 20% cigarette VAT rate (10% × 5 × 20% × tax base) so that the absolute increase in taxes or prices was approximately "10% × tax base." As a result, the findings using TCP data imply a price elasticity of −0.44 for male cigarette smoking and a price elasticity around −3.25 with regard to male dual use. Findings using GATS data imply very large price elasticities that were about −8.6 to −10.8.

Discussion

Using GATS and TCP India data linked with state tobacco VAT rates, we studied the relationship between state VAT rates and smoking. Results show that the prevalence of bidi smoking was very similar in both datasets (10.7% in TCP and 9.2% in GATS), whereas cigarette smoking and dual use were higher in the TCP India data (11.4% cigarette use and 3.7% dual use in TCP versus 5.8% cigarette use and 2.2% dual use in GATS). Given that some evidence suggests cigarette smoking is more prevalent in higher income or higher educated populations in India,[13] the higher prevalence of cigarette smoking and dual use in the TCP India data may be driven by the fact that the surveys were conducted in large cities and surrounding suburban areas where people are higher-educated and thus have higher income. This hypothesis is confirmed by the descriptive statistics for education; compared to the GATS, the TCP India sample has a smaller population with no formal education (23.8% vs. 31% in GATS) and a larger population with a college degree or higher (41.3% vs. 8.3% in GATS). In addition, the prevalence of cigarette smoking in West Bengal, one of the four TCP states, was much higher than the national average.[3]

We find that a 10% increase in cigarette VAT rates was associated with a 6.5% decrease in adult dual use of cigarettes and bidis and a 0.9% decrease in male cigarette smoking in TCP data, as well as with a 21.6% decrease in adult dual use and 17.2% decrease in cigarette smoking in GATS data. There are several reasons why the estimated associations of cigarette VAT rates with cigarette smoking and dual use were greater when GATS data were used, as compared to when TCP data were used. First, GATS estimates are very likely inflated because the data are a one-time cross-sectional snapshot that do not have a time dimension. As a result, the VAT estimates also reflect the associations between other factors and tobacco use behaviors, such as state-level tobacco use sentiment and the central tobacco control policies and tax increases, whereas these confounders were controlled for in TCP analyses using state fixed effects and a common year trend. Second, as aforementioned, compared to the GATS survey, TCP India surveys were conducted in large cities and surrounding suburban areas where people are higher-educated and have higher income. Therefore, TCP respondents may be less sensitive to tax and price increases because tobacco products are more affordable for them than for GATS respondents, who are more representative of the average Indian population.

Nevertheless, given that a cross-sectional comparison of jurisdictions that have undergone policy change tend to yield larger estimates,[30,31] the GATS analyses likely provide the upper bounds for estimates of the associations between VAT rates and smoking outcomes. Furthermore, because TCP analyses adjusted for the common trend in tobacco control efforts across the four states and examined a population more educated than the general Indian population, the estimates using TCP data are likely to provide the lower bounds. These findings are also consistent with previous studies that conclude that increasing taxes and prices reduces smoking in India.[10,12,13,32]

Compared to GATS estimates, TCP estimates are less likely to be upward biased by tobacco control policies and tax increases implemented by the central government. Findings using TCP data also imply a price elasticity of −0.44 for male cigarette smoking that is comparable to the estimates from John[10] and Joseph and Chaloupka.[12] Regardless, both GATS and TCP data show a greater association of cigarette VAT rates with dual use than with exclusive cigarette use. This greater association is likely due to that dual users are more sensitive to increasing cigarette prices than exclusive cigarette users since they can switch to exclusive bidi use or quit smoking all together. This hypothesis is also supported by previous studies showing that bidi and cigarettes are distinct markets owing to a combination of cultural and consumer perception differences between the two products.[5,19] In addition, unlike cigarette market that is dominated by Indian Tobacco Company and several big players,[33] bidis are produced by many small-scale firms and contractors that hire part-time workers, women and children to keep price low.[34] Therefore, it is likely that dual users who have already straddled the two markets are a group of smokers different from exclusive bidi or cigarette smokers.

This study did not find significant associations of bidi VAT rates with either bidi smoking or dual use, which may be due to a variety of reasons. First, bidis remained very cheap even with significant increases in VAT rates because of their low costs.[34] Recent studies consistently show that bidis are very affordable in India.[7,8,19,21,22,35] Therefore, consumers may not be as responsive to changes in lower bid prices as to changes in higher cigarette prices, supported by evidence that price elasticity tends to increase as prices go up and that price elasticity for bidis was found to be smaller than that for cigarettes in several studies.[11–13,36] Second, the complicated tax structure for bidis may reduce the amount of tax increases passed to price and thus decrease the effectiveness of bidi taxes.[37] Third, studies show that cigarettes are displacing bidis as income grows,[7,8] dual smokers may become more sensitive to cigarette prices than to bidi prices.

Our analyses have several limitations. First, due to the difference in survey methodology, we could not pool TCP and GATS India together to exploit tax changes over a longer period to identify the causal impacts of increasing VAT rates on tobacco use. Second, because of the same data limitation, we were unable to assess quitting and substitution behaviors while controlling for common confounders. Future research using repeated cross-sectional or longitudinal data will address these limitations. Third, although bidi and cigarette equations may be estimated more efficiently under a bivariate framework, there is no canned command in Stata to conduct such an analysis in combination with GEE in a longitudinal context. Nonetheless, we estimated a bivariate Probit model using GATS data and showed similar results regarding the association between VAT rates and tobacco use.

In sum, this is the first article that utilizes both TCP and GATS India to investigate the association between state tobacco VAT rates and smoking outcomes. Despite different sampling methods, both data support the conclusion that increasing cigarette VAT rates were significantly associated with decreased dual use of cigarettes and bidis, and with decreased cigarette use among males. These findings provide compelling evidence on the potential effect of higher state tobacco VAT rates in reducing smoking. Specifically, our TCP results suggest that higher cigarette VAT rates at the state level were associated with lower male cigarette smoking and lower dual use of cigarettes and bidis among all adults, after controlling for state-specific tobacco use sentiment and common policies and tax increases at the central government level. As tobacco products become more affordable as income grows,[8] state VAT rates can be an effective policy tool to reduce the affordability of tobacco and ultimately reduce tobacco use and its consequences in combination with other tobacco control policies and prevention measures. In addition, state VATs are levied on values and not eroded by inflation, and thus serve as a good complement to the specific central tax in reducing tobacco use.[38] In fact, the larger estimates of the negative association between state VAT rates and tobacco use in GATS data already indicate that the combined central and state tax effects may be greater.

Furthermore, recent studies show that cigarettes are displacing bidis,[7,8] particularly among younger smokers and smokers with no formal education. Increasing cigarette VAT rates may be very effective in tobacco control through reducing both cigarette smoking and dual use, especially when bidi and cigarette markets are likely distinct and switching from cigarettes to bidis is unlikely to occur.[5,19] Policy makers and state governments could consider further increasing cigarette taxes including VAT rates, as part of a comprehensive list of tobacco control measures, to help achieve their tobacco control goals. Our results also illustrate several challenges for tobacco control in India. First, similar to previous studies,[10,11] we estimated a moderate price elasticity around −0.44. The collective evidence indicates that there is room for India to improve the effectiveness of tax increases in reducing smoking. In particular, a handful of studies have pointed out that the complicated tax structure in India may have dampened the effectiveness of raising taxes as a tobacco control policy since it leads to more tax avoidance opportunities, including trading down to less taxed, cheaper brands.[8,16–18] The complicated tax structure also exacerbates the problem of low bidi prices by reducing how much tax increases are passed to prices.[37] Policy makers and governments may consider simplifying India's complex tobacco tax system during the broader discussions on tax reform. Second, we find that VAT rates imposed on bidis were about one-third of those on cigarettes, which add to the already strong evidence that there is substantial room to raise bidi prices.[8,19,37] The nonsignificant association between bidi VAT rates and smoking also illustrates that the bidi taxes may not be salient or high enough to reduce bidi smoking given the high affordability of bidis. Therefore, bidi taxes and prices need further and more sizable increases to reduce bidi smoking in India, as a complement to other tobacco control measures that India has committed to implement under the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC).[38–40]

In conclusion, state tobacco VAT rates, particularly higher cigarette VAT rates, are an effective means of reducing tobacco use and could lead to public health benefits when implemented with other effective tobacco control measures.[38–40] As the tax reform in India is moving towards a central GST system which may abolish state governing in local tobacco taxation, the new GST system could consider the effectiveness of state tobacco taxes in reducing smoking to either allow states to keep their authority in raising local tobacco

taxes or to design a GST system that is equally or more effective in reducing tobacco use.

Supplementary Material

Supplementary data are available at *Nicotine and Tobacco Research* online.

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Ethics approval

The study protocol and survey materials were approved by the Office of Research Ethics at the University of Waterloo, Canada and the Institutional Review Board at the Healis Sekhsaria Institute for Public Health, India.

Declaration of Interests

None declared.

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References

1. Jha P, Jacob B, Gajalakshmi V, et al.; RGI-CGHR Investigators. A nationally representative case–control study of smoking and death in India. *N Engl J Med*. 2008;358(11):1137–1147.
2. John RM, Sung HY, Max W. Economic cost of tobacco use in India, 2004. *Tob Control*. 2009;18(2):138–143.
3. *Global Adult Tobacco Survey, Fact Sheet India, 2009–2010*. International Institute for Population Sciences; 2010. http://www.who.int/tobacco/surveillance/en_tfi_india_gats_fact_sheet.pdf.
4. Singh A, Ladusingh L. Prevalence and determinants of tobacco use in India: evidence from recent Global Adult Tobacco Survey data. *PLoS One*. 2014;9(12):e114073.
5. International Institute for Population Sciences (IIPS), *Global Adult Tobacco Survey: GATS India 2009–2010*. Mumbai, India: IIPS. 2010. http://www.who.int/tobacco/surveillance/survey/gats/ind/en/
6. Singh A, Arora M, English DR, Mathur MR. Socioeconomic gradients in different types of tobacco use in India: evidence from Global Adult Tobacco Survey 2009–10. *Biomed Res Int*. 2015;2015:837804, 9 pages.
7. Mishra S, Joseph RA, Gupta PC, et al. Trends in bidi and cigarette smoking in India from 1998 to 2015, by age, gender and education. *BMJ Glob Health*. 2016;1(1):e000005.
8. Jha P, Guindon E, Joseph RA, et al. A rational taxation system of bidis and cigarettes to reduce smoking deaths in India. *Econ Polit Wkly*. 2011;42:44–51.
9. *IARC Handbooks of Cancer Prevention, Tobacco Control, Volume 14: Effectiveness of Tax and Price Policies for Control of Tobacco*; Lyon, France. 2011. https://www.iarc.fr/en/publications/pdfs-online/prev/handbook14/handbook14.pdf.
10. John RM. Price elasticity estimates for tobacco products in India. *Health Policy Plan*. 2008;23(3):200–209.
11. Guindon GE, Nandi A, Chaloupka FJ IV, Jha P. *Socioeconomic Differences in the Impact of Smoking Tobacco and Alcohol Prices on Smoking in India*. Cambridge, Massachusetts: National Bureau of Economic Research; NBER Working Paper No. 17580, November 2011. http://www.nber.org/papers/w17580.
12. Joseph RA, Chaloupka FJ. The influence of prices on youth tobacco use in India. *Nicotine Tob Res*. 2014;16(suppl 1):S24–S29.
13. Selvaraj S, Srivastava S, Karan A. Price elasticity of tobacco products among economic classes in India, 2011–2012. *BMJ Open*. 2015;5(12):e008180.
14. Shang C, Chaloupka F, Kostova D. Who quits? An overview of quitters in low- and middle-income countries. *Nicotine Tob Res*. 2014;16(suppl 1):S44–S55.
15. Pawar PS, Pednekar MS, Gupta PC, Shang C, Quah AC, Fong GT. The relation between price and daily consumption of cigarettes and bidis: findings from the Tobacco Control Policy Evaluation Wave 1 Survey. *Indian J Cancer*. 2014;51(suppl 1):S83–S87.
16. Shang C, Chaloupka FJ, Zahra N, Fong GT. The distribution of cigarette prices under different tax structures: findings from the International Tobacco Control Policy Evaluation (ITC) Project. *Tob Control*. 2014;23(suppl 1):i23–i29.
17. Chaloupka FJ, Kostova D, Shang C. Cigarette excise tax structure and cigarette prices: evidence from the global adult tobacco survey and the U.S. National Adult Tobacco Survey. *Nicotine Tob Res*. 2014;16(suppl 1):S3–S9.
18. Shang C, Chaloupka FJ, Fong GT, Thompson M, O'Connor RJ. The association between tax structure and cigarette price variability: findings from the ITC Project. *Tob Control*. 2015;24(suppl 3):iii88–iii93.
19. Nandi A, Ashok A, Guindon GE, Chaloupka FJ, Jha P. Estimates of the economic contributions of the bidi manufacturing industry in India. *Tob Control*. 2015;24(4):369–375.
20. Shang C, Chaloupka FJ. The effects of state value-added taxes on tobacco prices and tax revenues in India. In: 6th Biennial Conference of the American Society of Health Economists; June 14, 2016; Philadelphia, PA.
21. Kostova D, Chaloupka FJ, Yurekli A, et al.; GATS Collaborative Group. A cross-country study of cigarette prices and affordability: evidence from the Global Adult Tobacco Survey. *Tob Control*. 2014;23(1):e3.
22. Shang C, Chaloupka F, Kostova D. Who quits? An overview of quitters in low- and middle-income countries. *Nicotine Tob Res*. 2014;16(suppl 1):S44–S55.
23. Kostova D, Chaloupka FJ, Shang C. A duration analysis of the role of cigarette prices on smoking initiation and cessation in developing countries. *Eur J Health Econ*. 2015;16(3):279–288.
24. International Institute for Population Sciences (IIPS), *Global Adult Tobacco Survey: GATS India 2009–2010*. Mumbai, India: IIPS. 2010. http://www.who.int/tobacco/surveillance/survey/gats/ind/en/.
25. World Health Organization WTFI. *Economics of Tobacco Toolkit: Economic Analysis of Demand using Data from the Global Adult Tobacco Survey (GATS)*. Geneva: World Health Organization. 2010.
26. Sinha D, Palipudi K, Oswal K, Gupta P, Andes L, Asma S. Influence of tobacco industry advertisements and promotions on tobacco use in India: findings from the Global Adult Tobacco Survey 2009–2010. *Indian J Cancer*. 2014;51(5):13–18.
27. Project I. *TCP India National Report. Findings from the Wave 1 Survey (2010–2011)*. Waterloo, Ontario, Canada/Navi Mumbai, India: University of Waterloo/Healis-Sekhsaria Institute for Public Health; 2013.
28. Curti D, Shang C, Ridgeway W, Chaloupka FJ, Fong GT. The use of legal, illegal and roll-your-own cigarettes to increasing tobacco excise taxes and comprehensive tobacco control policies: findings from the ITC Uruguay Survey. *Tob Control*. 2015;24(suppl 3):iii17–iii24.
29. Shang C, Chaloupka FJ, Fong GT, Thompson M, Siahpush M, Ridgeway W. Weight control belief and its impact on the effectiveness of tobacco control policies on quit attempts: findings from the ITC 4 Country Survey. *Tob Control*. 2015;24(suppl 3):iii41–iii47.

30. Shang C, Huang J, Cheng KW, Li Q, Chaloupka FJ. Global evidence on the association between POS advertising bans and youth smoking participation. *Int J Environ Res Public Health*. 2016;13(3):306. doi:10.3390/ijerph13030306.
31. Shang C, Huang J, Li Q, Chaloupka FJ. The association between point-of-sale advertising bans and youth experimental smoking: findings from the Global Youth Tobacco Survey (GYTS). *AIMS Public Health*. 2015;2(4):832–844.
32. Guindon GE. The impact of tobacco prices on smoking onset in Vietnam: duration analyses of retrospective data. *Eur J Health Econ*. 2014;15(1):19–39.
33. Arora M, Reddy KS, Stigler MH, Perry CL. Associations between tobacco marketing and use among urban youth in India. *Am J Health Behav*. 2008;32(3):283–294.
34. Nandi A, Ashok A, Guindon GE, Chaloupka FJ, Jha P. Estimates of the economic contributions of the bidi manufacturing industry in India. *Tob Control*. 2015;24(4):369–375.
35. Nargis NS, Stoklosa M, Drope J, et al. *The Trend in Affordability of Tobacco Products in Bangladesh 2009–2015: Evidence from ITC Bangladesh Surveys*. Waterloo, Canada: University of Waterloo; 2016.
36. Tauras JA, Huang J, Chaloupka FJ, Farrelly MC. The effect of cigarette prices on cigarette sales: exploring heterogeneity in price elasticities at high and low prices. *NBER Working Paper No 22251*. 2016.
37. Sunley E. *India: The Tax Treatment of Bidis. Bloomberg Initiative to Reduce Tobacco Use*. New York: Bloomberg Philanthropies; 2008. ISBN: 978-2-914365-35-2. http://global.tobaccofreekids.org/files/pdfs/en/IW_facts_products_bidis_taxes.pdf.
38. Centers for Disease Control and Prevention. Best Practices for Comprehensive Tobacco Control Programs—2014 [Internet]. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014. http://www.cdc.gov/tobacco/stateandcommunity/best_practices/pdfs/2014/comprehensive.pdf. Accessed August 7, 2015.
39. Gravely S, Giovino G, Craig L, et al. Implementation of key demand-reduction measures of the WHO Framework Convention on Tobacco Control and change in smoking prevalence in 126 countries: an association study. *Lancet Public Health*. 2017;2(4):e166–e174.
40. Ngo A, Cheng KW, Chaloupka FJ, Shang C. The effect of MPOWER scores on cigarette smoking prevalence and consumption. *Prev Med*. 2017. doi:10.1016/j.ypmed.2017.05.006.