Exploring the Relationship Between Cigarette Prices and Smoking Among Adults: A Cross-Country Study of Low- and Middle-Income Nations

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ABSTRACT

Introduction: Evidence on the relationship between cigarette prices and adult smoking in low- and middle-income countries (LMICs) is relatively limited. This study offers new descriptive evidence on this relationship using data from a set of 13 LMICs.

Methods: We used Global Adult Tobacco Survey (GATS) cross-country data from approximately 200,000 participants aged 15 years and older. Estimates on the relationship between prices and adult smoking were obtained from logit models of smoking participation and ordinary least squares models of conditional cigarette demand.

Results: Higher prices were associated with lower demand across countries in terms of both smoking prevalence and daily number of cigarettes smoked among smokers. Our estimates suggest that the total price elasticity of cigarette demand in LMICs is approximately −0.53. We found that higher socioeconomic status (SES), represented through wealth and education effects, is associated with lower chance of smoking overall, but among existing smokers, it may be associated with a larger number of cigarettes smoked.

Conclusions: After controlling for a set of individual demographic and country characteristics, cigarette prices retained a significant role in shaping cigarette demand across LMICs. Because higher SES is associated with a reduced chance of smoking overall but also with increased daily consumption among current smokers, optimal tobacco tax policies in LMICs may face an added need to accommodate to shifting SES structures within the populations of these countries.

INTRODUCTION

Tobacco consumption is a leading cause of preventable death, with 100 million deaths attributed to it during the 20th century, and nearly a billion deaths projected for the 21st century (World Health Organization [WHO], 2008). Low- and middle-income countries (LMICs), where most of the world's smokers live, are likely to be disproportionately affected by the adverse consequences of tobacco use (Giovino et al., 2012; Tobacco Atlas, 2012). Despite growing concern over tobacco use in LMICs, evidence on the determinants of smoking in these countries is not as extensive as it has been for high-income countries (HICs), reflecting data limitations frequently associated with LMICs. This study uses individual-level data from the initial wave of the first nationally representative cross-country standardized protocol survey of adult smoking behavior in LMICs, the Global Adult Tobacco Survey (GATS), to explore the link between adult smoking behavior and a key

mechanism for affecting this behavior, cigarette prices. Raising tobacco prices and taxes has been repeatedly shown to be effective in reducing tobacco use in HICs (International Agency for Research on Cancer [IARC], 2011) and has been identified by the WHO Framework Convention for Tobacco Control (FCTC) as a leading tobacco control policy tool (WHO, 2003). We use the difference in cigarette prices across a set of 13 LMICs to examine the extent of the association between prices and smoking participation and conditional cigarette demand and use this association to estimate the respective price elasticities.

By examining smoking among adults in LMICs, this research extends prior analysis of cigarette demand among youth aged 13–15 in LMICs (Kostova, Ross, Blecher, & Markowitz, 2011; Nikaj & Chaloupka, 2013). While the sample of countries and analytic framework in this analysis are not entirely comparable to prior studies of younger age groups, they may provide general insight on the differences in price sensitivity across different age groups in LMICs. This research

further contributes to the existing literature by pooling individual-level data from countries whose populations represent the majority of the world's smokers.

The analysis of individual-level data has an econometric advantage over analytic frameworks that use aggregate country data of cigarette demand (e.g., among others, Blecher, 2010; Chapman & Richardson, 1990; Da Costa e Silva, 1998; Hu & Mao, 2002; Mao, Jiang, & Gong, 1997; Xu, Hu, & Keeler, 1998; Yuanling & Zongyi, 2005). While aggregate demand models can raise econometric concerns about simultaneity bias by modeling aggregate country cigarette demand as a function of country cigarette prices, the use of individual data lessens this bias since no single individual can affect country prices through his/her personal consumption. Existing analysis of individual-level data from LMICs traditionally focuses on individual countries: for example, China (Bishop, Liu, & Meng, 2007; Lance, Akin, Dow, & Loh, 2004; Mao, Sung, Hu, & Yang, 2007; Mao & Xiang, 1997; Mao, Yang, & Ma, 2003), India (John, 2008), Russia (Lance et al., 2004; Oglobin & Brock, 2003), Turkey (Bilgic, Florkowski, & Akbay, 2010; Önder, 2002), and Vietnam (Van Kinh, Ross, Levy, Nguyen, & Vu, 2006). Price elasticity estimates from these studies can vary considerably and can range from negligible (Lance et al., 2004; Mao et al., 2007; Oglobin & Brock, 2003) to price elastic (Van Kinh et al., 2006).

In this study, we use a pooled country cross-sectional framework where each country is represented with a single year of data. Given the lack of repeated cross-sections by country over time, we have limited methodological tools with which to address unobserved country factors such as social norms that could influence the relationship between prices and smoking. To some extent, unobserved country differences can be proxied by observable differences in countries' income levels, which we control for in addition to controlling for local rates of exposure to cigarette advertising and antismoking messaging. However, due to the possibility of remaining bias from country-level unobserved factors, we do not identify a causal price effect. This paper, therefore, provides primarily descriptive evidence on the direction of the relationship between adult smoking and prices in LMICs, as well as insight into the role that socioeconomic status (SES) plays on cigarette consumption.

METHODS

We obtained data on individual smoking behavior and characteristics from the GATS. The GATS is a system of nationally representative surveys developed by the WHO and the Centers for Disease Control and Prevention (CDC) to track tobacco use among persons aged 15 and older across countries with a common standardized methodology. Between 2008 and 2011, 15 countries completed the survey, representing more than 60% of the world's population and more than 68% of the world's smokers (Bangladesh, Brazil, China, Egypt, India, Mexico, Philippines, Poland, Romania, Russia, Thailand, Turkey, Ukraine, Uruguay, and Vietnam). In this study, we use data on all of these countries except Brazil, which did not collect information on personal wealth from the survey participants. Since Poland is a HIC, it was excluded from analyses pertaining exclusively to LMICs, but was included in some models. Individuals with nonresponse on any of the analysis variables were excluded (less than 1% of the original sample), and the

final sample size of 13 LMICs and Poland consists of 212,751 individuals. The dependent variables are self-reported current smoking of cigarettes (among all survey respondents) and self-reported average number of cigarettes smoked per day (among smokers only). In this set of countries, the highest smoking rate was observed in Russia (39.1%), followed by Turkey (31.3%) and Poland (30.4%) (Table 1). Conditional cigarette demand, defined as the average number of cigarettes smoked per day by current smokers, was highest in Turkey (nearly 18 cigarettes per day), followed by Poland, Russia, and Ukraine with 17 daily cigarettes. Approximately half of the countries in our sample have majority rural populations, and post-secondary degrees are most common in Russia, Ukraine, and Poland.

While data on personal or household income are not typically collected in the GATS, the survey asks about possession of certain core household items (flush toilet, telephone, mobile phone, television, radio, refrigerator, car, moped/motorcycle, washing machine, computer, plus additional items, depending on the country). Using responses to these questions, Palipudi et al. (2012) have created an index of wealth relevant to each country, consisting of five quintile-based categories of personal wealth: very low, low, medium, high, and very high. In this analysis, we use this wealth index as a proxy for personal income. In our set of countries, Russia and Mexico have the largest proportion of respondents with high or very high wealth indicators; Thailand and Vietnam have the lowest.

Cigarette prices were obtained from the GATS using individual responses on the most recent amount spent on cigarettes, averaged at the primary sampling unit (PSU) level. Using PSU-level prices eliminates the simultaneity that is otherwise characteristic of the individual smoking-price relationship and ensures that the direction of the relationship flows from prices to smoking and not vice versa. Some PSUs do not contain individual responses on cigarette prices, which prevents the calculation of an average price specific to these PSUs. We match individuals in these PSUs using their residence type (urban or rural) with prices averaged at the urban/rural level for each country. Cigarette prices were then transformed into a common dollar currency using country-specific purchasing power parity (PPP) conversion factors (International Monetary Fund [IMF] World Economic Outlook Database, 2012). The PPP adjusts prices for the local cost of living and increases the comparability of prices across countries.

To account for country-specific characteristics that may influence smoking, all models control for per capita gross domestic product (GDP), expressed in PPP-adjusted dollars (source: IMF World Economic Outlook Database, 2012). The models also include controls for the local rate of exposure to cigarette advertising and the local rate of exposure to antismoking messages. Each of these variables is defined as the PSU-level average of a binary individual-level variable indicating whether in the past month, the respondent had observed cigarette advertising or, respectively, antismoking messages in at least one of the following venues: stores, newspapers or magazines, television, radio, or billboards. Since these rates of exposure are aggregated at the PSU level prior to being included as controls in the models of smoking, the reverse causality bias between individual smoking and exposure to smoking-related information is reduced. The PSU-level rates of exposure to advertising and antismoking messages indirectly control for differences across countries in non-price tobacco control activity such as enforcement of advertising restrictions and distribution

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Table 1. Sample Means

Country	Survey year	% Current smokers	Average number of cigarettes smoked per day	% With high school degree or higher	% With high or very high wealth index	Age	% Male	% Urban	N
Bangladesh	2009	23.1	5.1	14.8	35.9	35.8	50.0	26.2	9,565
China	2010	28.1	16.1	65.7	45.8	41.8	50.9	46.1	13,349
Egypt	2009	19.4	16.4	52.7	40.8	35.2	51.0	45.3	20,918
India	2009	13.9	2.1	27.9	29.4	35.9	51.7	29.3	69,156
Mexico	2009	15.9	9.3	58.1	54.0	37.2	47.7	77.8	13,591
Philippines	2009	28.2	10.5	61.4	43.1	36.5	49.9	49.7	9,700
Poland	2009	30.4	17.1	84.3	45.8	44.2	47.8	62.0	7,815
Romania	2011	26.6	16.5	42.8	45.6	46.1	48.5	52.1	4,068
Russia	2009	39.1	16.9	96.0	58.5	43.9	45.3	74.5	11,402
Thailand	2009	23.8	12.5	45.3	31.6	41.1	48.6	31.0	20,525
Turkey	2008	31.3	17.7	34.2	44.0	39.2	49.1	69.7	9,018
Ukraine	2010	28.8	16.9	88.9	49.8	44.4	45.4	67.9	8,142
Uruguay	2009	25.0	15.2	52.9	51.8	43.6	47.4	92.7	5,581
Vietnam	2010	23.8	10.9	54.3	33.1	38.6	48.6	30.7	9,921

Note. Means derived using weights for complex survey design.

Table 2. Means of PSU-Level and Country-Level Variables

Country	GDP per capita, PPP USD	Average PSU-level price paid per pack, PPP USD	Average PSU-level advertising exposure rate	Average PSU-level exposure rate to antitobacco messaging	Number of PSUs
Bangladesh	1,493	1.27	0.40	0.48	399
China	7,299	1.59	0.12	0.63	100
Egypt	5,901	2.43	0.12	0.71	194
India	2,916	3.05	0.24	0.58	2365
Mexico	14,217	4.12	0.44	0.83	260
Philippines	3,659	0.92	0.71	0.74	793
Poland	17,579	4.26	0.16	0.70	399
Romania	11,034	4.99	0.26	0.81	199
Russia	14,945	1.13	0.46	0.65	600
Thailand	8,507	2.83	0.07	0.90	264
Turkey	12,988	3.07	0.06	0.88	400
Ukraine	6,071	1.50	0.31	0.65	599
Uruguay	12,799	3.38	0.34	0.87	164
Vietnam	2,854	1.24	0.12	0.91	656

Note. PSU = primary sampling unit; GDP = gross domestic product; PPP = purchasing power parity; USD = US dollars.

of antismoking information. For instance, the PSU-level rate of advertising exposure is lowest in countries with comprehensive advertising bans such as Thailand and Turkey and is highest in countries with relative freedom of advertising such as Russia and Philippines (Table 2).

We use a standard two-part model of cigarette demand where the first part models the probability of smoking participation (smoking prevalence) and the second part models the amount of cigarettes consumed among smokers (conditional cigarette demand). We estimate the models of smoking participation with logit regression and use ordinary least squares regression for the models of conditional cigarette demand. Control variables in all models, besides cigarette prices, include age, gender, urban/rural residence, education level in four categories, wealth status in five categories, country per capita GDP, and local rates of exposure to cigarette advertising and antitobacco messages. Year dummy variables were included to control for independent year-specific effects on smoking. Country fixed effects were not included since each country was represented

with only a single year of data, and country per capita GDP was used to proxy for differences in unobserved factors across countries. To account for correlation between smoking outcomes within countries, standard errors were clustered by country, and price elasticities of smoking participation and conditional cigarette demand were calculated at the mean characteristics of the sample.

RESULTS

Cigarette price is negatively and significantly associated with lower smoking rates (Table 3). We estimate that the adult price elasticity of smoking participation for the sample of 13 LMICs is approximately −0.36, indicating that for a 10% increase in price, we can expect to see a 3.6% mean reduction in smoking prevalence on average (Table 3, Part 1). The price elasticity of participation is reduced, slightly, to −0.32 when a HIC, Poland, is added to the sample of LMICs (Table 4, Part 1).

Table 3. Average Marginal Effects From Two-Part Model of Cigarette Demand, 13 GATS LMICs

	Part 1	Part 2
	Smoking participation	Cigarettes smoked per day
	(N = 204,936)	(N = 38,736)
Cigarette price, PPP USD	−0.025* (0.014)	−0.709*** (0.267)
Local rate of exposure to cigarette advertising	0.045 (0.030)	−2.232 (2.604)
Local rate of exposure to antismoking messages	−0.004 (0.028)	2.472* (1.498)
Age	−0.000 (0.001)	0.004 (0.019)
Male	0.351*** (0.023)	4.806*** (1.040)
Urban residence	0.008 (0.015)	0.515 (0.654)
Education (relative to no formal education/less than primary)		
Completed primary/less than secondary	−0.051*** (0.014)	0.771* (0.403)
Completed secondary/completed high school	−0.044** (0.019)	1.545*** (0.595)
Completed college/university or higher	−0.085*** (0.019)	1.163 (0.785)
Wealth (relative to lowest wealth index)		
Low	0.001 (0.010)	−0.023 (0.302)
Mid	−0.013 (0.009)	0.102 (0.413)
High	−0.022 (0.014)	0.121 (0.475)
Highest	−0.046*** (0.017)	0.330 (0.561)
Per capita GDP, in 000s PPP USD	0.008* (0.004)	0.883*** (0.168)
Price elasticity	−0.360	−0.166

Note. GATS = Global Adult Tobacco Survey; LMICs = low- and middle-income countries; PPP = purchasing power parity; USD = US dollars; GDP = gross domestic product. Standard errors are clustered by country and indicated within parentheses. All models include year fixed effects.
*$p < .1$, **$p < .05$, ***$p < .01$.

We find that being male is strongly associated with a higher chance of smoking, while having higher levels of education and wealth are both associated with lower smoking rates. The education and income effects are particularly evident at the highest levels of these socioeconomic indicators; we estimate that the chance of smoking is lower by 8.5% points among those with college degree or higher relative to those with no education, and it is lower by 4.6% points among those at the highest wealth index relative to those at the lowest (Table 3, Part 1). Per capita GDP has a small but statistically significant positive effect while the rates of exposure to cigarette advertising and to antismoking messages are not statistically significant factors in determining smoking participation.

Cigarette price is negatively and significantly associated with lower cigarette consumption among smokers (Table 3, Part 2). We estimate that the price elasticity of conditional cigarette demand in the set of 13 LMICs is −0.17, indicating that a 10% increase in price is associated with a 1.7% decrease in the average number of cigarettes smoked by smokers in our sample. The price elasticity of conditional demand is slightly larger at −0.24 in the sample of countries that includes Poland (Table 4, Part 2). Among smokers, being male, being more educated, and living in a country with a higher per capita GDP are factors associated with heavier smoking. The estimated effects of the wealth index categories are not statistically significant, however this may reflect the relatively high level of statistical correlation between wealth and education and a degree of measurement error in the wealth index variable, rather than lack of relationship between income and smoking intensity. The local rate of advertising exposure does not appear to be a significant driver of smoking intensity. The local rate of exposure to antismoking messages has a positive and marginally significant association with smoking

intensity, which likely reflects a reverse causality effect in that heavier smokers are more likely to observe antismoking information.

DISCUSSION

We find that higher cigarette prices are significantly associated with lower adult smoking in LMICs. Compared to prior estimates of price elasticity among youth in LMICs (−2.1, Kostova et al., 2011; −2.2, Nikaj & Chaloupka, 2013), the estimated total price elasticity among adults in LMICs from this study (−0.53) is considerably lower. This is consistent with the presumption that youth are more sensitive to prices, possibly a reflection of tighter income constraints.

This analysis yields insight into the relationship between SES and smoking behavior in LMICs. Using both education and the wealth index as SES indicators, we find that the probability of smoking decreases with higher SES while the number of cigarettes smoked by current smokers increases. This relationship shows that while higher SES in LMICs can encourage increased consumption among those who already smoke, it is likely to prevent the decision to smoke in the first place (thus indicating that cigarettes are a "normal good"—a good that is consumed more when incomes grow—while the underlying decision to use cigarettes is an "inferior good"—a good that is consumed less when incomes grow). Though prior research on the SES determinants on conditional cigarette demand in LMICs is limited, our results on smoking participation are consistent with SES gradients found in prior studies of smoking prevalence in LMICs (Hosseinpoor, Parker, Tursan d'Espaignet, & Chatterji, 2012; Palipudi et al., 2012; Pampel & Denney, 2011) and HICs (IARC, 2011).

Table 4. Average Marginal Effects From Two-Part Model of Cigarette Demand, 13 GATS LMICs, Plus 1 HIC (Poland)

	Part 1	Part 2
	Smoking participation	Cigarettes smoked per day
	(N = 212,751)	(N = 40,910)
Cigarette price, PPP USD	−0.022* (0.012)	−0.745*** (0.204)
Local rate of exposure to cigarette advertising	0.038 (0.035)	−2.183 (2.475)
Local rate of exposure to antismoking messages	−0.015 (0.029)	2.535* (1.490)
Age	−0.000 (0.001)	0.008 (0.019)
Male	0.342*** (0.026)	4.616*** (0.911)
Urban residence	0.009 (0.015)	0.539 (0.631)
Education (relative to no formal education/less than primary)		
Completed primary/less than secondary	−0.050*** (0.016)	0.849** (0.401)
Completed secondary/completed high school	−0.041* (0.023)	1.627*** (0.590)
Completed college/university or higher	−0.082*** (0.023)	1.222 (0.759)
Wealth (relative to lowest wealth index)		
Low	0.002 (0.010)	−0.006 (0.283)
Mid	−0.011 (0.009)	0.079 (0.391)
High	−0.020 (0.014)	0.059 (0.432)
Highest	−0.045*** (0.017)	0.219 (0.516)
Per capita GDP, in 000s PPP USD	0.009*** (0.003)	0.858*** (0.134)
Price elasticity	−0.324	−0.240

Note. GATS = Global Adult Tobacco Survey; LMICs = low- and middle-income countries; HIC = high-income country; PPP = purchasing power parity; USD = US dollars; GDP = gross domestic product. Standard errors are clustered by country and indicated within parenthesis. All models include year fixed effects.
*$p < .1$, **$p < .05$, ***$p < .01$.

The policy implications of opposing SES effects on, alternately, smoking participation and smoking intensity among smokers are not negligible. As LMICs experience economic growth and improve the SES of their citizens, cigarettes are likely to become more affordable, which, on the one hand, is an incentive to increase consumption among those who smoke. On the other hand, we show that higher SES is also associated with lower chance of smoking. It is justifiable, therefore, to expect that as disposable incomes and education among people in LMICs grow, the initial increase in the volume of cigarettes consumed due to higher SES may eventually be offset by a relative contraction in smoking prevalence that is also associated with higher SES. Meanwhile, tobacco tax initiatives to reduce the affordability of cigarettes over time may counteract smokers' income incentive to consume more cigarettes by ensuring that cigarette prices increase faster than incomes over time.

Though we use coefficients from both education and the wealth index to interpret the SES gradient, the estimated impact of the wealth index in this study is likely to have been attenuated by the fact that the wealth index is an imperfect measure of income. The variability of the wealth index across persons in each country depends on how different each individual's surveyed list of possessions is relative to the average in his/her country. While classifying the wealth index into quintiles ensures a certain level of variability, ties across individuals with the same list of possessions can result in unequal distribution of the wealth index categories, as these ties get assigned to a neighboring quintile. This can reduce the variability of the wealth index categories within countries, which in turn would bias the wealth index coefficients toward zero and could explain the lack of statistical significance for some wealth index categories.

The remaining limitations of this report arise primarily from the lack of survey data over time. Though the presently estimated total price elasticity of −0.53 is within the range of prior estimates for LMICs of −0.2 to −0.6 (Chaloupka & Tauras, 2011; IARC, 2011), it may partially reflect the impact of unobserved country characteristics that cannot be explicitly addressed in a cross-country analytic setup. The causality of the price effect and the associated elasticity will be determined with greater precision as the GATS is repeated over time, providing multiple survey years for each country. The future availability of country-specific temporal data will allow for tracking the change in cigarette consumption in response to cigarette price changes over time and will improve upon the estimated relationship between prices and consumption reported in this article.

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DECLARATION OF INTERESTS

The conclusions in this paper are those of the authors and do not necessarily represent the official position of their affiliated organizations.

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