As countries improve their cigarette tax policy, cigarette consumption declines

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ABSTRACT

Background This study examines the association between the Tobacconomics cigarette tax scores and cigarette consumption in 97 countries during the period of 2014–2020.

Methods Data on countries' retail cigarette sales and overall cigarette tax scores from 2014 to 2020 are drawn from the proprietary Euromonitor International database and the Tobacconomics Cigarette Tax Scorecard (second edition). Information on countries' tobacco control environments and demographic characteristics is from the relevant years' WHO Report on the Global Tobacco Epidemic, and the World Bank's World Development Indicators database. Ordinary least squares regressions are employed to examine the link between countries' overall cigarette tax scores and cigarette consumption. All regressions control for countries' tobacco control environments, countries' demographic characteristics, year indicators and country fixed effects.

Results Each unit increase in the overall cigarette tax scores is significantly associated with a reduction of 9% in countries' per-capita cigarette consumption during 2014–2020. The reduction is more pronounced in low and middle-income countries (9%) than in high-income countries (6%). The modest improvement in scores from 2014 to 2020 is associated with a reduction of 3.27% in consumption, while consumption could have been reduced by 20.74% had countries implemented optimal tax policies that would earn the highest score of 5.

Conclusions Our results provide evidence on the association between higher cigarette tax scores and lower cigarette consumption. To reduce tobacco consumption, governments must strive to implement all four components in the Cigarette Tax Scorecard at the highest level.

INTRODUCTION

Tobacco use is the leading cause of preventable death worldwide, with more than 8 million deaths each year.[1] Most of these preventable deaths occur in low and middle-income countries (LMICs). Research shows that a significant tobacco tax increase that leads to higher prices is the most effective and cost-effective tobacco control policy tool for reducing tobacco use.[2 3] However, many countries—particularly LMICs—have been slow to adopt these policies, or they do not implement these policies effectively.

In 2020, to facilitate policy makers' comparative evaluation of their country's current cigarette tax policies, the Tobacconomics team released the first edition of the *Tobacconomics Cigarette Tax Scorecard* assessing countries' cigarette tax policy

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Growing evidence indicates the effectiveness of each cigarette tax component (i.e., cigarette price, tax share, and tax structure) on reducing cigarette smoking.
⇒ The study is the first to examine the effects of comprehensive cigarette tax policies—measured by the Tobacconomics overall cigarette tax scores—on actual smoking behaviours across countries.

WHAT THIS STUDY ADDS

⇒ The study provides evidence on the association between higher cigarette tax scores and lower cigarette consumption, in which the association is more pronounced in low and middle-income countries than in high-income countries.
⇒ This association adds to the efficacy of the Tobacconomics Cigarette Tax Scorecard in evaluating cigarette taxes across countries.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ To reduce tobacco consumption, governments must strive to implement all four components in the Cigarette Tax Scorecard at the highest level by implementing tax rates that significantly increase absolute cigarette prices, reducing cigarette affordability, increasing tax shares of cigarette prices, and applying appropriate tax structures to further reduce tobacco use and its associated burdens.

performance on a 5-point scale. The Scorecard synthesises established best practices, focusing on four key components: (1) cigarette price, (2) changes in the affordability of cigarettes over time, (3) the share of taxes in retail cigarette prices, and (4) cigarette tax structures. The Scorecard shows that most countries did not tax cigarettes effectively during 2014–2018, with nearly half of them scoring less than 2 out of the highest score of 5, and with limited improvement over the previous 6 years.[4] In November 2021, the Tobacconomics team released the second edition of the Scorecard, which shows that some countries improved their tobacco tax systems during 2014–2020, but the improvements were insufficient to significantly decrease tobacco use.[5]

Previous studies have examined the effects of each cigarette tax component on cigarette smoking. Higher cigarette prices have been shown to decrease overall tobacco consumption,[6–10] cause

current smokers to quit[11–14] and prevent young people from starting smoking.[8 15–17] Similarly, studies have shown that as cigarettes become less affordable, consumption decreases.[9 18–20] Affordability is often measured as relative income price (RIP)—the percentage of per-capita income required to purchase 100 packs of cigarettes. RIP counterintuitively increases as affordability decreases. A 1% increase in RIP is estimated to reduce cigarette consumption by 0.49%–0.57%.[18] A higher share of taxes in retail cigarette prices also generally indicates higher retail cigarette prices and thus reductions in cigarette consumption.[21] More complicated tax structures are significantly associated with higher cigarette consumption. This is typically due to higher price variation and opportunities for smokers to substitute with cheaper cigarettes. Changing from a specific to an ad valorem structure is associated with an increase of 6%–11% in cigarette consumption, and changing from a uniform to a tiered structure is associated with an increase of 34%–65% in cigarette consumption.[22]

Despite growing evidence on the effects of each cigarette tax component on cigarette smoking, little is known about the effects of all four cigarette tax components on actual smoking behaviours, especially across countries. To address this research gap, this study examines the relationship between a comprehensive set of cigarette tax policies—measured by the Tobacconomics overall cigarette tax scores—and cigarette consumption and tests the hypothesis that countries with higher overall cigarette tax scores are more likely to experience lower cigarette consumption during 2014–2020, controlling for the wider tobacco control environment in each country. Using data from the second edition of the *Tobacconomics Cigarette Tax Scorecard*, we use regression analysis to evaluate this relationship while controlling for each country's tobacco control environment, demographic characteristics, and potential observed and unobserved time-specific and country-specific factors that may affect cigarette consumption.

METHODS

Data

Tobacconomics cigarette tax scores

Data on countries' overall cigarette tax scores for 2014, 2016, 2018, and 2020 are drawn from the second edition of the *Tobacconomics Cigarette Tax Scorecard*.[5] The Scorecard (second edition) assesses cigarette tax policy performance in 160 countries on a 5-point scale based on four key components of cigarette taxation: (1) cigarette price, (2) changes in cigarette affordability, (3) tax share of price, and (4) tax structure. The Scorecard measures countries' performances on each of the four components on a scale of 0–5, with a score of 5 indicating the strongest performance. The composite overall cigarette tax scores are then constructed as the average of all four component scores and could range from 0, for countries with a score of 0 on all four components, to 5, for countries with a score of 5 on all four components.[5] The information on how each component score is calculated is available in the online supplemental appendix.

To examine the link between cigarette tax scores and cigarette consumption, we use countries' overall cigarette tax scores instead of all four component scores. Because the four component scores are highly collinear, including all four of them in the analyses would likely underestimate the effectiveness of these scores in reducing cigarette consumption. In addition, by using overall cigarette tax scores, we use the greatest possible variation in scores over time to assess the link between the scores and cigarette consumption.

Euromonitor International retail cigarette sales

The Euromonitor International cigarette and tobacco country reports provide information on countries' retail sales of cigarettes defined as duty-paid, machine-manufactured white-stick products, including internet sales for 2014–2020.[23] This definition of cigarettes is designed to exclude the volume of non-machine-manufactured products such as bidis/beedis and other smoking products made with tobacco that do not resemble cigarettes as recognised in the USA or Europe or are not machine manufactured.[23] Retail cigarette sales are used as a proxy of cigarette consumption. Thus, annual per-capita cigarette consumption for each year in a country is derived as the ratio of the country's total retail cigarette sales to the size of the population aged 15 and older.

Countries' tobacco control environments

Data on countries' tobacco control environments—measured by four elements (POWE) of the MPOWER scores for years 2014, 2016, 2018 and 2020—are from the *WHO Report on the Global Tobacco Epidemic* for the years 2015, 2017, 2019 and 2021.[1 24–26] The MPOWER measures were introduced by WHO in 2008 to assist party countries with implementation of the WHO Framework Convention on Tobacco Control (FCTC). The MPOWER package includes six measures: monitoring tobacco use and prevention policies (M); protecting people from tobacco smoke (P); offering help to quit using tobacco (O); warning people about the dangers of tobacco use (W); enforcing bans on tobacco advertising, promotion and sponsorship (E); and raising taxes on tobacco products (R). The information on how each MPOWER measure is constructed is shown in the online supplemental appendix. These measures have been shown to be effective in reducing smoking[12 27 28] and provide guidelines for countries as to where more action is needed.[24]

For the POWE measure, the values range from 1 to 5. A score of 1 demonstrates no known or recent data or data that are not both recent and representative of the national population. A score of 2–5 indicates the lowest to the highest level of policy implementation. Since the *M* measure for monitoring is not related to a specific intervention, and the Tobacconomics cigarette tax scores already measure the performance of tax policies including the *R* measure for tax increases, M and R scores are excluded from the analyses. The composite POWE scores are then constructed as the sum of each POWE score for each country and survey year and included in the analyses. The composite POWE scores could range from a low score of 4 to a high score of 20.

Countries' demographic information

The information on countries' demographic characteristics—such as gross domestic product (GDP) per capita, percentage of the total population aged 15–64 and percentage of the total population aged 65 and older—is gathered from the World Bank's (WB) World Development Indicators database.[29] We control for GDP per capita and purchasing power parity (PPP) (constant 2017 international dollars) in the analyses. GDP per capita in PPP is derived as GDP converted to international dollars using PPP rates.[29] We also construct a high-income country (HIC) dummy that classifies countries as high income based on the WB classification for each survey year.

To compile the final analytical sample, we merge all the data using year and country identifiers. The final sample includes countries that have at least two or three complete data of countries' retail cigarette sales and overall cigarette tax scores. The

final sample includes 97 countries. Due to seven missing values of overall cigarette tax scores for a few countries in certain years, our final sample includes 381 country-year observations for years 2014, 2016, 2018, and 2020. Approximately 44% of countries in the sample are HICs.

Statistical analyses

Main analyses

To allow for the relationship between countries' overall cigarette tax scores and cigarette consumption to change proportionally, we use log of per-capita cigarette consumption as the main outcome of the analyses. We use ordinary least squares regressions to examine the association between countries' overall cigarette tax scores and cigarette consumption. All regressions control for countries' tobacco control environment (POWE), country-level GDP per capita, percentage of the population aged 15–64, percentage of the population aged 65 and older, year indicators, and country fixed effects. The full regression model is shown in the online supplemental appendix. By including both year and country indicators in the regressions, we control for potential observed and unobserved time-specific and country-specific factors that may affect cigarette consumption. Standard errors (SEs) are clustered at the country level to adjust for intertemporal correlations. All analyses are conducted in Stata V.15.0.

Simulations

Using the estimated coefficients in the main analyses, we estimate the reduction in consumption attributable to the score increases from 2014 to 2020, as well as the additional reduction if all countries had increased their overall scores to 5 by 2020. Specifically, we first estimate the main regression analyses and use the Stata command 'predict' to estimate the average consumption in 2020 under the three scenarios: (1) all countries have their actual scores from 2014 in 2020, (2) all countries have their actual scores from 2020 in 2020, and (3) all countries have a score of 5 in 2020. The percent reduction in consumption attributable to the score increases from 2014 to 2020 is calculated as the ratio of the difference between the estimated average cigarette consumption in 2020—in the second scenario and the first scenario—and the estimated average cigarette consumption in 2020 in the first scenario. Similarly, the percent reduction in consumption if all countries had increased their overall scores to 5 by 2020 is calculated as the ratio of the difference between the estimated average cigarette consumption in 2020—in the third scenario and the first scenario—and the estimated average cigarette consumption in 2020 in the first scenario.

Sensitivity analyses

Since it may take a year or longer for policies (scores) to have measurable effects on cigarette consumption, we regress the current (time=t) cigarette consumption on one lagged period (time=t-1) of countries' overall cigarette tax scores to further examine the link between the scores and cigarette consumption. Due to a 2-year gap between the releases of the *WHO Report on the Global Tobacco Epidemic* that are used to construct the Tobacconomics cigarette tax scores, *t-1* represents a 2-year difference.

To examine the robustness of our results, we also conduct the following sensitivity analyses. First, instead of controlling for the composite POWE score, we control for each POWE measure in the analyses. We are aware of potential problems with multicollinearity in the main regressions. To accommodate for that, we estimate the main regressions with and without the dummy
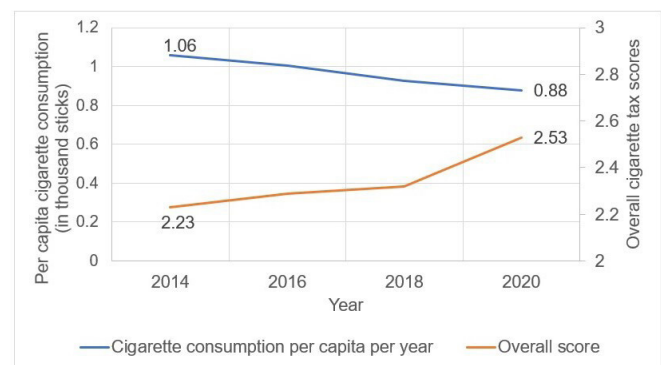

Figure 1 Countries' overall cigarette tax scores and per-capita cigarette consumption, 2014–2020.

variable for HICs. To check for multicollinearity, we further calculate the variance inflation factor (VIF). Specifically, we regress the overall scores on all other covariates and estimate the VIF using the formula: $VIF = 1/(1 - R^2)$.

RESULTS

Figure 1 shows changes over time in countries' overall cigarette tax scores and per-capita cigarette consumption during 2014–2020. While countries' overall cigarette tax scores increased from 2.23 in 2014 to 2.53 in 2020, countries' per-capita cigarette consumption decreased from more than 1060 cigarette sticks in 2014 to 880 cigarette sticks in 2020.

Table 1 presents the summary statistics of the analytical sample. On average, the per-capita cigarette consumption was approximately 970 cigarette sticks per year. The overall cigarette tax score was 2.34—just less than half of the highest score of 5, indicating ample room for improvement. The average score of POWE was 15.60 out of the highest score of 20. The lowest score of each POWE measure is 2. The average GDP per capita was approximately US$25 800. The average percentages of the population aged 15–64 and 65 and older were 65.38% and 11.13%, respectively.

Table 2 shows the association between countries' overall cigarette tax scores and cigarette consumption. The estimates suggest that a unit increase—one full point on the Scorecard—in countries' overall cigarette tax scores was significantly associated with a reduction of 9% in countries' per-capita cigarette consumption. The reduction was more pronounced in LMICs

Table 1 Summary statistics

Variable	Mean	SD
Per-capita cigarette consumption (in thousand sticks)	0.97	0.67
Per-capita cigarette consumption (in thousand sticks)—HICs	1.10	0.46
Per-capita cigarette consumption (in thousand sticks)—LMICs	0.88	0.77
Overall cigarette tax score	2.34	1.17
Overall cigarette tax score—HICs	3.00	0.93
Overall cigarette tax score—LMICs	1.87	1.09
GDP per capita (in $10 000)	2.58	2.04
POWE score	15.60	2.37
% population aged 15–64	65.38	5.37
% population aged 65 and older	11.13	6.60
Observations (n)	381	
Countries (n)	97	

GDP, gross domestic product; HICs, high-income countries; LMICs, low and middle-income countries.

Table 2 The link between countries' overall cigarette tax scores and cigarette consumption, 2014–2020

Outcome	Log (cigarette consumption)		
Sample	Whole sample	HICs	LMICs
Overall cigarette tax score	−0.09***	−0.06***	−0.09**
SE	0.02	0.01	0.03
Year indicators	Yes	Yes	Yes
Country indicators	Yes	Yes	Yes
Mean (consumption in thousand sticks)	0.97	1.10	0.88
Mean (overall cigarette tax score)	2.34	3.00	1.87
Observations (n)	381	158	223
Countries (n)	97	43	58

+$p<0.10$; *$p<0.05$; **$p<0.01$; ***$p<0.001$. All regressions control for POWE scores, country-level gross domestic product (GDP) per capita, percentage of the population aged 15–64, percentage of the population aged 65 and older, year fixed effects, and country fixed effects. Standard errors (SEs) were clustered at the country level.
HICs, high-income countries; LMICs, low and middle-income countries.

than in HICs. Specifically, a unit increase in overall cigarette tax scores was significantly associated with a reduction of 6% in per-capita cigarette consumption in HICs, while a similar increase was significantly associated with a 9% reduction in per-capita cigarette consumption in LMICs. Online supplemental appendix table A1 shows a fuller set of results with estimates of other controls including POWE, HIC dummy, and countries' demographic characteristics.

Table 3 presents the simulation results that predict the countries' per-capita cigarette consumption under different scenarios, along with the calculated percent reduction. As table 3 indicates, the modest improvement in scores from 2014 to 2020 is associated with a reduction of 3.27% in consumption, while consumption could have been reduced by 20.74% if countries had implemented optimal tax policies that would earn the highest score of 5. Consumption could have been reduced by 11.11% if HICs had implemented optimal tax policies that would earn the highest score of 5. If LMICs had implemented optimal tax policies at the highest level, they would experience a reduction of 28.05% in cigarette consumption. Online supplemental appendix table A2 shows the predicted percent reductions in cigarette consumption if all countries had increased their scores from 0 in 2014 to 5 in 2020.

Results of sensitivity analyses suggest the robustness of our findings. Online supplemental appendix table A3 shows the link between the past overall cigarette tax scores at time (t-1) and current cigarette consumption at time (t) during 2016–2020.

The estimates suggest that countries with higher past overall cigarette tax scores experienced significant reductions in current cigarette consumption ($p<0.05$). Online supplemental appendix table A4 shows that our estimates are robust to whether we control for the composite POWE score or each POWE measure and whether we include HIC dummy. Our VIF number is 6.68, which is smaller than 10. As a rule of thumb, a VIF above 10 indicates serious multicollinearity that needs to be corrected.[30] Thus, multicollinearity is not a significant issue in this context.

Limitations
This study has some limitations. First, our measure of cigarette consumption captures only legal retail cigarette sales and excludes the illicit sales. Due to the lack of reliable illicit trade data, we could not account for illicit cigarette sales in our analyses. Although Euromonitor International has data on sales of illicit cigarettes, the illicit trade estimates from Euromonitor International are not reliable, with discrepancies across editions.[31 32] Thus, we do not include sales of illicit cigarettes in our measure. Due to the lack of reliable, consistent and comparable data of roll your own (RYO) cigarettes over time, we could not account for RYO cigarettes in our models. Given the lack of comprehensive data on the taxation of other tobacco products, the *Tobacconomics Cigarette Tax Scorecard* mainly focuses on cigarette taxation. To the extent that taxes and prices on other non-cigarette products (i.e., bidis, smokeless tobacco and waterpipe tobacco) are low, relative to cigarette taxes and prices, there will be opportunities for substitution to the relatively cheaper products. If smokers switch from licit to illicit cigarettes and/or to other close substitutes, the actual reductions in cigarette consumption that are associated with increases in countries' overall cigarette tax scores may be lower than our estimates.

In this study, we use Euromonitor International as the data source for retail cigarette sales. However, Euromonitor International now accepts funding from tobacco industry and tobacco industry entities to generate 'Smoke-Free Index' and examine illicit trade.[32] Although we do not use illicit trade estimates from Euromonitor International in our analyses, the data and the results of this study should be viewed with caution. Second, our results may be sensitive to which countries are included in the analytical samples. Globally, there were 58 HICs (29.74%) and 137 LMICs (70.26%) in 2020,[29] but our sample contains a higher proportion of HICs (44%). Our sample also includes a greater share of countries with higher performance on both cigarette tax scores and POWE scores. Thus, our results on the association between countries' overall cigarette tax scores and

Table 3 Simulation results—reduction in cigarette consumption, 2014–2020

A. Reduction in cigarette consumption attributable to score increases from 2014 to 2020			
Scenario	Actual scores in 2014	Actual scores in 2020	% reduction
Cigarette consumption in 2020 (in thousand sticks)—whole sample	0.89	0.86	−3.27
B. Reduction in cigarette consumption if all countries had increased their scores to 5 by 2020			
Scenario	Actual scores in 2014	All 5 in 2020	% reduction
Cigarette consumption in 2020 (in thousand sticks)—whole sample	0.89	0.70	−20.74
Cigarette consumption in 2020 (in thousand sticks)—HICs	0.99	0.88	−11.11
Cigarette consumption in 2020 (in thousand sticks)—LMICs	0.82	0.59	−28.05

Countries' average actual overall score in 2014 is 2.23, while countries' average actual overall score in 2020 is 2.53. The average actual overall scores in 2014 are 2.98 for HICs and 1.68 for LMICs. The average actual overall scores in 2020 are 3.21 for HICs and 2.10 for LMICs. The percent reduction is calculated as the ratio of the difference in cigarette consumption between 2020 and 2014 to cigarette consumption in 2014.
HICs, high-income countries; LMICs, low and middle-income countries.

cigarette consumption may not generalise to the full sample of countries.

Third, cigarette consumption is a stock value of both smoking participation and smoking intensity. Using the aggregate data of overall cigarette tax scores and cigarette consumption at the national level does not allow us to examine differential effects of cigarette tax policies on smoking participation and smoking intensity, nor the effects of those policies on different subpopulations of interest. Thus, future research may benefit from using longitudinal individual-level data to investigate the differential effects of cigarette tax policies on those outcomes and subpopulations.

Fourth, the Tobacconomics overall cigarette tax scores are constructed as the average of the four tax components, implying that each of the four tax component scores has equal weight. It is possible that some tax components are more effective than other measures in reducing smoking and should be assigned greater weight. Future research should further investigate the effects of those tax components with different assigned weights. Despite those limitations, our results are robust to different sensitivity analyses and are consistent with the findings of previous studies.

DISCUSSIONS AND CONCLUSIONS

This study examines the link between the Tobacconomics cigarette tax scores and countries' cigarette consumption and documents a significant association between higher overall cigarette tax scores and reduced cigarette consumption. Specifically, a unit increase in overall cigarette tax scores is significantly associated with a reduction of 9% in countries' per-capita cigarette consumption. Our results suggest that the association between higher cigarette tax scores and lower cigarette consumption was more pronounced in LMICs than in HICs. A unit increase in cigarette tax scores was significantly associated with a reduction of 9% in cigarette consumption in LMICs and a reduction of 6% in cigarette consumption in HICs. Online supplemental appendix table A5 shows the association between four component scores and cigarette consumption and demonstrates that overall cigarette tax scores are better at capturing the effectiveness of comprehensive tobacco taxation policies.

Our simulation results suggest that the modest improvement in scores from 2014 to 2020 is associated with a reduction of 3.27% in consumption, while consumption could have been reduced by 20.74% had countries implemented optimal tax policies that would earn the highest score of 5. Our results further suggest that consumption could have been reduced by 11.11% if HICs had implemented optimal tax policies that would earn the highest score of 5. If LMICs had implemented optimal tax policies at the highest level, they would experience a reduction of 28.05% in cigarette consumption. Our results are in line with the findings of previous studies that document the effectiveness of comprehensive tobacco control policies in reducing smoking[12 27 28] and larger effects of tobacco control policies (ie, prices) on cigarette smoking in LMICs.[33–35] While a 10% increase in cigarette prices was estimated to decrease cigarette smoking by 2.50%–5%, with an average of 4%, in HICs, a similar increase would reduce cigarette smoking by 2%–8%, with an average of 5%, in LMICs.[33]

Our study is the first to examine the effects of comprehensive cigarette tax policies—measured by the Tobacconomics overall cigarette tax scores—on actual smoking behaviours across countries. Our results indicate that higher overall cigarette tax scores were significantly associated with reduced cigarette consumption, and that the reduction was more pronounced in LMICs

than in HICs. Our results are in line with recommendations on strengthening countries' cigarette tax systems from the WHO FCTC Article 6 guidelines, the *WHO Technical Manual on Tobacco Tax Policy and Administration*, and the WB *Tobacco Tax Reform* and *Curbing the Epidemic* reports. Our results suggest that countries—particularly LMICs—should strive to implement all four components in the Cigarette Tax Scorecard at the highest level by implementing tax rates that significantly increase absolute cigarette prices, reducing cigarette affordability, increasing the tax share of cigarette prices and applying appropriate tax structures to further reduce tobacco use and its associated burdens.

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Appendices

Main regression model

The following regression framework is used to examine the association between countries' overall cigarette tax score and per capita cigarette consumption.

Log (per capita cigarette consumption) $_{(it)}$ = α_0 + α_1 Overall score$_{(it)}$ + α_2 High income$_{(it)}$ + α_3 Rescaled GDP per capita$_{(it)}$ + α_4 POWE score$_{(it)}$ + α_5 Percent population aged 15-64$_{(it)}$ + α_6 Percent population aged 65 and over$_{(it)}$ + $\sum_{t=2016}^{t=2018}$ time$_{(t)}$ + $\sum_{i=2}^{i=97}$ country$_{(i)}$ + $\varepsilon_{(it)}$

in which: i = 1, 2,…, 97 (index of countries)

t = 2014, 2016, 2018, and 2020 (index of years)

Annual per capita cigarette consumption for each year in a country is derived as the ratio of the country's total retail cigarette sales to the size of the population aged 15 and older. Countries' GDP per capita is rescaled in ten thousand dollars for easier interpretation. The omitted year is year 2014. Similar regressions are used to examine the association between overall tax scores and cigarette consumption among HICs and LMICs. The only difference is that the high-income country dummy is not included in those regressions.

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Main regression results

Appendix Table A1: Main Regression Results

Sample	Whole sample	HICs	LMICs
Outcome: log (per capita cigarette consumption)			
Overall score	-0.09***	-0.06***	-0.09**
	(0.02)	(0.01)	(0.03)
Rescaled GDP per capita (in ten thousand dollars)	0.03	-0.00	0.29
	(0.04)	(0.02)	(0.25)
High income country dummy	0.10***	-	-
	(0.02)	-	-
POWE score	0.03*	0.01	0.03
	(0.01)	(0.01)	(0.02)
% Population aged 15-64	-0.04	-0.05	-0.04
	(0.02)	(0.03)	(0.03)
% Population aged 65 and over	-0.06	-0.03	-0.12
	(0.04)	(0.04)	(0.06)
Year dummies			
Year 2016	-0.07**	-0.08*	-0.05
	(0.02)	(0.03)	(0.03)
Year 2018	-0.14***	-0.18***	-0.11
	(0.04)	(0.05)	(0.05)
Year 2020	-0.18***	-0.24**	-0.13
	(0.05)	(0.07)	(0.07)
N of Observations	381	158	223
N of Countries	97	43	58

Note: Standard errors (SE) in parentheses. $+ p < 0.10$, $* p < 0.05$, $** p < 0.01$, $*** p < 0.001$. Due to a large number of country dummies included in the regressions, the estimates of the country dummy variables are not shown in the table.

Information on how each MPOWER measure is scored in the WHO Reports on the Global Tobacco Epidemic

M Score	1	No known data, or no recent data (since 2011) or data that is not both recent and representative (national population)
	2	Recent and representative data for either adults or youth
	3	Recent and representative data for both adults and youth
	4	Recent, representative, and periodic data (at least every 5 years) for both adults and youth
P Score	1	Data not reported or not categorized
	2	Up to two public places completely smoke-free
	3	Three to five public places completely smoke-free
	4	Six to seven public places completely smoke-free
	5	All public places completely smoke-free (or at least 90% of the population covered by complete subnational smoke-free legislation)
O Score	1	Data not reported
	2	None
	3	NRT (Nicotine replacement therapy) and/or some cessation services (neither cost-covered)
	4	NRT and/or some cessation services (at least one of which is cost-covered)
	5	National quit line, and both NRT and some cessation services cost-covered
W Score	1	Data not reported
	2	No warnings or small warnings (<30%)
	3	Medium size warnings (30%-49%) missing one or more appropriate characteristics OR large warnings (≥50%) missing four or more appropriate characteristics
	4	Medium size warnings (30%-49%) with all seven appropriate characteristics OR large warnings (≥50%) missing one or more appropriate characteristics
	5	Large warnings (≥50%) with all seven appropriate characteristics
E Score	1	Data not reported
	2	Complete absence of ban, or ban that does not cover national TV, radio, and print media
	3	Ban on national TV, radio, and print media only
	4	Ban on national TV, radio, and print media as well as on some but not all other forms of direct and/or indirect advertising
	5	Ban on all forms of direct and indirect advertising (or at least 90% of the population covered by complete subnational legislation)
R Score	1	Data not reported
	2	≤25% of retail price is tax
	3	26–50% of retail price is tax
	4	51–75% of retail price is tax
	5	>75% of retail price is tax

Source: WHO Report on Global Tobacco Epidemic Report 2017 (https://apps.who.int/iris/handle/10665/255874)

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Information on how each component of cigarette taxation is calculated in the Tobacconomics Cigarette Tax Scorecard

The first two components of the Scorecard scores are cigarette price – price of a 20-cigarette pack of the most sold brand in international dollars (Intl$), adjusted for purchasing power parity (PPP), and change in affordability. Each component is scored on a scale of 0 to 5. The scoring for those components is as follows.

Scoring – Cigarette Price	**Scoring – Change in Affordability**
5: Price ≥ 10 Intl$ PPP	5: 7.50% average annual change or higher
4: 8 ≤ price < 10	4: 5% ≤ average annual change < 7.50%
3: 6 ≤ price < 8	3: 2.50% ≤ average annual change < 5%
2: 4 ≤ price < 6	2: Average annual change < 2.50%
1: 2 ≤ price < 4	1: Reduced affordability, but no excise tax increase
0: Price < 2 Intl$ PPP	0: Increased affordability or no statistically significant change

The other two components of the Scorecard scores are tax share and tax structure. The Scorecard tax share component is constructed as the average of the scores for two tax share indicators—one based on the share of all taxes in cigarette prices and the other focused on the share of excise taxes in prices. The scoring for those components is below.

Scoring – Total Tax Share	**Scoring – Excise Tax Share**	**Scoring – Tax Structure**
		5: A uniform specific tax with an automatic inflation or other adjustment; or a uniform mixed system with greater share of specific tax, with an automatic adjustment for the specific component, the retail price as the base for the ad valorem component, and a minimum specific tax
5: 75% total tax share or higher	5: 70% excise tax share or higher	
		4: A uniform specific tax or uniform mixed system with a greater share of specific tax but without other features listed above
4: 65% ≤ share < 75%	4: 60% ≤ share < 70%	
3: 55% ≤ share < 65%	3: 50% ≤ share < 60%	3: A uniform mixed system with a greater share of ad valorem tax
2: 45% ≤ share < 55%	2: 40% ≤ share < 50%	2: A uniform ad valorem tax
1: 35% ≤ share < 45%	1: 30% ≤ share < 40%	1: A tiered specific or ad valorem excise tax 0: No excise tax
0: Total tax share < 35%	0: Excise tax share < 30%	0: No excise tax

Source: Chaloupka, F.J., Drope, J., Siu, E., Vulovic, V., Mirza, M., Rodriguez-Iglesias, G., Ngo, A., Laternser, C., Lee, H.M., Dorokhina, M., & Smith, M. (2021). Cigarette Tax Scorecard (2nd Edition). Tobacconomics

https://www.tobacconomics.org/files/research/738/tobacco-scorecard-report-2nd-ed-eng-v5.0-final-1.pdf

Appendix Table A2: Reduction in consumption if all countries had increased their scores from 0 in 2014 to 5 in 2020

Scenario	All 0 in 2014	All 5 in 2020	% Reduction
Cigarette consumption (in thousand sticks) – whole sample	1.32	0.70	-46.67%
Cigarette consumption (in thousand sticks) – HICs	1.47	0.89	-39.56%
Cigarette consumption (in thousand sticks) – LMICs	1.16	0.59	-49.01%

Note: Using the estimated coefficients in the main analyses, we first predict countries' per capita cigarette consumption for each year under two different scenarios: 1) all countries with a score of 0 in 2014 and 2) all countries with a score of 5 in 2020. Specifically, we reset countries' overall cigarette tax scores to all 0s and all 5s. We then predict countries' per capita cigarette consumption under each scenario using the Stata command "predict." We calculate the predicted percent reductions in cigarette consumption under two scenarios by dividing the difference between the predicted cigarette consumption, in 2020 and in 2014, by the predicted cigarette consumption in 2014.

Appendix Table A3: The link between past overall cigarette tax scores and current cigarette consumption, 2016–2020

Outcome	Log (per capita cigarette consumption)		
Sample	Whole sample	HICs	LMICs
Lag (overall score)	-0.08*	-0.04+	-0.10*
(SE)	(0.03)	(0.02)	(0.04)
Year FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Mean (consumption in thousand sticks)	0.94	1.05	0.86
Mean (lag overall score)	2.29	2.98	1.79
N of Obs.	284	118	166
N of countries	97	42	57

Note: Standard errors (SE) in parentheses. + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. All regressions control for POWE scores, country-level GDP per capita, high income country dummy, percentage of the population aged 15–64, percentage of the population aged 65 and older, year fixed effects, and country fixed effects. Standard errors were clustered at the country level.

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Appendix Table A4: Sensitivity Analyses

Sample	Whole sample		HICs	LMICs
Overall score	-0.08***	-0.08***	-0.07***	-0.09**
	(0.02)	(0.02)	(0.02)	(0.03)
Rescaled GDP per capita (in ten thousand dollars)	0.04	0.03	-0.00	0.26
	(0.04)	(0.04)	(0.02)	(0.25)
High income country dummy	-	0.10***	-	-
		(0.02)		
POWE	0.03*	-	-	-
	(0.01)			
P Group	-	0.05	0.01	0.05
		(0.03)	(0.06)	(0.03)
O Group	-	0.04	0.04	0.04
		(0.03)	(0.03)	(0.04)
W Group	-	0.02	0.00	0.02
		(0.02)	(0.02)	(0.04)
E Group	-	0.02	0.02	-0.00
		(0.02)	(0.03)	(0.03)
Percent population aged 15-64	-0.03	-0.04	-0.05	-0.04
	(0.02)	(0.02)	(0.03)	(0.03)
Percent population aged 65 and over	-0.06	-0.06	-0.03	-0.13*
	(0.04)	(0.04)	(0.04)	(0.06)
Year dummies				
year 2016	-0.06**	-0.06*	-0.07*	-0.05

	(0.02)	(0.02)	(0.03)	(0.03)
year 2018	-0.14***	-0.13**	-0.17***	-0.09
	(0.04)	(0.04)	(0.04)	(0.06)
year 2020	-0.19***	-0.18**	-0.23***	-0.11
	(0.05)	(0.05)	(0.06)	(0.08)
N of Obs.	381	381	158	223
N of Countries	97	97	43	58

Note: Standard errors (SE) in parentheses. $+ p < 0.10$, $* p < 0.05$, $** p < 0.01$, $*** p < 0.001$. Due to a large number of country dummies included in the regressions, the estimates of the country dummy variables are not shown in the table.

Appendix Table A5: The Association between Component Tax Scores and Cigarette Consumption

Outcome: Log (per capita cigarette consumption)

Sample	Whole sample	HICs	LMICs
Price score	-0.04	0.00	-0.07+
	(0.03)	(0.02)	(0.04)
Affordability score	-0.01+	-0.02*	-0.01
	(0.01)	(0.01)	(0.01)
Average tax share score	-0.05*	-0.07**	-0.06+
	(0.02)	(0.02)	(0.03)
Tax structure score	-0.02	0.02	-0.03+
	(0.01)	(0.03)	(0.02)
Mean (consumption in thousand sticks)	0.97	1.10	0.88
Mean (component score)			
Price score	2.51	3.42	1.86
Affordability score	1.39	1.70	1.17
Average tax share score	2.66	3.48	2.07
Tax structure score	2.80	3.39	2.39
N of Countries	97	43	58
N of Obs.	381	158	223

Note: Standard errors (SE) in parentheses. $+p < 0.10$, $* p < 0.05$, $** p < 0.01$, $*** p < 0.001$. All regressions control for POWE scores, country-level GDP per capita, high income country dummy, percentage of the population aged 15-64, percentage of the population aged 65 and over, year fixed effects, and country fixed effects. Standard errors were clustered at the country level.