The Quest for Effective Tobacco Control Strategies: Revisiting Price and Taxation Policy

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The prevailing wisdom in scholarly and policy-making institutions dealing with public health is that skillful use of price and taxation policy will reduce the prevalence of tobacco consumption because of the inverse relationship between tobacco price and consumption. Empirical evidence of this axiomatic inverse relationship has been sparse. This paper analyzes the effects of increased taxation on consumption of tobacco products in 162 countries during 2005-2020. Results indicate that there is weak negative relationship between change in adult smoking prevalence and change in taxation suggesting that higher tax rates on tobacco products tend to lower adult smoking prevalence, but in a modest rather than robust sort of way. The small negative association indicates that perhaps it will take very large tax increases to meaningfully affect adult smoking.

Keywords: tobacco control, FCTC, tobacco taxation

INTRODUCTION

The basic inverse relationship between the price of any product and its demand, or the law of supply and demand, is a keystone of modern economics. The concept is intuitive-as products become more expensive, consumers tend to demand less of them. In terms of policy formulation and implementation as a tool of tobacco control, however, empirical evidence of this relationship-its extent, scope, range etc.-needs to be investigated. Building on cross-country data from the World Health Organization (WHO) database, the authors of this paper published an article in 2018 in this journal (Mukherjee and Ekanayake, 2018) analyzing the effects of increased taxation on consumption of tobacco products in the Framework Convention on Tobacco Control (FCTC) member countries during the period 2009-2015. In order to understand the role of taxation in reducing adult smoking prevalence, the authors used biennial data (2009-2015) for 136 countries and calculated the correlation coefficient between the two variables. In addition, they also investigated whether different policies used to discourage smoking have had any impact on adult smoking prevalence. Results indicated that although relationship between change in adult smoking prevalence and change in taxation between 2009 and 2015 was very weak, there was a negative relationship between change in adult smoking prevalence and change in taxation. This suggested that higher tax rates on tobacco products tend to lower adult smoking prevalence, but in a modest rather than in a robust sort of way.

The authors' last research result did not provide a strong conclusion or a reliable answer to the question whether increased taxation decreases tobacco consumption substantially to be a foundation of tobacco control policy. In fact, although the authors did not provide this policy recommendation, public policy based on the research result would dampen at best enthusiasm for progressively higher tobacco taxation to combat tobacco consumption. Meanwhile, worldwide there has been more stringent restrictions on tobacco and some indication of progressively higher taxation and other measures to decrease tobacco use (WHO: 2021b). So, in this paper, the authors revisit the analysis with updated information (2017- 2020 data from the WHO database) to investigate if there is a reliable answer to the question now- do increased taxation of tobacco products significantly decrease tobacco consumption in the FCTC member countries?

For centuries, governments around the world have imposed taxes on tobacco products. Historically, revenue generation has been the primary motivation for these taxes- a reliable source of revenue because tobacco have few good substitutes and have relatively inelastic demand. Over the past 60 years, the accumulation of evidence on the adverse health and economic effects of tobacco consumption has led many governments at the federal, state and local levels to progressively increase tobacco taxes for public health reasons- in efforts to reduce the consumption of tobacco and to recover the associated costs of the negative externalities associated with tobacco use, especially 'smoking' products. WHO FCTC, citing strong evidence base of research demonstrating the effectiveness of higher tobacco taxes in reducing the use of tobacco, mandated signatory governments to raise tobacco taxes toward achieving their public health objectives. As countries have become signatories to the treaty, several have adopted significant increases in their tobacco taxes. (Chaloupka FJ et al., 2012, Chaloupka FJ et al., 2009) So, the prevailing wisdom in scholarly and policy-making institutions dealing with public health is that skillful use of price and taxation policy will reduce the prevalence of tobacco consumption because of the inverse relationship between tobacco price and consumption. For example, WHO FCTC states in Article 6, "Price and tax measures are an effective and important means of reducing tobacco consumption … Each Party should … adopt … tax policies and … price policies on tobacco products, so as to contribute to the health objectives aimed at reducing tobacco consumption." Likewise, the US Office of the Surgeon General, Centers for Disease Control, in a landmark study commemorating 50 years of progress on reducing tobacco use, states "The evidence is sufficient to conclude that increases in the prices of tobacco products, including those resulting from excise tax increases, prevent initiation of tobacco use, promote cessation, and reduce the prevalence and intensity of tobacco use among youth and adults." (Centers for Disease Control, National Center for Chronic Disease Prevention and Health, 2014).

However, empirical evidence of this axiomatic inverse relationship between price increase and tobacco consumption has been rather sparse. Building on new (2021) cross-country data from the WHO database, this paper analyzes the effects of increased taxation on consumption of tobacco products in the FCTC member countries during the period 2005-2020. To understand whether taxation plays any role in reducing adult smoking prevalence, we have used annual data with a five-year gap over the period from 2005 to 2020 for 162 countries. In addition, we also investigated whether the level of economic development of countries as measured by per capita real income has had any impact on adult smoking prevalence. Results indicate that although relationship between change in adult smoking prevalence and change in taxation between 2005 and 2020 is relatively weak, there is a negative relationship between change in adult smoking prevalence and change in taxation. This corroborates our 2018 study findings that there is a relatively weak, negative relationship between change in adult smoking prevalence and change in taxation. Consequently, we reach the same conclusion that we reached in 2018, that is, higher tax rates on tobacco products tend to lower adult smoking prevalence, but in a modest rather than robust sort of way.

LITERATURE REVIEW

As mentioned previously, there is paucity of research exploring the effect of increased taxation (or increased price) on adult tobacco consumption. In a study using yearly economic data from Austria, Felsinger and Groman (2022) estimated the price elasticity of total tobacco consumption applying a model for regression analysis. Results indicated that between 1997 and 2015 the price elasticity of demand for

tobacco products (including cigarettes, cigars, and other tobaccos) was a statistically insignificant −0.661. When excluding 2 anomalous years and removing a variable of the regression model the elasticity was −0.691 and statistically significant. A number of researches have concluded that a substantial tobacco price increase has a negative effect on tobacco consumption in pre-adults (Gallet and List, 2003). Using data from the 1976 National Health Interview Survey (NHIS), Lewit and Coate (1982) estimated a smoking participation price elasticity estimate for adults ages 35 and over of -0.15. With updated data from the same periodic survey, Evans and Farrelly (1998) and Farrelly et al. (2001) found that younger smokers were more responsive to tobacco price increase through taxes but reported no association between increased taxes and tobacco consumption for adults over the age of 40. Ohsfeldt et al. (1998) used data from the Current Population Survey Tobacco Use Supplements (CPS-TUS 1992-93) to estimate the association between cigarette taxes and cigarette consumption for males. Participation tax elasticity estimate for adults ages 45 and over was -0.07. Using nine iterations of the CPS-TUS (1992-99) Tauras (2006) reported participation price elasticity estimates for adults ages 18 and older of -0.12. DeCicca and McLeod (2008) used data from the Behavioral Risk Factor Surveillance System (BRFSS) to estimate the association between cigarette tax increases in the 2001-2006 period, and smoking prevalence among adults ages 45-59 and 45-64. The authors reported participation elasticities of -0.3 for 45–59-year-olds and -0.2 for 45-64-year-olds. Lastly, Callison and Kaestner (2012) used data from Population Survey Tobacco Use Supplements (1995-2007) to focus on recent, large tax changes and employed a paired difference-in-differences technique to estimate the association between tax increases and cigarette consumption. Their estimates indicated that, for adults, the association between cigarette taxes and either smoking participation or smoking intensity is negative, small and not usually statistically significant. According to the study, "increases in cigarette taxes are associated with small decreases in cigarette consumption and that it will take sizable tax increases, on the order of 100%, to decrease adult smoking by as much as 5%."

It seems clear from research and policy literature that significant increase in tobacco price is needed to bring about significant decrease in tobacco consumption. However, in a majority of countries party to the FCTC, and thereby committed to taxation policy as a tobacco control tool, that level of commitment is lacking. According to the WHO FCTC Tobacco Tax Policy and Administration Report (2021) "tobacco taxation was, in 2018, the WHO MPOWER measure that was least implemented at the highest level of achievement. Even more concerningly, cigarettes have become more, rather than less, affordable in many low- and middle-income countries over the past decade. Many countries set rates at insufficient levels and increase them too infrequently…. This failure to advance tobacco taxation able to effect significant price increases constitutes a loss for governments in revenues, a loss for public health and a win for the tobacco industry." According to the report, as of 2020, only 40 countries-representing 13% of the world population-levy taxes that represent more than 75% of the retail price of a pack of cigarettes, which is the lower threshold recommendation of FCTC. In other words, only 13% of the world's population currently live in countries imposing appropriate tax-rates.

BACKGROUND AND DATA SOURCE

FCTC is a multilateral treaty under the auspices of the WHO. Adopted by the WHO in 2003, it entered into force in 2005 and by September 2022, has 182 parties to the Treaty representing more than 91% of the world population. The FCTC contains both demand reduction and supply reduction provisions. Key obligations in the treaty are to (a) enact comprehensive bans on tobacco advertising, promotion, and sponsorship; (b) increase tobacco taxes; (c) adopt and implement large, clear, visible, legible and rotating health warnings on tobacco products and their packaging; (d) protect people from exposure to tobacco smoke from indoor work and public places; and (e) ban the use of terms such as 'light' and 'mild'. In 2008, WHO introduced a package of six evidence-based tobacco control demand reduction measures, known as the MPOWER to assist countries to fulfil their FCTC obligations. MPOWER refers to M: Monitoring tobacco use and prevention policies; P: Protecting people from tobacco smoke; O: Offering help to quit tobacco use; W: Warning about the dangers of tobacco; E: Enforcing bans on tobacco advertising, promotion and sponsorship, and R: Raising taxes on tobacco.

Success in the primary objective of establishing the FCTC regime having been achieved, now there is a major thrust to implement provisions of the treaty and MPOWER measures, monitor implementation and stigmatize non-implementation in the member-countries. To this end, all member-countries are required to provide to the WHO secretariat biennial comprehensive reports containing data on their progress toward the M-Power objectives. We use this compendium of data for the years 2005-2020 and additional data from the World Bank, *World Development Indicators* database to conduct our research.

RELATIONSHIP BETWEEN TAXATION AND ADULT SMOKING PRELALENCE

In this section, we discuss the prevalence of adult smoking and the level of taxation on tobacco products among our selected group of 162 countries. In addition, we also discuss the relationship between the change in taxation and change in adult smoking prevalence among these countries.

Table 1 presents the change in the prevalence of current tobacco use among adults during the period from 2000 to 2020. We can make several observations from the data presented in Panel A in Table 1. First, there is a significant variation in the adult smoking prevalence among various regions in the world. Second, the overall adult smoking prevalence in both males and females in the world has dropped during this period. Third, smoking prevalence among males are higher than that of females in all world regions. Fourth, adult smoking prevalence is relatively higher in the Central Europe and the Baltics, Pacific Island Small States, South Asia, East Asia and the Pacific, European Union, and Europe and Central Asia regions than the rest of the regions. The data presented in Panel B in Table 1 reveal that adult smoking prevalence is relatively lower in the low-income countries and heavily indebted poor countries.

TABLE 1
CHANGES IN THE PREVALENCE OF CURRENT TOBACCO USE (% OF ADULTS)

Panel A: Country Groups by Region

	Both Sexes					Males					Females				
Region	2000	2005	2010	2015	2020	2000	2005	2010	2015	2020	2000	2005	2010	2015	2020
Africa Eastern and Southern	21.1	18.2	15.8	13.8	12.1	32.4	28.6	25.4	22.6	20.2	9.7	7.8	6.2	5.0	4.0
Africa Western and Central	12.8	10.6	8.8	7.3	6.1	21.6	18.1	15.2	12.9	11.0	4.0	3.0	2.2	1.6	1.2
Arab World	23.5	22.5	21.7	21.0	20.2	42.2	40.9	39.7	38.6	37.8	4.4	3.7	3.3	3.0	2.6
Central Europe and the Baltics	37.9	35.3	32.8	30.6	28.6	46.4	42.8	39.4	36.2	33.5	29.4	27.8	26.2	24.9	23.7
East Asia and the Pacific	29.8	28.9	27.9	27.0	26.3	53.2	52.2	51.0	50.1	49.2	6.5	5.5	4.7	4.0	3.5
Euro area	34.7	32.2	29.9	27.9	26.1	40.8	37.2	34.0	31.1	28.6	28.5	27.1	25.8	24.6	23.7
Europe and the Central Asia	35.0	32.2	29.7	27.5	25.5	46.7	42.5	38.9	35.7	32.8	23.0	21.5	20.2	19.1	18.3
European Union	35.6	32.9	30.5	28.3	26.4	42.0	38.3	35.0	32.0	29.3	29.1	27.5	26.0	24.6	23.5
Latin America and the Caribbean	25.1	21.4	18.2	15.6	13.4	33.3	28.5	24.5	21.1	18.3	16.9	14.1	11.9	10.1	8.6
Middle East and North Africa	23.2	21.8	20.8	19.9	19.0	40.4	38.6	37.3	36.0	35.0	5.7	4.8	4.0	3.5	3.0
North America	33.3	29.9	27.1	24.3	21.9	39.6	35.8	32.8	29.7	27.0	26.9	23.9	21.3	19.0	16.8
Pacific Island Small States	36.5	33.8	31.5	29.4	27.5	53.8	50.1	47.0	44.2	41.7	19.2	17.4	15.9	14.6	13.3
South Asia	52.7	44.3	37.3	31.8	27.0	67.7	59.6	52.8	46.9	41.4	37.7	28.9	21.9	16.6	12.5
Sub-Saharan Africa	17.6	15.0	12.8	11.1	9.5	27.7	24.1	21.0	18.4	16.2	7.3	5.8	4.5	3.6	2.8
World	**34.2**	**30.8**	**27.8**	**25.2**	**23.0**	**50.5**	**46.8**	**43.3**	**40.3**	**37.4**	**17.9**	**14.9**	**12.4**	**10.3**	**8.7**

Panel A: Country Groups by Level of Income

	Both Sexes					Males					Females				
Level of Income	2000	2005	2010	2015	2020	2000	2005	2010	2015	2020	2000	2005	2010	2015	2020
Heavily Indebted Poor Countries	20.0	16.9	14.3	12.3	10.6	30.8	26.7	23.1	20.2	17.9	9.3	7.2	5.5	4.3	3.3
High Income Countries	34.0	30.5	27.5	24.7	22.5	42.4	38.0	34.1	30.6	27.6	25.5	23.1	20.9	19.0	17.4
Low and Middle Income Countries	34.2	30.8	27.9	25.3	23.1	52.6	48.9	45.4	42.4	39.5	15.9	12.8	10.3	8.4	6.8
Low Income Countries	21.7	18.9	16.3	14.3	12.5	33.6	29.9	26.5	23.6	21.2	9.8	7.8	6.1	4.9	3.8
Lower Middle Income Countries	42.6	36.9	32.0	28.1	24.7	59.9	54.0	48.9	44.6	40.6	25.2	19.6	15.0	11.6	8.9
Middle Income Countries	34.9	31.5	28.6	26.1	23.9	53.6	50.0	46.6	43.7	40.9	16.2	13.1	10.6	8.6	7.0
Upper Middle Income Countries	27.4	26.2	25.0	23.9	23.1	47.4	45.9	44.2	42.7	41.2	7.6	6.7	6.0	5.4	4.9
World	**34.2**	**30.8**	**27.8**	**25.2**	**23.0**	**50.5**	**46.8**	**43.3**	**40.3**	**37.4**	**17.9**	**14.9**	**12.4**	**10.3**	**8.7**

Source: The World Bank, *World Development Indicators Database 2022*.

Table 2 presents the countries with highest prevalence of current tobacco use among adults during the period from 2000 to 2020. The data presented in Table 2 reveal that four of the top five countries are in the Asia and the Pacific region. Though the prevalence of current tobacco uses among males tend to be higher than that of females in almost countries, it is interesting to note that, in Nauru, the prevalence of current tobacco use among females is higher than that of males.

TABLE 2
TOP 25 COUNTRIES WITH THE HIGHEST PREVALENCE OF CURRENT TOBACCO USE (% OF ADULTS): (RANKING BY THE PREVALENCE RATE IN 2020, BOTH SEXES)

	Both Sexes					Males					Females				
Country	2000	2005	2010	2015	2020	2000	2005	2010	2015	2020	2000	2005	2010	2015	2020
Nauru	63.4	59.2	55.5	51.8	48.5	57.3	54.8	52.6	49.9	47.8	69.4	63.6	58.3	53.6	49.1
Myanmar	66.9	60.6	54.6	48.8	44.1	83.8	79.4	76.0	72.0	68.5	50.0	41.8	33.1	25.6	19.7
Kiribati	68.5	60.4	52.7	46.4	40.6	83.1	74.8	66.9	60.4	53.9	53.9	45.9	38.4	32.3	27.3
Serbia	45.1	43.7	42.3	40.9	39.8	51.0	48.0	45.4	42.7	40.5	39.1	39.3	39.1	39.1	39.1
Papua New Guinea	54.1	49.7	45.9	42.5	39.3	71.5	66.2	61.5	57.4	53.5	36.7	33.2	30.2	27.5	25.1
Timor-Leste	53.5	49.5	46.0	42.5	39.2	86.7	81.6	77.1	72.3	67.6	20.3	17.3	14.8	12.7	10.8
Bulgaria	47.5	45.0	42.9	40.7	39.0	59.2	53.9	49.2	44.7	40.9	35.8	36.1	36.5	36.7	37.1
Lebanon	40.2	39.7	39.1	38.7	38.2	45.7	46.2	46.5	47.1	47.5	34.6	33.1	31.7	30.2	28.9
Indonesia	35.4	35.8	36.3	36.7	37.6	63.8	65.6	67.4	69.1	71.4	6.9	5.9	5.1	4.3	3.7
Latvia	43.8	41.9	40.1	38.5	37.0	61.3	58.0	55.1	52.5	50.3	26.3	25.7	25.1	24.4	23.7
Croatia	34.4	34.9	35.4	36.1	36.9	41.7	40.5	39.5	38.5	37.6	27.1	29.2	31.3	33.7	36.1
Solomon Islands	43.5	41.3	39.6	37.9	36.5	60.3	58.0	56.6	54.9	53.8	26.7	24.5	22.6	20.9	19.2
Tuvalu	48.8	45.3	41.8	38.4	35.6	68.2	63.3	58.5	53.7	49.8	29.3	27.3	25.0	23.1	21.3
Cyprus	40.9	39.2	37.7	36.4	35.1	60.6	56.7	53.2	50.1	47.0	21.1	21.6	22.2	22.7	23.2
Bosnia and Herzegovina	46.6	43.4	40.3	37.7	35.0	58.2	53.5	49.3	45.6	42.0	35.0	33.2	31.2	29.8	28.0
Jordan	30.7	31.7	32.6	33.7	34.8	51.2	52.5	53.7	55.2	56.8	10.1	10.8	11.4	12.1	12.8
Bangladesh	57.6	50.3	44.0	38.9	34.7	66.7	62.9	59.0	55.5	52.2	48.5	37.7	28.9	22.2	17.1
Greece	54.9	48.5	42.9	37.9	33.5	65.9	57.0	49.1	42.3	36.5	43.8	40.0	36.7	33.5	30.5
France	34.2	34.1	33.8	33.7	33.4	38.5	37.7	36.7	35.9	34.9	29.8	30.5	30.9	31.4	31.9
Lithuania	41.4	38.9	36.4	34.0	32.0	58.0	53.6	49.5	45.5	42.1	24.8	24.1	23.2	22.4	21.8
Andorra	35.9	34.8	34.0	33.0	31.8	42.5	40.5	39.0	37.3	35.3	29.3	29.1	28.9	28.6	28.3
Hungary	37.4	35.9	34.6	33.2	31.8	43.1	41.3	39.4	37.6	35.8	31.6	30.5	29.7	28.7	27.8
Lao PDR	52.5	46.2	40.5	35.8	31.8	76.0	70.1	63.6	58.2	53.3	28.9	22.3	17.3	13.3	10.3
Georgia	32.8	32.6	32.2	32.0	31.7	60.2	59.3	58.1	57.3	56.3	5.4	5.8	6.2	6.6	7.1
Slovak Republic	32.0	31.7	31.6	31.5	31.5	43.2	41.6	40.3	38.6	37.4	20.7	21.8	22.9	24.3	25.6

Source: The World Bank, *World Development Indicators Database 2022*.

The top 25 countries with the highest taxes on tobacco consumption are presented in Table 3. It is interesting to note that eighteen of the twenty-five countries listed in Table 3 are in the European Union, Europe and the Central Asia, or in the Central Europe and the Baltics. Table 3 also reveals that, between 2008 and 2020, tax rate on tobacco consumption has increased in all countries, except Ireland, Portugal, and Poland.

Having discussed the prevalence of tobacco consumption among adults for various regions and countries as well as the taxes on tobacco consumption, next we focus on the relationship between the change in taxation and change in adult smoking prevalence among the 162 countries in our sample. Figure 1 shows the relationship between the change in taxation and change in adult smoking prevalence.

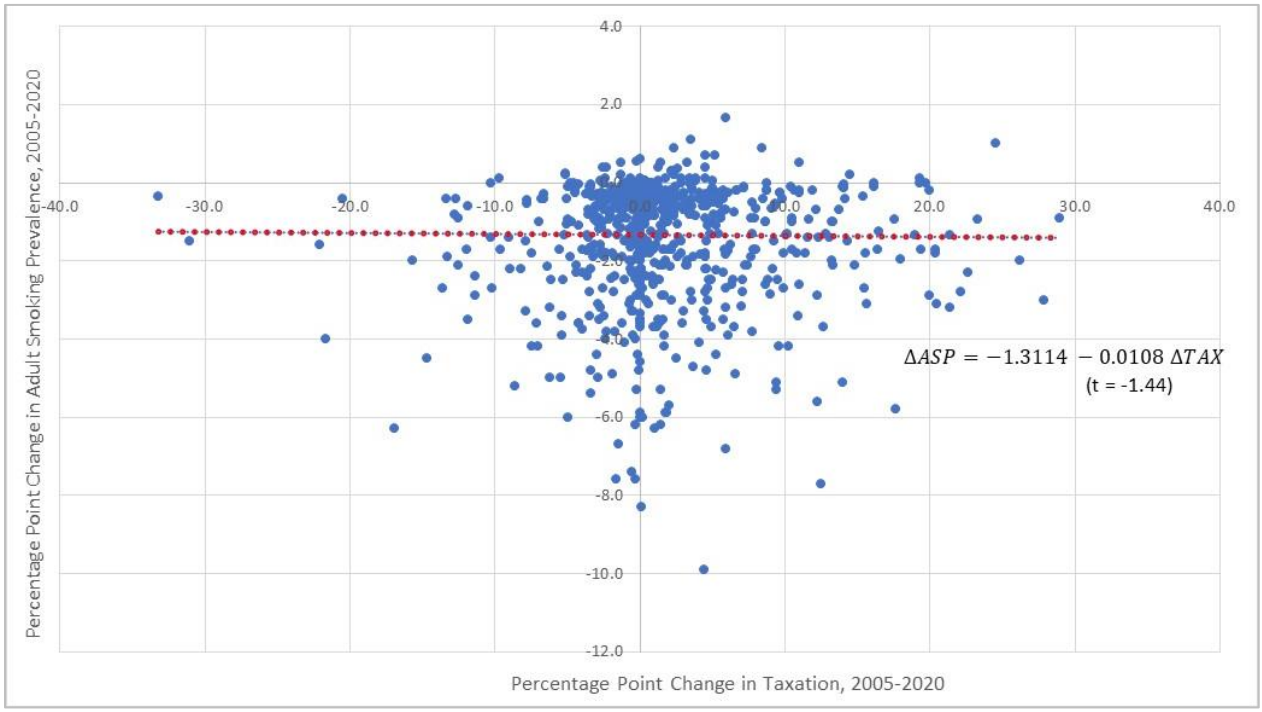
TABLE 3
TOP 25 COUNTRIES WITH HIGHEST TAXES ON TOBACCO CONSUMPTION
(RANKING BY THE TAX RATE IN 2020)

Country	2008	2010	2012	2014	2016	2018	2020
Finland	77.47%	78.80%	79.90%	81.59%	84.91%	87.41%	88.23%
Estonia	77.33%	82.58%	76.88%	77.24%	77.20%	86.38%	87.64%
Bulgaria	85.44%	88.70%	83.58%	85.58%	85.10%	87.09%	85.27%
Turkey	73.25%	78.25%	80.25%	82.13%	83.05%	81.37%	84.88%
Bosnia and Herzegovina	56.50%	72.15%	74.82%	82.10%	84.25%	83.80%	84.03%
Croatia	60.70%	71.70%	71.00%	75.26%	77.17%	78.80%	83.60%
France	80.39%	80.39%	79.86%	80.30%	80.30%	82.45%	83.23%
Israel	72.10%	72.29%	77.10%	81.29%	76.16%	75.91%	83.21%
New Zealand	70.04%	80.29%	74.02%	77.21%	74.94%	82.21%	82.00%
Brazil	57.15%	59.35%	63.15%	64.94%	67.95%	82.97%	81.55%
Georgia	48.59%	48.59%	46.83%	49.35%	69.25%	71.20%	81.24%
Mauritius	80.74%	71.71%	73.23%	72.52%	70.23%	83.54%	81.19%
Greece	73.47%	85.70%	82.16%	79.95%	80.60%	81.22%	80.84%
Madagascar	66.88%	76.31%	76.31%	80.44%	80.43%	80.43%	80.43%
North Macedonia	72.05%	72.05%	71.22%	72.59%	71.09%	81.25%	80.26%
Chile	76.37%	76.37%	81.54%	82.85%	89.13%	82.36%	80.04%
Latvia	71.51%	81.47%	79.14%	76.89%	79.83%	79.99%	79.90%
United Kingdom	76.57%	76.74%	80.12%	82.16%	80.50%	79.39%	79.25%
Ireland	79.53%	78.52%	78.97%	77.80%	78.26%	78.40%	78.87%
Slovenia	74.88%	75.87%	79.28%	80.41%	78.54%	79.19%	78.67%
Portugal	79.60%	78.98%	76.02%	74.51%	73.55%	71.66%	78.61%
Thailand	63.78%	68.74%	70.22%	73.13%	73.48%	78.60%	78.60%
Egypt	59.27%	73.75%	72.50%	73.13%	73.50%	77.19%	78.53%
Andorra	52.46%	58.02%	56.27%	68.18%	74.52%	79.34%	78.41%
Poland	93.84%	86.38%	79.59%	80.29%	78.24%	76.79%	78.40%

Source: World Health Organization, *WHO Report on the Global Tobacco Epidemic, 2021: Addressing New and Emerging Products*.

Figure 1 illustrates the changes in the average adult smoking prevalence and the average taxation between 2005 and 2020. The change in the average adult smoking prevalence and the average taxation were calculated by taking the average of the changes between 2005-2010, 2010-2015, 2015-2018, 2018-2019, and 2019-2020. Figure 1 indicates that although the relationship between change in adult smoking prevalence and change in taxation between 2005 and 2020 is relatively weak, there is a negative relationship between change in adult smoking prevalence and change in taxation. The slope coefficient of the trend line indicates that every 1-percentage point increase in tax rate lowers adult smoking prevalence rate by 0.0108 percentage points.

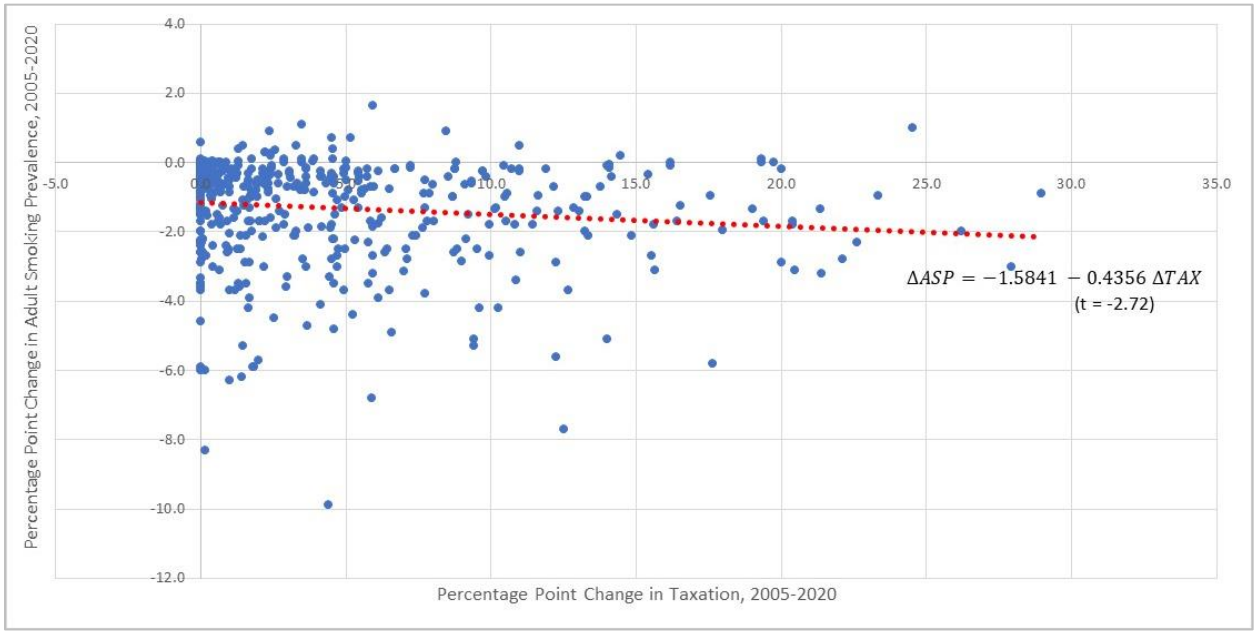
FIGURE 1
RELATIONSHIP BETWEEN THE CHANGE IN TAXATION AND CHANGE IN ADULT SMOKING PREVALENCE



Note: This figure shows the relationship between the change in adult smoking prevalence (ASP) and the change in taxation (TAX) between 2005 and 2020.

In order to understand whether the relationship between the change in taxation and change in adult smoking prevalence is different for countries that raised taxes on tobacco consumption and those that lowered the taxes on tobacco consumption, we separated the 162 countries into two groups and analyzed the relationship between the two groups of countries. The results of this analyses are presented in Figures 2 and 3. Figure 2 indicates that, for the countries that increased the taxes on tobacco consumption, the relationship between change in adult smoking prevalence and change in taxation between 2005 and 2020 is negative and the relationship between change in adult smoking prevalence and change in taxation much stronger than that presented in Figure 1. The slope coefficient of the trend line indicates that every 1-percentage point increase in tax rate lowers adult smoking prevalence rate by 0.4356 percentage points.

FIGURE 2
RELATIONSHIP BETWEEN THE CHANGE IN TAXATION AND CHANGE IN ADULT SMOKING PREVALENCE IN COUNTRIES THAT INCREASED TAXES ON TOBACCO CONSUMPTION



Note: This figure shows the relationship between the change in adult smoking prevalence (ASP) and the change in taxation (TAX) between 2005 and 2020 for countries that raised taxes on tobacco consumption.

Figure 3 indicates that, for the countries that decreased the taxes on tobacco consumption, the relationship between change in adult smoking prevalence and change in taxation between 2005 and 2020 is positive and the relationship between change in adult smoking prevalence and change in taxation much stronger than that presented in Figure 1. The slope coefficient of the trend line indicates that every 1-percentage point decrease in tax rate increases the adult smoking prevalence rate by 0.4817 percentage points.

MODEL SPECIFICATION AND DATA

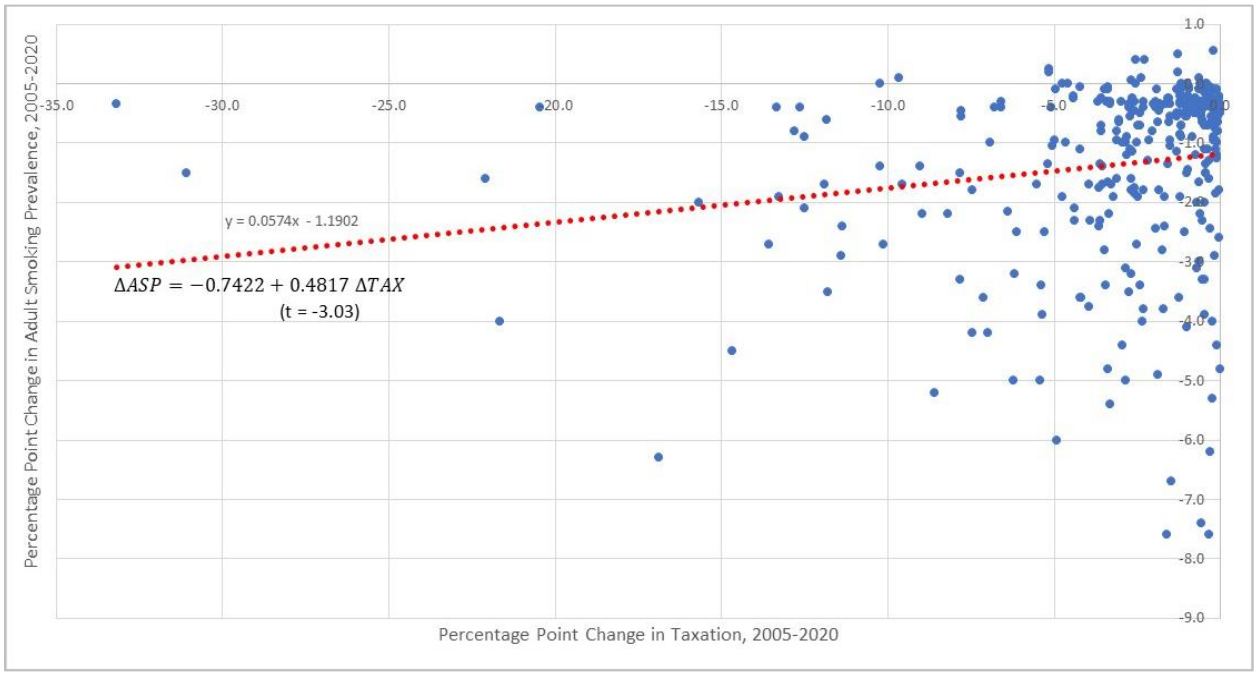
In order to investigate whether taxation on tobacco consumption has any impact on adult smoking prevalence we specify the following model:

$$ASP_{it} = \mu_i + \beta_1 TAX_{it} + \beta_2 lnPCI_{it} + \beta_3 DUM_{it} + \varepsilon_{it} \quad (1)$$

where ASP_{it} is the adult smoking prevalence as a percent of adult population, TAX_{it} is the tax rate on tobacco consumption (%) in country i in year t, $ln\ PCI_{it}$ is the natural logarithm of real per capita income in 2015 dollars in country i in year t, DUM_{it} is a dummy variable that takes value of 1 if the country i increased tax on tobacco consumption in year t and takes value 0 otherwise, i = 1, 2, 3, ……, 162 for each of the country in the panel and t = 1,..., 6 refers to the time period, μ_i is the country-specific fixed effects, and ε_{it} is to denote the estimated residuals which represent deviations from the long-run relationship. The inclusion of dummy variable in Equation (1) helps in identifying the effects of taxation on smoking prevalence in two group of countries, namely, the countries that raised tax on tobacco consumption and the countries that lowered tax, without having to estimate different models for each group. The expected sign of parameter α_1 can either be negative or positive depending on whether taxation deter

or encourage adult smoking. The expected sign of parameters α_2 can be expected to be negative as there are many policies in place in high income countries that discourage smoking. The expected sign of parameters α_3 can be expected to be negative since the countries that raise taxes on tobacco consumption are more successful in lowering the adult smoking prevalence.

FIGURE 3
RELATIONSHIP BETWEEN THE CHANGE IN TAXATION AND CHANGE IN ADULT SMOKING PREVALENCE IN COUNTRIES THAT REDUCED TAXES ON TOBACCO CONSUMPTION



Note: This figure shows the relationship between the change in adult smoking prevalence (ASP) and the change in taxation (TAX) between 2005 and 2020 for countries that reduced taxes on tobacco consumption.

We have also specified another model by adding two interactive terms to Equation (1) as shown in Equation (2).

$$ASP_{it} = \mu_i + \beta_1 TAX_{it} + \beta_2 lnPCI_{it} + \beta_3 DUM_{it} + \beta_4 PCI \times DUM_{it} + \beta_5 TAX \times DUM_{it} + \varepsilon_{it} \quad (2)$$

In addition to the models specified in Equations (1) and (2), we have also specified two models representing the change in adult smoking prevalence and the change in tax rate. The revised models take the following forms:

$$\Delta ASP_{it} = \mu_i + \alpha_1 \Delta TAX_{it} + \alpha_2 lnPCI_{it} + \alpha_3 DUM_{it} + \varepsilon_{it} \quad (3)$$

$$\Delta ASP_{it} = \mu_i + \alpha_1 \Delta TAX_{it} + \alpha_2 lnPCI_{it} + \alpha_3 DUM_{it} + \alpha_4 PCI \times DUM_{it} + \alpha_5 TAX \times DUM_{it} + \varepsilon_{it} \quad (4)$$

The expected sign of parameter α_1 can either be negative or positive depending on whether taxation deters or encourages adult smoking. The expected sign of parameters α_2 can be expected to be positive as higher levels of income increases the affordability of smokers. The expected sign of parameters α_3 can be expected to be negative since higher taxes can deter smoking. The expected signs of parameters α_4 and α_5 can either be negative or positive.

All the data used in this study were collected from the World Bank, *World Development Indicators Database 2022* and the WHO reports on global tobacco epidemic. These reports include *WHO Report on the Global Tobacco Epidemic, 2021: Addressing New and Emerging Products*; *WHO Report on the Global Tobacco Epidemic, 2019: Offer Help to Quit Tobacco Use*; *WHO Report on the Global Tobacco Epidemic, 2017: Monitoring Tobacco Use and Prevention Policies*; *WHO Report on the Global Tobacco Epidemic, 2015: Raising Taxes on Tobacco*; *WHO Report on the Global Tobacco Epidemic, 2013: Enforcing Bans on Tobacco Advertising, Promotion and Sponsorship*; and *WHO Report on the Global Tobacco Epidemic, 2011: Warning about the Dangers of Tobacco*.

EMPIRICAL RESULTS

The specified models are estimated using panel least squares estimation method. Our panel data covers 162 countries and 6 years (2005, 2010, 2015, 2018, 2019, and 2020). Due to some missing observations on some of the variables, we do not have a balanced panel. The estimated results are presented in Tables 4 and 5. Table 4 presents the estimated results of Equations (1) and (2). We have estimated five different models by introducing additional variables to the original model presented in Equation (1). All models were estimated using panel least squares estimation method. In order to identify whether fixed-effects model or random-effects model is appropriate, we have conducted the Hausman test. Since the Hausman test statistic is statistically significant at the 1% level of significance, all five models were estimated using the fixed-effects model.

TABLE 4
ADULT SMOKING PREVALENCE AND TAXATION: PANEL LS ESTIMATIONS (2005-2020)
[DEPENDENT VARIABLE: APS]

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
$Constant$	27.7821*** (10.04)	27.7456*** (10.69)	28.4350*** (10.87)	24.6462*** (11.17)	26.9319*** (10.87)
Tax	-0.0979*** (7.13)	-0.1077*** (7.92)	-0.0340*** (2.86)	-0.0340*** (2.85)	-0.0382*** (3.08)
$ln\ PCI$		-11.1687*** (9.85)	-10.8629*** (9.15)	-10.8852*** (9.12)	-10.8937*** (9.19)
Dum			0.6693*** (3.49)	0.5984** (2.54)	0.1029 (0.20)
$PCI \times Dum$				0.0011 (0.52)	
$Tax \times Dum$					0.0106 (1.21)
$Adjusted\ R^2$	0.9128	0.9413	0.9421	0.9422	0.9426
$Number\ of\ Observations$	972	972	972	972	972
$Random/Fixed\ Effects?$	FE	FE	FE	FE	FE
$Hausman\ Test$	46.25***	44.15***	48.11***	42.25***	44.25***

***Note**: Figures in parentheses are absolute values of t-statistics. Asterisks ** and *** indicate the statistical significance at the 5% level and 1% level, respectively.*

The fitness of each model is very good as is evident from the very high values of adjusted R^2. Results presented in Table 4 show that the sign of the taxation variable is negative, and it is statistically significant at 1% level of significance. Therefore, taxation is found to have a negative effect on adult smoking prevalence. The real per capita income variable has the expected negative sign, and it is statistically significant at the 1% level of significance. The dummy variable that separates countries into two groups depending on whether taxes were increased or decreased during our study period has a positive sign and it is statistically significant at the 1% level in Model 3, and it is statistically significant at the 5% level in Model 4. The interactive terms are positive, but they are not statistically significant.

Table 5 presents the estimated results of Equations (3) and (4). In this case also we have estimated five different models by introducing additional variables to the original model presented in Equation (3). As in the previous case, all models were estimated using panel least squares estimation method. In order to identify whether fixed-effects model or random-effects model is appropriate, we have conducted the Hausman test. Since the Hausman test statistic is statistically significant at the 1% level of significance, all five models were estimated using the fixed-effects model. Compared to the models presented in Table 4, the fitness of each model presented in Table 5 is relatively weak as is evident from the relatively low values of adjusted R^2. Results presented in Table 5 show that the sign of the change in taxation variable is negative, and it is statistically significant at 1% level of significance. Therefore, change in taxation is found to have a negative effect on change in adult smoking prevalence. The real per capita income variable has a positive sign, and it is statistically significant at the 1% level of significance. The dummy variable that separates countries into two groups depending on whether taxes were increased or decreased during our study period has a negative sign and it is statistically significant at the 1% level. The negative sign of the estimated coefficient of dummy variable indicates that the countries that raised the taxes on tobacco consumption are more successful in lowering the adult smoking prevalence than those that lowered the taxes on tobacco consumption. In this case too, the interactive terms are positive, but they are not statistically significant.

TABLE 5
CHANGE IN ADULT SMOKING PREVALENCE AND CHANGE IN TAXATION: PANEL LS ESTIMATIONS (2005-2020)
[DEPENDENT VARIABLE: ΔAPS]

Variable	Model 6	Model 7	Model 8	Model 9	Model 10
$Constant$	-1.3114*** (9.95)	-42.2557*** (13.29)	-42.8800*** (12.78)	-42.9355*** (12.75)	-42.7740*** (12.71)
ΔTax	-0.0108 (1.44)	-0.0152 (0.77)	-0.0186** (2.38)	-0.0185** (2.36)	-0.0184** (2.35)
$ln\ PCI$		5.0906*** (9.09)	4.8410*** (9.38)	4.8473*** (9.42)	4.8287*** (9.40)
Dum			-0.6085*** (5.64)	-0.6935*** (4.60)	-0.7024*** (2.79)
$PCI \times Dum$				0.0011 (0.21)	
$Tax \times Dum$					0.0017 (0.41)
$Adjusted\ R^2$	0.2646	0.4143	0.4410	0.4402	0.4401
$Number\ of\ Observations$	810	810	810	810	810
$Random/Fixed\ Effects?$	FE	FE	FE	FE	FE
$Hausman\ Test$	34.25***	36.55***	38.11***	38.25***	42.16***

***Note**: Figures in parentheses are absolute values of t-statistics. Asterisks ** and *** indicate the statistical significance at the 5% level and 1% level, respectively.*

CONCLUSION

With 182 parties to the FCTC, it is evident that significant curtailment of tobacco consumption is a near universal goal of governments across the world and that of coordinated global health policy. Significant and progressive increase in tobacco taxation is considered to be a key means of achieving this objective. So, in this research paper, we revisited the issue of tobacco taxes and adult smoking prevalence and extended the literature from overwhelmingly domestic or country level analysis to global level analysis of 162 countries between 2005 and 2020. Overall, our analyses indicate that the association between tobacco taxes and smoking participation is negative, small and not usually statistically significant. The small negative association indicates that perhaps it will take very large tax increases to meaningfully affect adult smoking. This is because with incremental small increase in taxation, tobacco companies often partially offset the effect of tax increase by discounts and promotions (Apollonio DE, Glantz SA., 2020) and the pool of smokers seemingly harden and adjust rather than abandon smoking. Our research ultimately raises questions about claims that, at the current time, tobacco tax increase WILL have an immediate and important beneficial health impact through reduced smoking prevalence. Rather, we believe progressively higher tobacco taxation should be an important component of a comprehensive tobacco control program along with other measures like smoke-free workplaces, robust graphic warning labels on tobacco packages, and strong, anti-tobacco media campaigns.

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World Health Organization. (2011). *WHO Report on the Global Tobacco Epidemic, 2011: Warning about the Dangers of Tobacco.*

APPENDIX: LIST OF COUNTRIES

Afghanistan	Cyprus	Kyrgyz Republic	Poland	Zambia
Albania	Czech Republic	Lao PDR	Portugal	Zimbabwe
Algeria	Denmark	Latvia	Qatar	
Andorra	Dominican Republic	Lebanon	Romania	
Argentina	Ecuador	Lesotho	Russian Federation	
Armenia	Egypt, Arab Rep.	Liberia	Rwanda	
Australia	El Salvador	Lithuania	Samoa	
Austria	Eritrea	Luxembourg	Sao Tome and Principe	
Azerbaijan	Estonia	Madagascar	Saudi Arabia	
Bahamas, The	Eswatini	Malawi	Senegal	
Bahrain	Ethiopia	Malaysia	Serbia	
Bangladesh	Fiji	Maldives	Seychelles	
Barbados	Finland	Mali	Sierra Leone	
Belarus	France	Malta	Singapore	
Belgium	Gambia, The	Marshall Islands	Slovak Republic	
Belize	Georgia	Mauritania	Slovenia	
Benin	Germany	Mauritius	Solomon Islands	

Bolivia	Ghana	Mexico	South Africa
Bosnia and Herzegovina	Greece	Moldova, Rep.	Spain
Botswana	Guatemala	Mongolia	Sri Lanka
Brazil	Guinea-Bissau	Montenegro	Sweden
Brunei Darussalam	Guyana	Morocco	Switzerland
Bulgaria	Haiti	Mozambique	Tanzania
Burkina Faso	Hungary	Myanmar	Thailand
Burundi	Iceland	Namibia	Timor-Leste
Cabo Verde	India	Nauru	Togo
Cambodia	Indonesia	Nepal	Tonga
Cameroon	Iran, Islamic Rep.	Netherlands	Tunisia
Canada	Iraq	New Zealand	Turkey
Chad	Ireland	Niger	Turkmenistan
Chile	Israel	Nigeria	Tuvalu
China	Italy	Norway	Uganda
Colombia	Jamaica	Oman	Ukraine
Comoros	Japan	Pakistan	United Kingdom
Congo, Dem. Rep.	Jordan	Palau	United States
Congo, Rep.	Kazakhstan	Panama	Uruguay
Costa Rica	Kenya	Papua New Guinea	Uzbekistan
Cote d'Ivoire	Kiribati	Paraguay	Vanuatu
Croatia	Korea, Rep.	Peru	Vietnam
Cuba	Kuwait	Philippines	Yemen, Rep.