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Effectiveness of Tobacco Control Policies in Reducing Smoking Prevalence in Sub-Saharan Africa

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Abstract

Increasing prevalence of non-communicable diseases is causing a strain on economies of low and middle income countries. A major, but preventable, contributing factor to this disease prevalence is tobacco use. Therefore, to decrease both mortality from these diseases and tobacco use, the World Health Organization introduced tobacco control measures called MPOWER. As sub-Saharan Africa consists of many low and middle income countries and is in the midst of a tobacco epidemic, this paper aims to answer the research question "To what extent has the implementation of the MPOWER measures of the Framework Convention on Tobacco Control affected smoking prevalence in sub-Saharan Africa from 2010 to 2016?". Data on MPOWER was obtained from reports by the World Health Organization; smoking prevalence of 29 sub-Saharan African countries was found on the World Bank Database. The methodology used was a two-way fixed effects model with country and year fixed effects. The analysis looked at the effects of MPOWER on total, female and male smoking prevalence. The results indicate that MPOWER, as a whole, did not have an effect on total or female smoking prevalence but did decrease male smoking prevalence in 29 sub-Saharan African countries from 2010 to 2016. These countries did not have much progress in implementing MPOWER and the measures did not have a strong impact on decreasing smoking. Furthermore, gender is an important consideration as differing effects of the measures were found.

Table of Contents

Introduction

71% of all global deaths in 2018 were attributable to chronic diseases, with three-quarters of these deaths occurring in low and middle income countries (World Health Organization, 2018). The costs associated with treating non-communicable diseases can have a major negative impact on both the economy and further development of a country. However, the World Health Organization (WHO) claims that 80% of heart disease, stroke and diabetes are preventable by addressing risk behaviors (WHO, 2005); these include tobacco use, harmful alcohol use, insufficient physical activity and excess salt intake or unhealthy diet (WHO, 2018). Therefore, avoiding chronic disease incidence ex-ante through prevention of risk factors rather than focusing on ex-post treatment efforts is especially important in low and middle income countries, such as the ones in sub-Saharan Africa, as treatment is limited due to a lack of resources and access to health care (Abegunde, Mathers, Adam, Ortegon, & Strong, 2007).

Tobacco use is one of the main behavioral risk factors of non-communicable diseases that can be prevented (WHO, 2005). However, in sub-Saharan Africa, smoking rates are on the rise with males smoking more than females (Brathwaite, Addo, Smeeth & Lock, 2015). The tobacco industry has been using demographic and economic changes and loose tobacco control implementation in the area to their advantage to further expand and increase sales (Brathwaite et al., 2015). Additionally, due to increasing urbanization in Africa, smoking is becoming more common in the younger generation (Magitta, 2018). With these demographic, economic and social changes in sub-Saharan Africa, both adoption and implementation of tobacco control policies may be vital to halt increasing smoking prevalence.

To aid countries with the implementation of tobacco control policies, in 2003, the World Health Organization established The Framework Convention on Tobacco Control (FCTC) which outlines specific demand-reducing measures with the acronym of MPOWER which stands for: monitoring tobacco use, protecting others from smoke, offering help to quit, warning about the dangers, enforcing bans on advertisement and promotion, and raising taxes on tobacco products (WHO, n.d.). Based on past evidence that these policies are both feasible and cost-effective, the World Health Organization (2013) insists that countries fully implement each of the MPOWER measures to experience larger effects on tobacco use rates. By lowering smoking rates, countries will be working to decrease mortality from non-communicable diseases which will in turn lighten the strain on economies, governments and health care systems and allow for further development (WHO, 2013). Therefore, it is of social relevance to assess both implementation and effectiveness of MPOWER measures in sub-Saharan Africa.

In this paper, I study whether MPOWER measures have had an impact on smoking prevalence in sub-Saharan Africa. Existing papers have found that the implementation of these measures has a negative association with smoking prevalence (Dubray, Schwartz, Chaiton, O'Connor, & Cohen, 2015; Anderson, Becher, & Winkler, 2016; Gravely et al., 2017; Ngo, Cheng, Chaloupka, & Shang, 2017). I aim to add to the existing literature in several ways. Firstly, I examine the effects of implementing the MPOWER measures in the specific setting of sub-Saharan Africa as past literature looked at the effects on a global scale. Secondly, I include an additional year of MPOWER data from the WHO. Therefore, the research question is formulated as follows:

"To what extent has the implementation of the MPOWER measures of the Framework Convention on Tobacco Control affected smoking prevalence in sub-Saharan Africa from 2010 to 2016?"

I use a two-way fixed effects methodology with both country and year fixed effects to investigate this relationship. To answer the research question, I focus on the MPOWER measures as a combined score and its effect on total smoking prevalence and therefore, hypothesize that an increase in the combined score had a negative effect on smoking prevalence in sub-Saharan Africa. As an addition to this analysis, I check for the presence of gender heterogeneity in the effects, as well as the effectiveness of each of the MPOWER measures.

The abovementioned analysis reveals that an increase in the combined MPOWER score has not had a significant effect on total smoking prevalence in 29 of the sub-Saharan African countries. When looking at gender heterogeneity of the effects of the MPOWER score on smoking prevalence, I find that an increase in the score significantly decreased male smoking prevalence by 0.135 percentage points but did not significantly affect female smoking prevalence. Looking at the effectiveness of each of the MPOWER measures simultaneously, the analysis shows that none of the measures had an effect on total or male smoking prevalence. However, I find that an increase in the measure E increased female smoking prevalence by 0.117 percentage points.

The next section critically analyzes existing literature on MPOWER measures and their effects on smoking prevalence. This is followed by an explanation of the data and methodology chosen for the analysis. After, the results of this analysis are presented. In the discussion section, I discuss the results in connection with previous literature and mention the limitations of this study. Lastly, the conclusion consists of the answer to the research question, summary of the main findings, policy implications and ideas for further research.

Literature Review

As of 2017, out of the 44 low and middle income sub-Saharan African countries within the WHO African region, 39 had ratified the Framework Convention of Tobacco Control (WHO, 2017). However, many of these countries still fail to legally comply with guidelines set out by the FCTC. With the tobacco epidemic currently impacting Africa, Tumwine (2011) emphasized the need for these countries to both implement and comply with all FCTC guidelines, including the MPOWER measures. This is vital at this stage as health systems in countries with lower incomes are unable to deal with the immense burden of both tobacco related illnesses and chronic diseases. To strengthen their tobacco control, sub-Saharan African countries must continue to implement MPOWER at higher levels, push back against the expanding tobacco industry and increase political action against this epidemic (Tumwine, 2011).

Various existing literature track compliance and implementation of these particular tobacco control strategies such as MPOWER but few look at their effects on smoking prevalence, especially in sub-Saharan African. Papers written by Dubray et al. (2015), Anderson et al. (2016), Gravely et al. (2017) and Ngo et al. (2017) looked at the effects of the MPOWER measures on smoking prevalence on a global scale. The first empirical analysis on this subject analyzed the effects of the measures on smoking by gender, with 59 countries for males and 56 countries for females for the period between 2006 and 2009 (Dubray et al., 2015). The analysis revealed that monitoring tobacco use decreased smoking prevalence by 1.07 percentage points for males and 1.04 percentage points for females. Furthermore, they found that raising taxes also decreased smoking by 0.95 percentage points for males and 0.41 for females. Anderson et al. (2016) looked at a combined policy score for all MPOWER measures. They found that implementation of the MPOWER measures significantly increased between the years 2007 and 2014. They also found a negative relationship between a higher policy score and smoking prevalence. To add to this, Gravely et al. (2017) conducted an association study with 126 countries over a 10 year period. The results showed that implementing an extra MPOWER measure to its highest level in addition to all others, is associated with a 1.57 percentage point decrease in smoking prevalence. Lastly, using a combined composite score for the MPOWER measures, Ngo et al. (2017) found that an increase in that score significantly decreased adult and male smoking prevalence by 0.2 and 0.3 percentage points, respectively but found no effect on female smoking prevalence.

In some ways, the articles on this particular topic are in agreement in terms of findings, concerns and limitations. Based on the findings from all of the articles mentioned above, there is an indication that there is a negative relationship between implementation of the MPOWER measures and smoking prevalence. These findings are based on analyses of a 3, 7 and 10-year period. However, the latest data that was used in these papers is 2015 and therefore, I aim to add data from 2016 as a new WHO Report on the Global Tobacco Epidemic has since then been published and made available. This paper also contributes to existing literature as it solely looks at low and middle income countries which have been mostly left out of previous analyses. Dubray et al. (2015) included mostly high income countries in their analysis as lower income countries lack smoking prevalence data due to insufficient surveys on smoking; a lack of data is a recurring impediment to this type of research. Nevertheless, Anderson et al. (2016), who looked at both low and middle income countries and high income countries, found that policy scores do affect countries with varying income levels differently. Furthermore, based on previous studies which find that particular tobacco interventions may have larger effects in low and middle income countries, Ngo et al. (2017) believe that their estimates of the effect of the measures on smoking may have been underestimated. They also call on future research to check how these measures affect countries that are at different stages of the tobacco epidemic. Therefore, with sub-Saharan Africa consisting of many low and middle income countries and being currently in the midst of a tobacco epidemic, it is of high relevance to study this topic.

The true effect of tobacco control on smoking prevalence and the estimates that the literature has found may differ due a number of reasons. These include the status of the MPOWER measures and the potential existence of non-MPOWER measures. Both Dubray et al. (2015) and Anderson et al. (2016) voice their concern that legislation of the MPOWER measures does not necessarily translate into their implementation. This is particularly relevant in Africa where a lack of political efforts and a growing tobacco industry impedes full compliance with the FCTC guidelines (Tumwine, 2011). Furthermore, there may be other tobacco control policies being implemented which are not part of the MPOWER measures but which may have affected the estimates found by past literature (Dubray et al., 2015; Gravely et al., 2017). For example, there may be other programs to reduce smoking or policies that are implemented on a sub-national level or even in rural areas. This calls for research on other tobacco reducing policies.

Even with a variety of variables and methods used, previous studies found similar negative effects of MPOWER on smoking prevalence. The first empirical analysis by Dubray et al. (2015) looked at each of the MPOWER measures separately but also as one combined score. Similarly, Anderson et al. (2016) and Ngo et al. (2017) used a combined score of all MPOWER measures. Gravely et al. (2017), on the other hand, looked at the change in the number of measures that were implemented at the highest level. Ngo et al. (2017) and Gravely et al. (2017) argued that as countries implement the MPOWER measures, each individual measure becomes highly collinear with the others and therefore a combined score is more suitable for this type of analysis. However, as sub-Saharan African countries have been much slower with the adoption and implementation of these measures, it may still be beneficial to check both the separate measures as well as the combined score.

Not only are there different ways to look at the changes in the MPOWER measures, there is also a divergence with regards to the method used to analyze their effects on smoking prevalence. Whereas Anderson et al. (2016) and Gravely et al. (2017) used linear regressions, Dubray et al. (2015) used fixed effects regressions and Ngo et al. (2017) used fractional logit regressions with a two-way fixed effects model. Comparing smoking prevalence between two points in time with a linear regression would only result in associations between changes in MPOWER measures and smoking prevalence. This is the case because when looking at many different countries, there is a great number of variables that differ between them that are not taken into account, therefore, linear regressions result only in association. Dubray et al. (2015) used a fixed effects regression; this overcomes some limitations of the ordinary least squares linear regression methodology. However, they looked at a short time period from 2006 to 2009 and were not able to fully control for country specific unobservable effects (Ngo et al., 2017). Ngo et al. (2017), on the other hand, using a longer time span and applying a two-way fixed effects methodology and falsification test came the closest to establishing a causal impact of the MPOWER measures on smoking. Therefore, I will be using certain parts of Ngo et al.’s (2017) methodology for this analysis.

To conclude, as said earlier, findings from previous studies are in accordance with each other that there is a negative association between the MPOWER measures and smoking prevalence. There is also evidence that there are varying effects of the MPOWER measures in countries with different income levels. Therefore, I will be analyzing these effects in low and middle income countries in sub-Saharan Africa as most of the literature looks at higher income countries. Additionally, as found by Dubray et al. (2015) and Ngo et al. (2017) with a fixed effects methodology, there is a negative relationship between a combined score of the MPOWER measures and smoking prevalence. With the incorporation of parts of the methodology in the study by Ngo et al. (2017), I aim to move in the direction of establishing a causal relationship between tobacco control measures as outlined by the FCTC and smoking prevalence in sub-Saharan African countries between the years 2010 and 2016.

Data and Methodology

Data

MPOWER. Biennial data on the MPOWER measures of the FCTC for the years 2010, 2012, 2014 and 2016 were obtained from WHO reports on the Global Tobacco Epidemic. As mentioned earlier, MPOWER consists of six tobacco control measures:

M: monitoring tobacco use

P: protecting people from tobacco smoke

O: offer help to quit tobacco use

W: warn about the dangers of tobacco

E: enforce bans on tobacco advertising, promotion and sponsorship

R: raise taxes on tobacco

A particular country fits into a certain category for each of the measures for a given year. The M measure has four categories that range from data unavailability to the existence of recent, representative and periodic surveys to monitor tobacco use (WHO, 2011). For the other five measures (POWER), there are five categories for each that range from no data to the highest action possible for that measure. A detailed diagram of the categories for each measure can be found in Appendix A. As described by Dubray et al. (2015) and Ngo et al. (2017), a country scores 1 for having no data and 4 for full monitoring for measure M and scores between 1 and 5 for POWER[1]. Therefore, the minimum combined score obtainable for the measures is 6 (1 for each MPOWER category) and the maximum is 29 (4 for M and 5 for each POWER category). Missing values in measures P and E are due to the fact that the data provided to the World Health Organization was not backed up by legal proof of the legislation of the measures and was therefore inconsistent with the measures in other years.

Outcome Variable. The outcome variable for this analysis is smoking prevalence for individuals above the age of 15. Data on smoking prevalence was obtained from the World Bank Database for World Development Indicators. The World Bank receives estimates from the WHO based on various models and statistical methods. Smoking prevalence is defined as the percentage of individuals above the age of 15 who smoke, on a scale from 0 to 100. This data does not include smokeless tobacco use. Furthermore,

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[1] As described by the WHO in the Global Tobacco Epidemic Reports, various considerations must be taken into account when interpreting changes in R or tax share changes. R is defined as the share of total taxes in the retail price of the most widely sold brand of cigarettes; therefore, the tax share changes are dependent on both tax and price changes. For some countries, an increase in tax may result in a lower tax share or vice versa. For this reason, estimates for R may be different.

smoking prevalence percentages are age-standardized. To see effects of tobacco control measures on both genders, the dataset includes smoking prevalence rates for the total population, females and males. Due to a lack of data availability in developing countries, only 29 sub-Saharan countries were included in the analysis. The panel dataset consists of 116 observations, with 29 countries for 4 years.

Control Variables. Control variables included in this analysis are GDP per capita, GDP growth, the Human Development Index (HDI) and percentage of the population living in the urban and rural areas. Data on GDP per capita, GDP growth and proportion of those living in urban and rural areas were retrieved from the World Bank Database. Data on the HDI was extracted from the Human Development Reports published on the United Nations Development Programme website. GDP per capita at purchasing power parity (PPP) is in 2017 constant international dollars. GDP per capita may be correlated with the MPOWER measures as there may be an indication of the national economic capacity to implement these measures. Smoking prevalence and GDP per capita may also be correlated because as an economy grows and income increases, there may be more affordability of tobacco products. The proportion of people living in urban areas compared to rural areas was added to the analysis due to the earlier explained effects of urbanization on smoking. These control variables were chosen because they may be contributing factors to smoking prevalence. If this contribution is strong, an inclusion of these factors may reduce omitted variable bias and provide more precise estimates.

Descriptive Statistics.

Table 1

Descriptive Statistics

Variable	N	Mean	Standard Deviation	Min	Max
Score	113	17.6	3.4	11	26
M	116	2.2	0.8	1	4
P	115	2.8	1.1	1	5
O	116	3.2	0.8	2	5
W	116	3.0	1.2	2	5
E	114	3.4	1.2	2	5
R	116	2.9	0.8	1	5
Smoking Prevalence, Total	116	14.3	6.2	3.9	29.4

Smoking Prevalence, Female	116	3.4	3.1	0.1	13.7
Smoking Prevalence, Male	116	25.7	10.8	7.7	53.9
GDP per capita (PPP)	116	4921.0	5692.8	746.9	26063.4
GDP growth	116	5.3	3.4	-2.8	19.7
HDI	116	0.5	0.1	0.3	0.8
Urban	116	39.4	15.3	15.5	67.9
Rural	116	60.6	15.3	32.1	84.5

Notes: Smoking prevalence is a percentage on a scale from 0 to 100. GDP per capita (PPP) is in 2017 constant international dollars. HDI is on a scale from 0 to 1. Urban and Rural are a percentage on a scale from 0 to 100.

As seen in Table 1, over the seven years, the mean combined score of the MPOWER measures for the countries included in the analysis is 17.6. With a possible maximum combined score of 29, it can be seen that sub-Saharan African countries still need to adopt the measures at higher levels to increase the combined score. This can also be seen for each measure separately where the mean of each is below 4. As suggested by previous literature and seen in the descriptive statistics above, mean smoking prevalence among men is more than 7 times than that of the mean female smoking prevalence. As many countries of sub-Saharan Africa are classified as developing, the HDI for these countries is low. Furthermore, in these 29 sub-Saharan African countries, more people live in rural areas than in urban areas.

Figure 1 presents sub-Saharan Africa's progress in implementing MPOWER measures from 2010 to 2016.

Figure 1. Combined Mean Score Between 2010 and 2016 for 29 Sub-Saharan African Countries.

It can be seen that there has been an increase in the mean of the combined score of MPOWER measures for the 29 sub-Saharan African countries included in the analysis. However, this was a small change in implementation of the full MPOWER measures after six years. Furthermore, as the confidence intervals of the mean combined score in 2010 and the one in 2016 overlap, this provides evidence that the increase in the mean score was not statistically significant. Similarly, as found by Anderson et al. (2016), the African region is behind other regions in the legislation and implementation of the measures.

To visualize progress in implementation of each MPOWER measure individually, Figure 2 presents changes in each measure from the year 2010 to 2016.

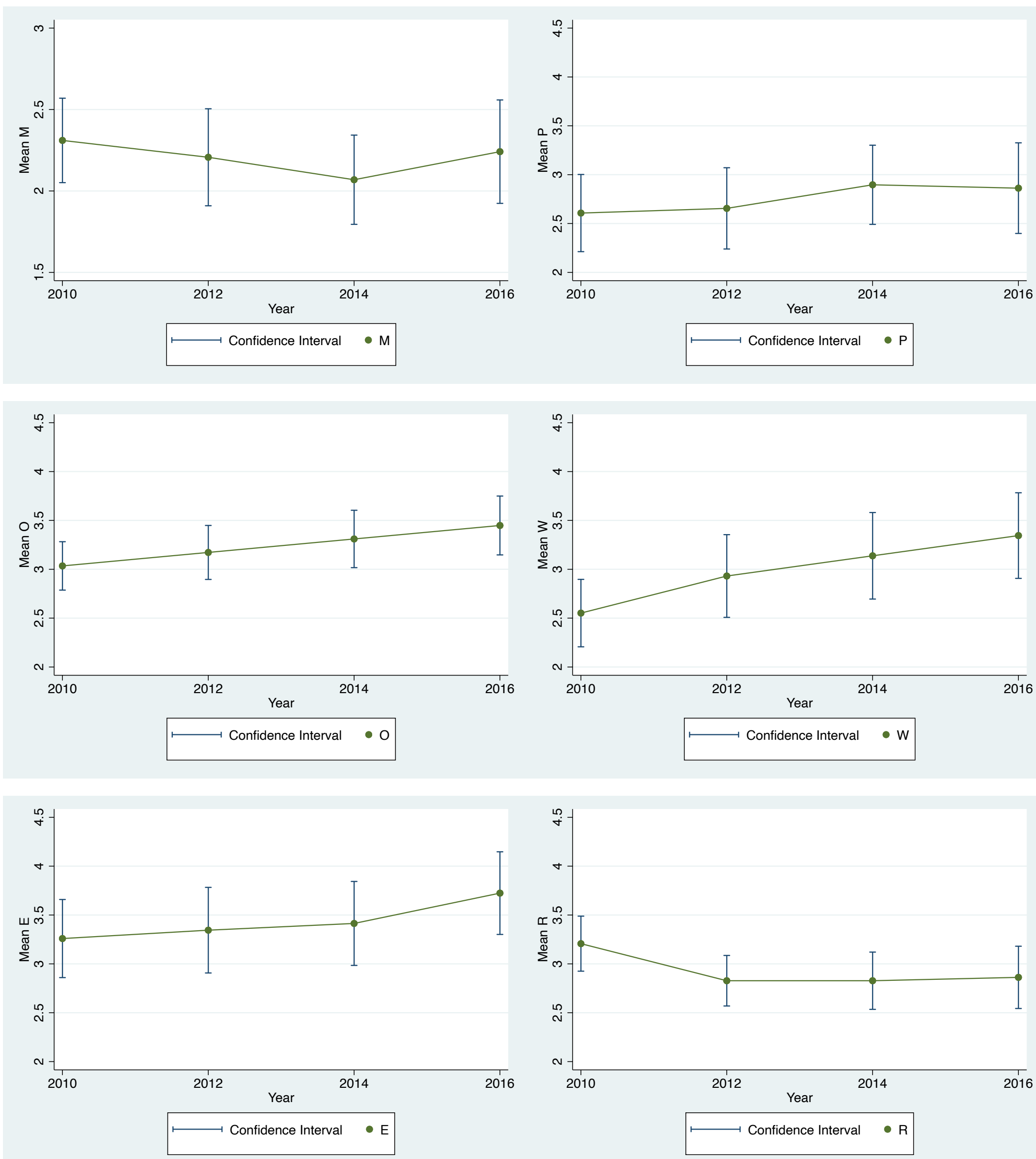


Figure 2. Mean M, P, O, W, E, R Scores Between 2010 and 2016 for 29 Sub-Saharan African Countries.

Measures O, W and E have a clear upward trend from the year 2010 to 2016. As described in Footnote 1, the drop in the score for measure R from 2010 to 2012 may be explained by a change in either price and/or tax that change the share of total taxes in the retail price of the most widely sold brand of cigarettes. As seen from the overlap of confidence intervals from 2010 to 2016, none of the changes in the MPOWER measures were statistically significant.

Methodology

Model Specification. The main analysis of this paper explored the relationship between the combined score of MPOWER measures and smoking prevalence in sub-Saharan Africa with the use of a fixed effects (FE) model. The combined MPOWER score was calculated as described in the MPOWER section. An ordinary least squares (OLS) regression with year dummies was used as the baseline analysis. For the two-way fixed effects model, the following specification with country and year specific effects was used:

Equation 1.

$$TotalSmokingPrev_{it} = \beta_0 + a_i + \beta_1 score_{it} + ControlVariables_{it} + \gamma_t + \varepsilon_{it},\ i = 1, \ldots, 29\ , t = 2010, 2012, 2014, 2016$$

where $TotalSmokingPrev_{it}$ is the smoking prevalence of a country i in year t, β_0 is the constant, a_i is the country specific effect, β_1 is the fixed effect estimator, $score_{it}$ is the combined MPOWER score for country i in year t, γ_t is the year dummy and ε_{it} is the error term.

In this analysis, the fixed effect estimator was obtained by looking specifically at within country variation. As mentioned in the study of Ngo et al. (2017), a limitation of the paper by Dubray et al. (2015) was that it was not able to fully control for country specific effects. Therefore, country fixed effects were vital to this analysis because there are various time-invariant characteristics that may have affected smoking prevalence in each country. These characteristics include but are not limited to culture, religion, geographical location and climate. Additionally, this analysis controlled for year specific effects with the use of year dummies. These were added as there are characteristics such as GDP per capita, GDP growth and HDI that vary through time and matter for the analysis.

Furthermore, to investigate the effectiveness of each of the MPOWER measures on smoking prevalence, each measure was included as a regressor in the fixed effects model.

Equation 2.

$$TotalSmokingPrev_{it} = \beta_0 + a_i + \beta_1 M_{it} + \beta_2 P_{it} + \beta_3 O_{it} + \beta_4 W_{it} + \beta_5 E_{it} + \beta_6 R_{it} + ControlVariables_{it} + \gamma_t + \varepsilon_{it}, \ i = 1, \dots, 29, t = 2010, 2012, 2014, 2016$$

where $TotalSmokingPrev_{it}$ is the smoking prevalence of a country i in year t, β_0 is the constant, a_i is the country specific effect, β is the fixed effect estimator, each MPOWER measure is included as a regressor for country i in year t, γ_t is the year dummy and ε_{it} is the error term.

To check for gender heterogeneity of effects of the score and each MPOWER measure, the outcome variable was changed to either female or male smoking prevalence in Equation 1 and Equation 2. In all analyses, standard errors were clustered at the country level to control for heteroskedasticity and auto-correlation.

Placebo Tests. To check the robustness of the results, placebo tests were run. This robustness check is similar to that of Ngo et al. (2017) who did a falsification test. Lead variables (t+1) of the score and each MPOWER measure were created. Then, Equation 1 and Equation 2 were modified that the independent variables, namely the score and each MPOWER measure were replaced by their leads, or future values. Regressing smoking prevalence on the future combined score and each measure helps to determine if there is a problem of endogeneity because if there is a significant relationship between the future score and current smoking prevalence, endogeneity may be present. However, if the relationship is not significant then there is a stronger indication of a causal relationship.

Results

Effects of Combined MPOWER Score on Total Smoking Prevalence

To investigate the relationship between the combined MPOWER score of a country and its smoking prevalence, an OLS and fixed effects model were run. An OLS regression without country dummies was used as the baseline to compare effects found in the FE model as specified in Equation 1.

Table 2

Effects of Combined MPOWER Score on Total Smoking Prevalence using OLS and FE

Variable	OLS	FE
Score	-0.522**	-0.051
	(0.187)	(0.040)
Country FE	No	Yes
Year FE	Yes	Yes
Constant	23.589**	-23.190*
Observations	113	113
Adjusted R^2	0.212	0.257

Notes: p-values are as follows: p<0.1*, p<0.05**, p<0.001***. Standard errors are in parentheses and were clustered by country for the FE model. Country FE are country fixed effects and Year FE are the year fixed effects. The model controlled for GDP per capita, GDP growth, HDI and population living in urban/rural areas.

As seen in Table 2, the OLS model suggests that a one point increase in the combined MPOWER score is associated with a 0.522 percentage point decrease in smoking prevalence. Furthermore, this estimate is statistically significant at the 5 percent significance level. The fixed effects model, however, provides countering evidence. The estimate from FE model shows that a one point increase in the score led to a decrease of 0.051 percentage points in smoking prevalence within the 29 sub-Saharan African countries included in the analysis. This coefficient is both small and statistically insignificant.

The large difference between the coefficients between the OLS and FE models gives an indication that country specific effects are important for the analysis. The large and significant estimate provided by the OLS model suggests that there is an upward bias in deterring effects of the MPOWER measures. In the OLS model, country specific effects are omitted and therefore may cause omitted variable bias which leads to a coefficient which is both biased and inconsistent. A fixed effects model is able to control for these country specific time-invariant omitted variables which have an effect on the outcome variable and are correlated with the independent variable. An example of such variables are culture and religion. In sub-Saharan African countries, both cultural and religious factors are important in determining both smoking prevalence and to what extent smoking is accepted (Brathwaite et al., 2015). Furthermore, these factors have a relationship with both the implementation and effectiveness of policies such as the MPOWER measures that intend to decrease smoking prevalence (Brathwaite et al., 2015). Therefore, once these factors are taken into account in the fixed effects model, the estimate becomes minor and insignificant suggesting that cultural and religious factors can have a detrimental impact on the intended effects of the

MPOWER measures. This may explain the reason that some countries which have a higher MPOWER score, see smaller effects on smoking prevalence as seen in the insignificant coefficient of the FE model.

Gender Heterogeneity of Effects of Combined MPOWER Score on Smoking Prevalence

To check for gender heterogeneity of effects of the combined MPOWER score on smoking prevalence, fixed effects regressions similar to those in Equation 1 with female and male smoking prevalence as the outcome variable were run. The results are presented in Table 3.

Table 3

Effects of Combined MPOWER Score on Female and Male Smoking Prevalence

Variable	Female	Male
Score	0.034	-0.135*
	(0.023)	(0.073)
Country FE	X	X
Year FE	X	X
Constant	-2.474	-44.480*
Observations	113	113
Adjusted R^2	0.479	0.187

Notes: p-values are as follows: p<0.1*, p<0.05**, p<0.001***. Standard errors were clustered by country and are in parentheses. Country FE are country fixed effects that were added to the model as well as Year FE which are the year fixed effects. The model controlled for GDP per capita, GDP growth, HDI and population living in urban/rural areas.

Only one significant result was found when checking for gender heterogeneity of effects of the combined MPOWER score on smoking prevalence. In the regression of male smoking prevalence on the combined score, controlling for GDP per capita, GDP growth, HDI and urban and rural ratio, the coefficient is -0.135 and statistically significant at the 10 percent significance level. This is an indication that within the 29 countries that are included in the analysis, a one point score increase in the combined score decreased male smoking prevalence by 0.135 percentage points. For the female analysis, the coefficient of 0.034 is both small and statistically insignificant. This suggests that an increase in the score did not have a significant effect on female smoking prevalence in the sub-Saharan African countries. The lack of any effect on female smoking prevalence may be explained by the fact that female smoking rates are much lower than male rates in sub-Saharan Africa.

Effects of Each MPOWER Measure on Total Smoking Prevalence

To investigate the effects of each of the MPOWER measures on total smoking prevalence, the regression depicted in Equation 2 was run. The results of this regression are presented in Table 4.

Table 4

Effects of Each MPOWER Measure on Total Smoking Prevalence

Variable	Total
M	-0.060
	(0.139)
P	-0.046
	(0.133)
O	-0.019
	(0.109)
W	-0.049
	(0.080)
E	0.015
	(0.109)
R	-0.177
	(0.133)
Country FE	X
Year FE	X
Constant	-23.171
Observations	113
Adjusted R^2	0.227

Notes: p-values are as follows: p<0.1*, p<0.05**, p<0.001***. Standard errors were clustered by country and are in parentheses. Country FE are country fixed effects that were added to the model as well as Year FE which are the year fixed effects. The model controlled for GDP per capita, GDP growth, HDI and population living in urban/rural areas.

In the regression of total smoking prevalence on each MPOWER measure, controlling for GDP per capita, GDP growth, HDI and urban and rural ratio, even though most negative, none of the coefficients were found to be statistically significant. The largest coefficient found is for the measure R or tax share that suggests that a one point increase in the R score decreased total smoking prevalence by 0.177 percentage points. However, as this coefficient is not statistically significant, no conclusions can be made from this coefficient. The lack of significant results for each MPOWER measure may be explained by several reasons. Firstly, statistical insignificance of effects of the measures may show that individually MPOWER measures did not have a true impact on total smoking in the 29 sub-Saharan African countries from 2010 to 2016. Secondly, even though it was useful to look at the effects of each of the MPOWER measures separately, potential collinearity between them that was voiced as a concern by Ngo et al. (2017) may have resulted in underestimation of these effects.

Gender Heterogeneity of Effects of Each MPOWER Measure on Smoking Prevalence

To check effects of each MPOWER measure on female and male smoking prevalence, fixed effects regressions similar to those in Equation 2 with female and male smoking prevalence as the outcome variable were run.

Table 5

Effects of Each MPOWER Measure on Female and Male Smoking Prevalence

Variable	Female	Male
M	0.121	-0.240
	(0.123)	(0.192)
P	-0.010	-0.066
	(0.073)	(0.247)
O	0.047	-0.123
	(0.070)	(0.224)
W	-0.080	-0.005
	(0.065)	(0.131)
E	0.117*	-0.110
	(0.066)	(0.216)
R	0.014	-0.342
	(0.074)	(0.221)
Country FE	X	X
Year FE	X	X
Constant	-3.942	-42.852
Observations	113	113
Adjusted R^2	0.506	0.157

Notes: p-values are as follows: p<0.1*, p<0.05**, p<0.001***. Standard errors were clustered by country and are in parentheses. Country FE are country fixed effects that were added to the model as well as Year FE which are the year fixed effects. The model controlled for GDP per capita, GDP growth, HDI and population living in urban/rural areas.

Only one statistically significant coefficient was found for female smoking prevalence. This result suggests that within the 29 sub-Saharan African countries used in the analysis, a one point increase in the measure E increased female smoking by 0.117 percentage points. However, an increase in smoking prevalence is the opposite of the desired effect of the MPOWER measures. A possible explanation of this finding, which was mentioned earlier, is similar to that of Ngo et al. (2017) because all measures being included as individual regressors may lead to collinearity between them. For example, the negative effects that measure E may possibly have, may have been already captured in the negative effect of measure P or W. However, as all other measures have a positive coefficient but are not significant, this may suggest the individual measures did not have the indented effect on female smoking and that smoking prevalence of this population is increasing regardless of implementation of individual measures. Furthermore, as seen in Table 5, the largest effects on male smoking prevalence were from measures M and R with a coefficient of -0.240 and -0.342, respectively. However, none of the MPOWER measures had a statistically significant effect on male smoking prevalence in the 29 sub-Saharan African countries.

Placebo Tests

Placebo tests were run to check for endogeneity. As statistically significant effects of the combined MPOWER score were found for male smoking prevalence in Table 3, the placebo test for that regression are presented in Table 6. The rest of the placebo tests are presented in Appendix B.

Table 6

Placebo Test: Effects of Future Combined MPOWER Score on Current Male Smoking Prevalence

Variable	Male
Future Score	-0.176*
	(0.103)
Country FE	X
Year FE	X
Constant	-36.521
Observations	87
Adjusted R^2	0.048

Notes: p-values are as follows: p<0.1*, p<0.05**, p<0.001***. Standard errors were clustered by country and are in parentheses. Country FE are country fixed effects that were added to the model as well as Year FE which are the year fixed effects. The model controlled for GDP per capita, GDP growth, HDI and population living in urban/rural areas.

It was found that the future MPOWER score had a significant effect on current male smoking prevalence. This gives an indication that there may be a problem of endogeneity in this analysis. As endogeneity suggests that the independent variable and the error term are correlated, this may mean that there are time-varying omitted variables that are important for the analysis which were not included. This is discussed in more detail in the next section.

Discussion

Progress of the implementation of the MPOWER package in 29 of the sub-Saharan African countries for the period between 2010 and 2016 has been minor. As seen from Figure 1, the mean combined MPOWER score increased by less than two points. This increase in score was both small and insignificant. Furthermore, changes in each of the MPOWER measures were statistically insignificant. These countries have not been able to follow the World Health Organizations recommendation to fully follow the FCTC guidelines by implementing each MPOWER measure at its highest level. This may be due to the reason that low and middle income countries such as the ones sub-Saharan Africa suffer from multiple economics tradeoffs which deter the full implementation of tobacco control policies. Furthermore, the small increase in the MPOWER score may be explained by various factors that pose a threat to the implementation of these measures such as the lack of national capacity for implementation and tobacco industry activity within the area (Anderson et al., 2016).

The lack of a significant increase in the MPOWER score may be one of the explanations for the minor effects of MPOWER found on total smoking prevalence. Whereas, Ngo et al. (2017) found that increasing the MPOWER score reduces adult smoking rates by 0.2 percentage points, this study found a much smaller and insignificant effect. As shown in Table 2, the coefficient from the fixed effects model suggests that an increase of one point in the combined MPOWER score decreased total smoking prevalence by 0.051 percentage points in the 29 sub-Saharan African countries between 2010 and 2016. However, as this result was statistically insignificant, this study found that in these countries, MPOWER did not have a significant effect on total smoking prevalence for that time period. As culture and religion are strong determinants of smoking prevalence in this area, the MPOWER measures may not have had as large of an effect as found by previous studies. However, because the fixed effects model creates one constant for each country for all time-invariant unobservable variables, effects of culture and religion cannot be estimated.

Even though no significant effect was found of the MPOWER score on total smoking prevalence, a significant effect was when smoking prevalence was separated by gender. The results indicate that an increase in MPOWER score significantly decreased male smoking prevalence by 0.135 percentage points in sub-Saharan Africa. This coefficient was found to be -0.3 in the study by Ngo et al. (2017). Ngo et al. (2017) mention previous studies that found larger effects of MPOWER-like measures in low and middle income countries compared to higher income countries. However, in the 29 sub-Saharan African low and middle income countries, the coefficient of 0.135 found in this study is smaller than of that found in Ngo et al. (2017). This may be due to the fact that increases in MPOWER score in this region may not translate into large drops in smoking prevalence because of factors such culture and religion as mentioned earlier. Furthermore, as mentioned by Anderson et al. (2016), legislation does not translate into implementation and therefore even if there was an increase in the MPOWER score, this may not mean the measure was implemented leading to small changes in smoking prevalence. Nevertheless, it was found that in this region, male smoking prevalence significantly decreased with a higher MPOWER score.

However, as found from the robustness check, this analysis may have suffered the problem of endogeneity where the independent variable, MPOWER, and the error term may be correlated. The error term may include time-varying omitted variables which due to data unavailability, were not included in the analysis. For a fixed effects model to provide unbiased estimates, these time-varying unobservable characteristics must be included in the regression as control variables. An example of such an omitted variable is tobacco industry growth and activity within sub-Saharan African countries. The tobacco industry and the MPOWER measures may be correlated as tobacco companies lobby policy makers to weaken tobacco control policies, expand and increase their presence in the region (Tumwine, 2011). Furthermore, the tobacco industry has been able to impact smoking rates not only through weak tobacco policy implementation. Market expansion of these companies into Africa increased cigarette use by 33% (Lee, Ling, & Glantz, 2012). The expansion has also made cigarettes both more accessible and affordable for people in this region (Gilmore, Fooks, Drope, Bialous, & Jackson, 2015). By omitting tobacco industry strength from the analysis, MPOWER coefficients may indicate higher deterring effects of the tobacco control policies than they truly are.

Just like Ngo et al. (2017), this study found no relationship between the MPOWER score and female smoking prevalence. This could be due to the reason, as suggested by Ngo et al. (2017), that female smoking prevalence is much smaller than male smoking. This could particularly apply to sub-Saharan

Africa where the idea of women smoking is not seen as desirable and even disrespected (Brathwaite et al., 2015). The insignificance of the 0.034 coefficient may imply several things. Firstly, as mentioned earlier, an increase in the MPOWER score may not mean that the measures had actually been implemented and therefore that increase may not show intended effects on smoking prevalence. Secondly, time-varying omitted variables may be important for this analysis. However, as mentioned earlier in the study, there is evidence that smoking rates among women have been increasing in sub-Saharan Africa and therefore this relationship is ever more important to monitor and investigate in the coming years.

No significant relationship was found between the individual MPOWER measures and total and male smoking prevalence but only one significant result was found for the female analysis. Dubray et al. (2015) found that an increase in measures M and R decreases male smoking prevalence by 1.07 and 0.95 percentage points, respectively. The fixed effects analysis revealed that in the sub-Saharan African region, measures M and R had the largest coefficients of -0.240 and -0.342, respectively. However, neither of these were statistically significant. As for the female analysis, Dubray et al. (2015) found that an increase in M and R decreases female smoking prevalence by 1.04 and 0.41 percentage points, respectively. This study found only one significant effect for the individual MPOWER measures that suggests that a one point increase in the E measure increased female smoking prevalence by 0.117 percentage points. This result shows an effect in the opposite direction, namely a positive relationship which may be explained by the omission of tobacco industry activity from the analysis. Measure E aims to enforce bans on tobacco advertising, promotion and sponsorship but as the tobacco industry aims to do the opposite, the positive coefficient may be picking up this effect instead of providing the true effect of this measure. Gilmore, et al. (2015) found that the tobacco industry encourages women to promote cigarettes and smoking in general to quash cultural ideals and show that females smoking should be more accepted. In the end, it was difficult to establish a relationship between MPOWER and smoking prevalence when measures were looked at simultaneously.

Even though this study does consider some of the limitations of previous studies written on this topic, it has some limitations of its own. Firstly, although it is beneficial to look specifically at sub-Saharan African countries to see how MPOWER measures work in this area of the world, data coming from this area is often limited and not fully reliable. For this reason, it is difficult to estimate the true effects of the measures on smoking prevalence. Secondly, this paper cannot confirm causality due to the potential issue of endogeneity. However, by carrying out a methodology that is able to address some of the limitations of previous studies, this study was able to get closer to establishing causal effects. As mentioned earlier, omitted variable bias from time-varying variables that were not controlled for may have biased the fixed effects estimators. In this particular study, other possible omitted variables for the analysis apart from tobacco industry may be cigarette prices and non-MPOWER policies that are correlated with both MPOWER measures and smoking prevalence within these particular countries. Lastly, the data on smoking prevalence from the World Bank was only available for the years 2010 to 2016 and therefore effects over a longer time period were not able to be estimated.

Limitations and findings of this study create opportunities for further research. To address the limitation of data unavailability, researchers may need to do thorough searches to find data. On top of this, interviewing key figures within countries may increase reliability of the data obtained. A suggestion for further research is to look at the effects of the composite score on smoking prevalence in all sub-Saharan countries as a whole to get a more representative picture of its effects in this region. Lastly, with the finding of gender heterogeneity in the effects of MPOWER on smoking prevalence, future studies should look at the effects by gender as these may be masked when looking at the effect on total smoking prevalence.

Conclusion

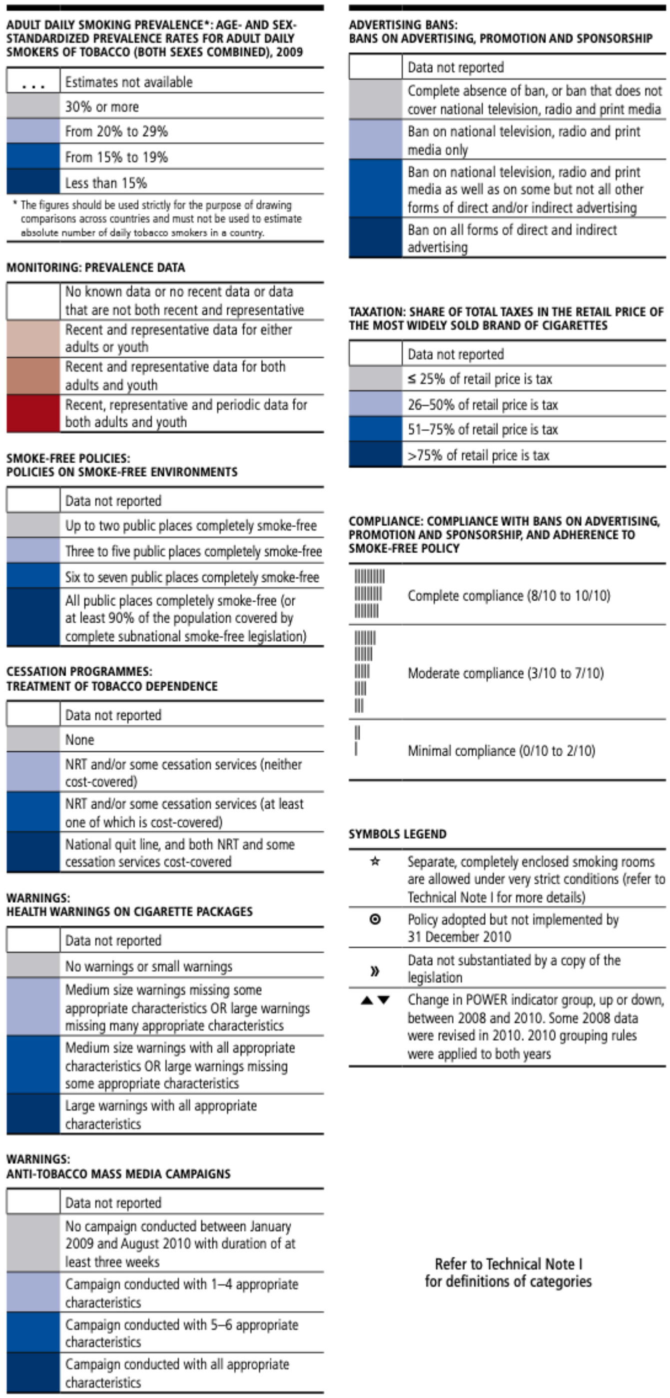
This paper aimed to investigate the effects of the WHO suggested MPOWER measures on smoking prevalence in sub-Saharan Africa by answering the research question, "To what extent has the implementation of the MPOWER measures of the Framework Convention on Tobacco Control affected smoking prevalence in sub-Saharan Africa from 2010 to 2016?" From the analysis conducted, I found that the combined MPOWER score did not have a significant effect on total smoking prevalence in 29 sub-Saharan African countries and therefore, my hypothesis that MPOWER decreased smoking prevalence was rejected. However, when looking at gender heterogeneity of effects of the score, the analysis revealed that MPOWER significantly decreased male smoking prevalence but had no significant effect on female smoking prevalence. Looking at each of the MPOWER measure separately, only one significant result was found which indicated an increase in E had a positive effect on female smoking prevalence. Therefore, the answer to the research question is that the implementation of the MPOWER package, as a whole, of the Framework Convention on Tobacco Control somewhat negatively affected male smoking prevalence but had no significant effect on total or female smoking prevalence, in sub-Saharan Africa from 2010 to 2016. However, as mentioned earlier, it is important to note that legislation and implementation are not the same thing which can be seen as a limitation. Nevertheless, this study contributes to existing literature in the fact that it was able to analyze the MPOWER effects in a new setting where the tobacco epidemic is only becoming more visible.

The findings of this study present some policy implications. The result that an increase in the MPOWER measures as a whole decreased smoking prevalence amongst males in the 29 countries analyzed gives indication that the MPOWER package may truly be an evidence based tool that can help countries lower their smoking rates. However, in this study the negative and significant result is found only for the male population and the effects estimated are smaller than in previous studies. The insignificant effects found on female smoking prevalence may be an indication that small increases in MPOWER score or solely legislation do not lead to the intended effects of the MPOWER package. Therefore, these sub-Saharan African countries may require an increase in capacity to fully implement these measures at their highest levels as the WHO states that impacts of the measures are best when implemented fully. With higher levels of implementation, countries may experience even lower smoking rates which would in turn decrease mortality from non-communicable diseases and alleviate the burden on health care systems. Furthermore, the finding that measure E increased female smoking prevalence may be an indication that expansion and strength of the tobacco industry in sub-Saharan African countries is a major barrier for tobacco control policies such as MPOWER.

There are a number of ideas and recommendations for further research. Firstly, as the tobacco industry is currently a prevalent player on the markets in sub-Saharan Africa, further research into their activity and impact on policy implementation and smoking prevalence would reduce the omitted variable bias mentioned earlier and give less biased estimates of the effects of MPOWER. Secondly, it may be insightful to look at the effects of non-MPOWER measures being implemented in sub-Saharan Africa. These policies may be detrimental to the effects the MPOWER measures are trying to have and yet, on the other hand, they may only ameliorate these effects when implemented in combination with MPOWER. Lastly, to get more insight into the relationship between the MPOWER measures and smoking prevalence in countries with lower incomes, it may be beneficial to look at other low and middle income countries outside of the African region.

Appendix A

Categories of Each MPOWER Measure



ADULT DAILY SMOKING PREVALENCE*: AGE- AND SEX-STANDARDIZED PREVALENCE RATES FOR ADULT DAILY SMOKERS OF TOBACCO (BOTH SEXES COMBINED), 2009

. . .	Estimates not available
	30% or more
	From 20% to 29%
	From 15% to 19%
	Less than 15%

* The figures should be used strictly for the purpose of drawing comparisons across countries and must not be used to estimate absolute number of daily tobacco smokers in a country.

MONITORING: PREVALENCE DATA

	No known data or no recent data or data that are not both recent and representative
	Recent and representative data for either adults or youth
	Recent and representative data for both adults and youth
	Recent, representative and periodic data for both adults and youth

SMOKE-FREE POLICIES: POLICIES ON SMOKE-FREE ENVIRONMENTS

	Data not reported
	Up to two public places completely smoke-free
	Three to five public places completely smoke-free
	Six to seven public places completely smoke-free
	All public places completely smoke-free (or at least 90% of the population covered by complete subnational smoke-free legislation)

CESSATION PROGRAMMES: TREATMENT OF TOBACCO DEPENDENCE

	Data not reported
	None
	NRT and/or some cessation services (neither cost-covered)
	NRT and/or some cessation services (at least one of which is cost-covered)
	National quit line, and both NRT and some cessation services cost-covered

WARNINGS: HEALTH WARNINGS ON CIGARETTE PACKAGES

	Data not reported
	No warnings or small warnings
	Medium size warnings missing some appropriate characteristics OR large warnings missing many appropriate characteristics
	Medium size warnings with all appropriate characteristics OR large warnings missing some appropriate characteristics
	Large warnings with all appropriate characteristics

WARNINGS: ANTI-TOBACCO MASS MEDIA CAMPAIGNS

	Data not reported
	No campaign conducted between January 2009 and August 2010 with duration of at least three weeks
	Campaign conducted with 1–4 appropriate characteristics
	Campaign conducted with 5–6 appropriate characteristics
	Campaign conducted with all appropriate characteristics

ADVERTISING BANS: BANS ON ADVERTISING, PROMOTION AND SPONSORSHIP

	Data not reported
	Complete absence of ban, or ban that does not cover national television, radio and print media
	Ban on national television, radio and print media only
	Ban on national television, radio and print media as well as on some but not all other forms of direct and/or indirect advertising
	Ban on all forms of direct and indirect advertising

TAXATION: SHARE OF TOTAL TAXES IN THE RETAIL PRICE OF THE MOST WIDELY SOLD BRAND OF CIGARETTES

	Data not reported
	≤ 25% of retail price is tax
	26–50% of retail price is tax
	51–75% of retail price is tax
	>75% of retail price is tax

COMPLIANCE: COMPLIANCE WITH BANS ON ADVERTISING, PROMOTION AND SPONSORSHIP, AND ADHERENCE TO SMOKE-FREE POLICY

	Complete compliance (8/10 to 10/10)
	Moderate compliance (3/10 to 7/10)
	Minimal compliance (0/10 to 2/10)

SYMBOLS LEGEND

☆	Separate, completely enclosed smoking rooms are allowed under very strict conditions (refer to Technical Note I for more details)
⊙	Policy adopted but not implemented by 31 December 2010
»	Data not substantiated by a copy of the legislation
▲▼	Change in POWER indicator group, up or down, between 2008 and 2010. Some 2008 data were revised in 2010. 2010 grouping rules were applied to both years

Refer to Technical Note I
for definitions of categories

Figure A1. Categories of Each MPOWER Measure. Reprinted from *WHO report on the global tobacco epidemic 2011, Warning about the dangers of tobacco*, by World Health Organization, 2011, retrieved from https://www.who.int/tobacco/global_report/2011/en/ Copyright 2011 by World Health Organization.

Appendix B

Placebo Tests for Effects of the Combined MPOWER Score on Total and Female Smoking Prevalence

Table B1

Placebo Test: Effects of Future Combined MPOWER Score on Current Total and Female Smoking Prevalence

Variable	Total	Female
Future Score	-0.086	0.012
	(0.056)	(0.016)
Country FE	X	X
Year FE	X	X
Constant	-15.460	2.617
Observations	87	87
Adjusted R^2	0.062	0.426

Notes: p-values are as follows: p<0.1*, p<0.05**, p<0.001***. Standard errors were clustered by country and are in parentheses. Country FE are country fixed effects that were added to the model as well as Year FE which are the year fixed effects. The model controlled for GDP per capita, GDP growth, HDI and population living in urban/rural areas.

Placebo Tests for Effects of Each MPOWER Measure on Total, Female and Male Smoking Prevalence

Table B2

Placebo Test: Effects of Each MPOWER Measure on Current Total, Female and Male Smoking Prevalence

Variable	Total	Female	Male
Future M	-0.113	0.071	-0.301
	(0.159)	(0.103)	(0.264)
Future P	-0.021	-0.004	-0.021
	(0.090)	(0.079)	(0.159)
Future O	0.127	0.072	0.174
	(0.157)	(0.090)	(0.302)
Future W	-0.179	-0.128	-0.220
	(0.159)	(0.099)	(0.259)
Future E	-0.027	0.116	-0.153
	(0.084)	(0.070)	(0.180)
Future P	-0.183	0.013	-0.369
	(0.217)	(0.058)	(0.376)
Country FE	X	X	X
Year FE	X	X	X
Constant	-19.227	-1.390	-39.760
Observations	87	87	87
Adjusted R^2	0.017	0.462	-0.002

Notes: p-values are as follows: p<0.1*, p<0.05**, p<0.001***. Standard errors were clustered by country and are in parentheses. Country FE are country fixed effects that were added to the model as well as Year FE which are the year fixed effects. The model controlled for GDP per capita, GDP growth, HDI and population living in urban/rural areas.

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