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Stéphane Verguet
Department of Global Health, University of Washington

Cindy Gauvreau
Centre for Global Health Research, Saint Michael's Hospital and University of Toronto

Sujata Mishra
Centre for Global Health Research, Saint Michael's Hospital and University of Toronto

Mary MacLennan
Centre for Global Health Research, Saint Michael's Hospital and University of Toronto

Shane Murphy
Department of Global Health, University of Washington

Elizabeth Brouwer
Department of Global Health, University of Washington

Carol E. Levin
Department of Global Health, University of Washington

Rachel A. Nugent
Department of Global Health, University of Washington

Dean T. Jamison
Department of Global Health, University of Washington

Prabhat Jha
Centre for Global Health Research, Saint Michael's Hospital and University of Toronto

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by

Stéphane Verguet,[1*] Cindy Gauvreau,[2] Sujata Mishra,[2] Mary MacLennan,[2]

Shane Murphy,[1] Elizabeth Brouwer,[1] Carol E. Levin,[1] Rachel A. Nugent,[1]

Dean T. Jamison,[1] Prabhat Jha[2]

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Abstract

Tobacco taxation improves population health and increases government revenues, but has been criticized for being regressive. This paper examines the distributional consequences (across wealth quintiles) of a tax hike on tobacco products in China in terms of both financial and health outcomes. We use methods of extended cost-effectiveness analysis (ECEA), to estimate, across income quintiles, the health benefits, the net change in tax revenues, the net financial consequences for households, and the financial risk protection provided to households, caused by an increase in tobacco price of 50% through excise tax. Using plausible values for key parameters, including an average price elasticity of demand for tobacco of - 0.4, and considering only the male population, which constitutes the overwhelming majority of smokers in China, a 50% increase in tobacco price through excise tax over fifty years would lead to substantial years of life gained (about a third among the poorest), and substantial additional tax revenues (less than a tenth among the poorest). The increased tax would increase overall household expenditures on tobacco, but decrease these expenditures in the poorer and the poorest, and would provide insurance principally concentrated among the poorest.

[1]Department of Global Health, University of Washington, Seattle, WA, USA.
[2]Centre for Global Health Research (CGHR), Saint Michael's Hospital and University of Toronto, Toronto, ON, Canada.
*Correspondence to: Stéphane Verguet, verguet@uw.edu.

Introduction

Many low- and middle-income countries, such as China, have experienced an epidemiological transition, shifting from communicable to non-communicable diseases (IHME 2013), which imposes a growing economic burden on these countries (Bloom et al 2011; Jha et al. 2013). Behavioral changes have accelerated rapidly in China, including high rates of male smoking (Yang et al. 2008). In 2010, China's leading causes of death were stroke (1.7 million deaths), ischemic heart disease (950,000 deaths) and chronic obstructive pulmonary disease (COPD) (930,000 deaths) (Yang et al. 2013). In the same year, deaths attributable to smoking were estimated at 5,700,000 worldwide, 3,700,000 in low- and middle-income countries, and 1,200,000 in China alone (IHME 2013).

The economic costs of smoking are substantial. In 2000, China's tobacco-related economic costs were estimated at $5.0 billion (Sung et al. 2006). Smoking-related expenditures can push a significant proportion of low-income families into poverty. Tobacco-related medical spending and tobacco consumption spending combined were estimated to impoverish 31 million urban residents and 24 million rural residents in China (Liu et al. 2006).

In 2009, China launched a $130 billion 3-year health reform plan, with the goals of achieving universal health coverage (UHC) by 2020 and preventing medical impoverishment (Yip et al. 2012). While tax increases are most effective to reduce demand for tobacco and healthcare costs (Chaloupka et al. 2011), they can also raise revenues and support health financing (WHO, 2010; Jha et al. 2012). Tax comprises about two thirds of retail price of cigarettes in most high income countries but less than half of the total price in most low- and middle-income countries, such as China (Jha and Chaloupka, 2000).

A traditional view is that excise taxes, such as tobacco taxes, are regressive, that is to say the poor pay a higher share of their income in taxes than do the rich (Stiglitz 2000), an important concern for policymakers (Warner 2000). Tobacco taxation can be distributed regressively, but still considered progressive, as progressivity is sensitive to the way in which taxation burden is assessed (Remler 2004). A tax increase may not actually be regressive because the poor are usually more price responsive than the rich (Warner 2000; Chaloupka 1991; Townsend et al. 1994; Farrely et al. 1998).

Despite the controversy of tax progressivity, little work has examined the distributional consequences of increased tobacco taxation in low- and middle-income countries (Jha et al. 2012). Using extended cost-effectiveness analysis (ECEA) methods (Verguet et al. 2012; Verguet et al. 2013), we study a hypothetical increased excise tax which would raise the total price of tobacco by 50% in China. In the Chinese smoking male population (the overwhelming majority of smokers in China; 53% of men are smokers compared to 2% of women) (GATS 2010), we estimate the distributional consequences (across income quintiles) of this hypothetical tax hike, in terms of: health benefits (years of life gained), net change in tax revenues, net change in expenditures on both tobacco products and tobacco-related disease (e.g. stroke) treatment, and the financial risk protection provided to households.

Methods

Model

Our modeling approach draws substantially from Jha et al. (2012). Because Chinese males comprise the vast majority of smokers in the country, this study focuses solely on the male population, which we follow dynamically over fifty years. The population is divided into five age groups: future smokers i.e. currently under 15 years of age (representing potential future smokers), between 15 and 24 years of age, between 25 and 44 years of age, between 45 and 64 years of age, and above 65 years of age; into income quintiles; and into two settings (urban vs. rural).

The introduction of a tax increase on tobacco products has five main consequences: i) it decreases the number of years of life lost due to tobacco upon smoking cessation; ii) it affects tax revenues as tobacco price increases and cigarette consumption changes; iii) it affects the household expenditures on tobacco depending on tobacco price increase and cigarette consumption changes; iv) it decreases expenditures on the treatment of tobacco-related disease as a consequence of the reduction in tobacco-related disease burden; v) it brings financial risk protection to households by preventing the medical expenditures related to the treatment of tobacco-related disease.

First, we estimate the number of years of life gained (YLG) due to the tax increase. Upon quitting, smokers gain a certain number of YLGs, depending on their age at cessation (Doll et al. 2004). We express YLGs as a function of age a at cessation. China's male life expectancy is currently 71 (WHO 2011). Hence, the number of YLGs is assumed to be realized 71 - a years after cessation. The number of quitters at a is related to the participation elasticity, assumed to be half of the price elasticity of demand for tobacco – price elasticity of demand for tobacco refers to the change in number of cigarettes purchased by a population when price changes.

Second, we estimate the net change in tax revenues. The annual change is related to the change in cigarette consumption (related to price elasticity), to the change in taxes per cigarette pack (from $0.30 to $0.67 here), and to the number of smokers in a given age group. Likewise, we estimate the net change in expenditures on tobacco, related to price elasticity, to the change of price per cigarette pack (from $0.74 to $1.11), and to the number of smokers in a given age group. The price elasticity is assumed to be twice as large among the youngest age groups (15-24 year-olds and the future smokers i.e. under 15 year-olds) (Jha et al. 2012).

Third, we estimate the net change in expenditures on treatment of tobacco-related disease, following the decreased number of tobacco-related deaths. The number of tobacco-related deaths averted is estimated, assuming that about 50% of smokers die of their addiction, and that this risk is reduced upon quitting by 98% in the 15-24 year-olds, 85% in the 25-44 year-olds, 75% in the 45-64 year-olds, and 25% in the above 65 year-olds (Jha et al. 2012). Subsequently, we attribute the share of these tobacco-related deaths due to cancer (neoplastic disease), stroke, ischemic heart disease, and chronic obstructive pulmonary disease (COPD), which are the four largest tobacco-related diseases in China (IHME 2013). Finally, based on the causes of death above, accounting for healthcare utilization, we assign treatment-related costs, to which we deduce the share reimbursed by insurance. Finally, using a money-metric value of insurance (Verguet et al. 2012), we quantify the financial risk protection provided to the households related to the decrease in the risk of expenditures on the treatment of tobacco-related disease.

The results are then aggregated by income quintile. All analyses are conducted using the R statistical software (www.r-project.org).

Model parameters

All model inputs can be found in Table 1. By necessity, many of our model parameters are the same across income quintiles in the male population, while others are specific to income quintiles. For example, smoking prevalence and intensity (cigarettes per day) increases marginally as income quintile decreases (GATS 2010).

One key driver of the analysis is the price elasticity of demand for tobacco in China by income quintile. While all income quintiles have a negative price elasticity of demand for tobacco, we assume that the poorest income quintile is the most price elastic; the other quintiles are progressively less price elastic (based on Mao et al. 2008).

Table 1. Inputs used in the modeling for the tobacco tax increase (50% price increase) in China.

Input	Value	Source
Male population	• 677 million	United Nations (2011) Authors' assumptions
Distribution per age group (% of population)	• Under 15: 18% • 15-24 year-olds: 17% • 25-44 year-olds: 33% • 45-64 year-olds: 24% • Above 65: 8%	United Nations (2011)
Distribution per setting (% of population)	• Rural: 49.5% • Urban: 50.5%	World Bank (2012)
Smoking prevalence per age group (% of population)	• 15-24 year-olds: 33.6% • 25-44 year-olds: 59.3% • 45-64 year-olds: 63.0% • Above 65: 40.2%	GATS China report (2010)
Relative smoking prevalence per income quintile	• Income quintiles I to IV: 1.14 times average per age group • Income quintile V: 0.86 times average per age group	Authors' assumption based on education levels in the GATS China report (2010)
Cigarette consumption (cigarettes per day) per income quintile	• Income quintile I to V: {15.6, 15.5, 13.8, 12.7, 12.7}	Authors' assumption based on education levels in the GATS China report (2010)
Price per pack (20 cigarettes) (2011 US$)	• $0.74 (before tax increase) • $1.11 (after tax increase)	Jha et al. (2012)'s assumptions
Price elasticity of demand for cigarette per income group	• Income quintile I to V: {-0.64, -0.51, -0.38, -0.25, -0.12}	Authors' assumptions based on Mao et al. (2008)
Distribution of tobacco-related disease mortality, per cause (%)	• COPD: 11.3% • Stroke: 45.5% • Heart disease: 22.8% • Neoplasm: 20.4%	IHME (2013), GBD 2010
Years of life gained upon tobacco cessation, per age group	• 15-24 year-olds: 10 years • 25-44 year-olds: 9 years • 45-64 year-olds: 6 years • Above 65: 3 years	Authors' assumptions based on Doll et al. (2004)
Tobacco-related disease treatment costs (2011 US$)	• COPD: $2,078 • Stroke: $2,024 • Heart disease: $10,845	Based on: Jun She et al. (2013); Le et al. (2013); Lee et al. (2005); Wei et al. (2010); Ma et al. (2010); Heeley et al. (2009); He et al. (2009); Zeng et al.

	• Neoplasm (lung cancer): $13,826	(2012)
Utilization of healthcare by tobacco-related disease (%)	• COPD: 33% • Stroke: 80% • Heart disease: 81% • Neoplasm: 50%	Based on Zhong et al. (2007); Zhao et al. (2009); Chai et al. (2011); Yu et al. (2010); and authors' assumption
Relative utilization of healthcare per income quintile	• Income quintile I to V: {0.79, 0.98, 1.00, 1.08, 1.15} times average (applies to % above)	Authors' assumption based on WHO SAGE WAVE 1
Fraction of healthcare costs reimbursed by insurance schemes (%)	• 50%	Authors' assumption based on Yip et al. (2012)
Individual annual income (2011 US$)	• Income quintile I: < $1,652 • Income quintile II: $1,564 < < $3,075 • Income quintile III: $3,075 < < $4,850 • Income quintile IV: $4,850 < < $7,645 • Income quintile V: > $7,645	Income distribution based on gross national income (GNI) per capita of $4,940 and Gini of 0.42 Based on World Bank (2012)
Utility function as a function of individual income *y*	• ${y^{1-r}}/{1-r}$; $r = 3$	Verguet et al. (2012)

COPD, chronic obstructive pulmonary disease.

Results

For the base case scenario, after 50 years, 231 million years of life would be gained, of which 34% would accrue to the bottom income quintile (Table 2). The net change in tax revenues would be $547 billion, 8% of which would be borne by the bottom income quintile as opposed to 28% in the top income quintile (Table 2). The expenditures on tobacco would increase of about - $119 billion overall; however, these expenditures would decrease by $114 billion and - $34 billion in the bottom and near bottom income quintiles, respectively; whereas they would increase in the top three income quintiles, from - $40 billion to - $125 billion (Table 2). The expenditures on treatment of tobacco-related disease would decrease of $24 billion, 27% of which would be concentrated among the bottom income quintile (Table 1); and the financial risk protection afforded would amount to about $2 billion and be concentrated (74%) among the bottom income quintile (Table 2).

The increased taxes represent a larger share of income to the lower income quintiles (1.6% and 1.4% for the first and second income quintiles, respectively), than for the higher income quintiles (0.9% and 0.6% for the fourth and fifth income quintiles, respectively). However, the bottom income quintiles see decreases of expenditures on tobacco, representing 4.5% and 0.5% of their incomes, respectively, contrary to the top two income quintiles who see increases of expenditures on tobacco of 0.6% and 0.5% of their incomes, respectively. Likewise, expenditures on tobacco-related disease averted as a fraction of income are higher in the bottom two income quintiles (0.3% and 0.1%, respectively) than in the top two income quintiles (less than 0.1% each).

Table 2. Results (cumulative) for the tobacco tax increase (50% price increase) in China, after 50 years.

Outcome	Total	Income quintile I	Income quintile II	Income quintile III	Income quintile IV	Income quintile V
Years of life gained (millions)	231	79	63	47	31	11
Revenues raised						
2011 US$ billion	547	41	89	122	152	143
% of individual income		1.63	1.40	1.15	0.92	0.62
Expenditures on tobacco averted[a]						
2011 US$ billion	-119	114	34	- 40	- 102	- 125
% of individual income		4.51	0.54	- 0.38	- 0.62	- 0.54
Expenditures on tobacco-related disease treatment averted						
2011 US$ billion	24.0	6.6	6.9	5.3	3.7	1.5
% of individual income		0.26	0.11	0.05	0.02	0.02
Financial risk protection afforded[b] (2011 US$ billion)	1.8	1.3	0.3	0.1	0.1	< 0.1

[a] A negative sign implies a creation of expenditures.
[b] Measured by a money-metric value of insurance provided.

Discussion

This paper examines the distributional consequences of a 50% tax hike on tobacco products in China. Using plausible values for key parameters, we find that over fifty years, among the male population, a 50% increase in tobacco price would lead to 231 million years of life gained (about a third among the poorest) and $547 billion of additional tax revenues (less than 10% among the poorest). It would increase household expenditures on tobacco of $119 billion, but decrease these expenditures by $114 billion and $40 billion in the poorer and poorest quintiles, respectively; it would also decrease expenditures on tobacco-related disease by $24 billion (28% among the poorest). Finally, it would provide financial risk protection worth of $2 billion, principally concentrated (74%) among the poorest. This means that tobacco taxation can be a progressive policy instrument which brings significant health and financial benefits to households and substantial revenues to society, decrease expenditures on tobacco and tobacco-related disease most importantly in the poorer quintiles, as illustrated here by our China case study.

Our analysis presents limitations. First, there is the uncertainty in the parameter inputs among which most importantly is the price elasticity of demand for tobacco and treatment costs. Second, our epidemiological model presents some shortcomings. For example, the non-linear harm caused by smoking intensity is not modeled (Schane et al 2010). In addition, we could have built a more exhaustive dynamic model with mortality rates per age group with and without smoking, but simplicity of exposition and scarcity of data encouraged us to maintain our modeling approach. Fourth, our model did not take into account consequences on tobacco consumers' utility neither did it estimate the deadweight loss due to taxation (Stiglitz 2000).

As a conclusion, this paper demonstrates, that in spite of imposing a heavier burden of taxes on lower income groups, tobacco taxation can be a progressive policy instrument, which can bring substantial health benefits to the poorest and significantly decrease expenditures on tobacco and tobacco-related disease for the poorest, even more so as poorer income groups are more sensitive to increases in prices of tobacco product. Increased tobacco taxation also brings significant financial risk protection to the poorest households through the decrease of tobacco-related treatment expenditures. As a summary, with this China case study, we illustrate that tobacco taxation can be a progressive policy instrument.

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