

# The association between tax structure and cigarette price variability: findings from the ITC Project

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## ABSTRACT

**Background** Recent studies have shown that more opportunities exist for tax avoidance when cigarette excise tax structure departs from a uniform specific structure. However, the association between tax structure and cigarette price variability has not been thoroughly studied in the existing literature.

**Objective** To examine how cigarette tax structure is associated with price variability. The variability of self-reported prices is measured using the ratios of differences between higher and lower prices to the median price such as the IQR-to-median ratio.

**Methods** We used survey data taken from the International Tobacco Control Policy Evaluation (ITC) Project in 17 countries to conduct the analysis. Cigarette prices were derived using individual purchase information and aggregated to price variability measures for each surveyed country and wave. The effect of tax structures on price variability was estimated using Generalised Estimating Equations after adjusting for year and country attributes.

**Findings** Our study provides empirical evidence of a relationship between tax structure and cigarette price variability. We find that, compared to the specific uniform tax structure, mixed uniform and tiered (specific, ad valorem or mixed) structures are associated with greater price variability ( $p \leq 0.01$ ). Moreover, while a greater share of the specific component in total excise taxes is associated with lower price variability ( $p \leq 0.05$ ), a tiered tax structure is associated with greater price variability ( $p \leq 0.01$ ). The results suggest that a uniform and specific tax structure is the most effective tax structure for reducing tobacco consumption and prevalence by limiting price variability and decreasing opportunities for tax avoidance.

## INTRODUCTION

The effectiveness of increased cigarette excise taxes in reducing smoking has been studied extensively in the past several decades.<sup>1</sup> However, despite ubiquitous findings on increased taxes being the single most effective tobacco control measure, very few studies have focused on how the structure of excise taxation on tobacco products may impact its effectiveness. Economic theory and a handful of recent empirical studies indicate that, compared with a uniform specific excise tax system, other systems are associated with greater opportunities for tax avoidance.<sup>2–8</sup> For example, Ad valorem excises will increase the price difference between products with different pretax prices and are more likely to lead to greater price variability and opportunities for tax avoidance compared with specific excises. In addition, differential or tiered tax rates based on

either product prices or characteristics allow manufacturers to implement pricing strategies in response to increased taxes by manipulating these prices or characteristics. One report by the International Agency for Research on Cancer (IARC) suggests that complicated tax structures in some low-income and middle-income countries (LMICs) may impede the effectiveness of increased taxes (prices) for reducing smoking.<sup>1</sup>

Cigarette excise tax structure is defined by the tax base and whether different rates are imposed. A specific excise tax is a monetary tax levied on the quantity of tobacco products (eg, per package, or by weight) and an ad valorem excise tax is a tax levied as a percentage of the value of tobacco products (eg, manufacturer's price or retail price). A number of countries also impose a minimum specific tax and specific taxes may also vary in their application across product price tiers.<sup>2 5 6</sup> For example, since 2010, European Union (EU) countries were required by the Council of the EU to impose mixed taxes (a mix of both specific and ad valorem excises) with a tax burden of 60% of retail price of the most popular price category (except for countries where the total excises exceed €115 per 1000 cigarettes) and a specific tax floor of € 90 per 1000 cigarettes.<sup>9</sup>

In general, cigarette excise systems can be one of the following: uniform specific tax systems, tiered specific tax systems, ad valorem uniform systems, ad valorem tiered systems, mixed uniform systems or mixed tiered systems. According to the 2013 WHO Report on the Global Tobacco Epidemic<sup>10</sup> and the WHO Report on the Relationship between Tax and Price and Global Evidence,<sup>11</sup> as of 2012, out of 186 countries with tax information available, 20 countries have not yet imposed cigarette excise taxes, 56 countries employ a purely specific tax system, 50 countries use a purely ad valorem system and 60 use a mixed tax system. In addition, 34 out of 169 countries for which detailed information on tax structure is available are imposing differential rates based on a variety of characteristics.

Several recent studies present descriptive evidence of the association between tax structure and price variability. Using data from the Global Adult Tobacco Survey in 13 countries and the US National Adult Tobacco Survey, one study showed that countries applying a uniform tax rate and with more emphasis on specific taxes exhibit less variability in cigarette prices.<sup>5</sup> Similar findings were reported in another study that used 16 countries taken from the International Tobacco Control Policy Evaluation (ITC) Project to compare specific uniform tax structure with others' more

complicated tax structures.<sup>6</sup> In addition to these two studies, which used self-reported prices, one study collected retail prices in five Southeast Asian countries and found that ad valorem tax structures tend to have larger price variability than tiered specific tax structures,<sup>7</sup> and another study found that cigarette tax harmonisation in the EU may reduce price variability.<sup>8</sup>

There is only one recent study that assessed the association between tax structures and price variability using regression analysis. The authors employed tax and price data from 21 EU countries and found that the price gap between premium and low-priced cigarette brands is smaller in countries with a greater specific component.<sup>3</sup> However, that study could not conduct a proper comparison among pure specific, pure ad valorem and mixed systems because all EU countries are required to have both specific and ad valorem tax components in their excise tax structure.

Given the very limited empirical evidence, studies that use more rigorous analytical methods and that encompass all common tax structures are needed. This study was designed to conduct an extensive analysis of the association between tax structures and price variability, using data from ITC surveys in 17 countries. We compared the specific uniform tax system with all other possible systems with respect to price variability. Such empirical evidence can help guide the selection of tax structures that are most likely to improve the effectiveness of tax increases for reducing smoking.

## DATA

We use self-reported prices from the ITC Project survey data to construct price variability measures. The ITC Project consists of parallel longitudinal surveys of smokers and other tobacco users (and non-users in some countries) conducted in 22 countries inhabited by more than 50% of the world's population, 60% of the world's smokers and 70% of the world's tobacco users. The ITC Surveys are designed to evaluate the policies of the WHO Framework Convention on Tobacco Control (FCTC).<sup>12</sup> We employed all survey waves in 17 countries where cigarette purchase information was collected from smokers, including ITC-4 (the US, the UK, Australia and Canada) waves 1–8, the Netherlands waves 1 and 3–7, Germany waves 1–3, France waves 1–3, Republic of Korea waves 1–3, Mexico waves 1–6, Brazil waves 1–2, Uruguay waves 1–4, Mauritius waves 1–3, India wave 1, Bangladesh waves 1–2, China waves 1–3 and Thailand and Malaysia waves 1–5. The calendar years when these countries were surveyed are reported in online supplementary appendix I. In the ITC survey, a respondent may choose to report the price paid per pack or the price paid per stick. If the respondent bought cigarettes in carton, the total cost/money paid was reported. In addition, the number of sticks in a pack and the number in a carton were also asked. These questions allowed us to derive price per standard pack of 20 cigarettes in local currencies.<sup>i</sup>

We collected detailed information on tax structures for each country, including the type of structure (exclusively specific, exclusively ad valorem and mixed structure, with either uniform or tiered rates) and the shares of specific or ad valorem component among total excises from a variety of sources. Tax information during 2008–2012 was obtained from Table 9.1.0 of the

2013 WHO Report on the Global Tobacco Epidemic, which summarises the price of a 20-cigarette pack of the most popular brands and ad valorem and/or specific taxes as a percent of the price of most popular brand for each of the 162 countries.<sup>10 11</sup> For earlier years, the share of specific or ad valorem components among total excises for EU countries came from the Excise Duty Tables constructed by the European Commission and the share for other countries came from WHO country reports or was imputed using linear interpolation (see online supplementary appendix I). Information on whether a tiered tax structure existed was collected by Tobacco Merchants Association (TMA) and documented by a WHO report<sup>11</sup> and the *Technical Manual on Tobacco Tax Administration*.<sup>2</sup> These tax structure measures were further verified using information from some journal articles and reports<sup>13–23</sup> and Euromonitor International's country specific reports.<sup>ii</sup> When there are discrepancies in the reported type of structure, we chose the type that was confirmed at least by two different sources. The details of the data sources and methods are shown in online supplementary appendix I.

Tax structures of the 17 countries are presented in table 1. As of 2012, countries that impose tiered structures have various bases of tiers. For example, in Bangladesh, tiers are based on retail prices; in Brazil, tiers are based on whether the packaging is soft/hard; in China, tiers are based on manufacturers' prices; in India, tiers are based on cigarette length, whether they carry a filter and whether they are hand-made or machine-made.<sup>11</sup> During the study period, most countries did not change their type of tax structure. The two exceptions are Mexico, which switched its tax system from an ad valorem uniform to a mixed uniform structure in 2009 and Brazil, which switched its tax system from a specific tiered to a mixed tiered system in 2012. Therefore, in our analysis, we employed both cross-country variation and variation within the same country over time in tax structure to identify the association of tax structure with price variability. In addition, for each type of tax structure other than the ad valorem tiered structure, we have data from at least two countries, which better represent those structures than do data from a single country.

In order to estimate the association between tax structure and price variability, we constructed aggregated price variability measures at the national level using self-reported prices for each wave of the ITC countries. We first ranked prices and calculated the price difference between the upper and lower 25 centiles (75 centile minus 25 centile), that is also called the IQR; between the upper and lower 10 centiles; between the upper and lower 5 centiles; and between the upper and lower 1 centiles. Price variability was then calculated using the ratios of these differences to the median price. Similar measures such as the IQR-to-median ratio have been used to measure price variability in previous literature.<sup>6</sup>

Although sometimes an ITC survey wave was conducted across calendar years, in each wave a majority of respondents were surveyed within one calendar year. In order to link the price variability constructed from ITC surveys to the corresponding tax structure measures, we assigned the year when most respondents were surveyed to the price variability measures we constructed for a wave (see online supplementary appendix I). Since survey months and years were not available in the Brazil and India surveys, we used the reported survey period on the ITC Project website (<http://www.itcproject.org>) to

<sup>i</sup>0 and values used by ITC to fill missings such as 7; 7,777; 9; 9,999 were coded into missing. In rare cases, extreme values (3 observations) were dropped if they were about 20 times larger than the average value reported in the wave.

<sup>ii</sup><http://www.euromonitor.com/>

**Table 1** Tax structure by country

Country	Tax base	Tax rates
USA	Specific	Uniform
Canada		
Uruguay		
Australia		
Mauritius		
Republic of Korea		
India	Ad valorem	Tiered
Thailand		Uniform
Bangladesh		Tiered
China	Mixed (specific+ad valorem)	Uniform
Malaysia		
EU		
Mexico	Switched from ad valorem to mixed in 2009	
Brazil	Switched from specific to mixed in 2012	Tiered

EU, European Union.

decide which year to assign based on the number of survey months in each year. Next, using the assigned year, ITC data were linked to tax structure measures to carry out the analyses. In this way, we obtained a panel sample of 78 observations from 17 ITC countries, with each observation consisting of price variability and tax structure measures.

**METHODS**

GEE<sup>24</sup> were used in assessing the association between different tax structures and price variability in order to account for the correlation within the same country over time.<sup>25</sup> An identity link, Gaussian (normal) family and exchangeable correlations were applied in estimating the GEE parameters. The analyses were conducted using the XTGEE command in Stata SE V13.1. The model can be presented as the following equation:

$$\begin{aligned} \text{Variability}_{it} = & \alpha_0 + \alpha_1 \text{SpecificTiered}_{it} + \alpha_2 \text{AdvaloremUniform}_{it} \\ & + \alpha_3 \text{AdvaloremTiered}_{it} + \alpha_4 \text{MixUniform}_{it} \\ & + \alpha_5 \text{MixTiered}_{it} + \alpha_6 Y_t + \alpha_7 C_i + \varepsilon_{it} \end{aligned} \tag{1}$$

where SpecificTiered<sub>it</sub>, AdvaloremUniform<sub>it</sub>, AdvaloremTiered<sub>it</sub>, MixUniform<sub>it</sub>, MixTiered<sub>it</sub> are dichotomous indicators for specific tiered, ad valorem uniform, ad valorem tiered, mixed uniform and mixed tiered tax structures, respectively, with specific uniform tax structure as the omitted category.

The covariates (C<sub>i</sub>) are a dummy for EU countries that all impose a tax structure that are subject to EU requirements on minimum tax floor and tax burden, and a dummy for India, Canada and the US where states or provinces have jurisdictions on cigarette excise taxes, or cigarettes can be sold without excise taxes on First Nations/Indian reservations. The other controls are year fixed effects (Y<sub>t</sub>), which to some extent account for the unobserved global trend of tobacco market activities such as the availability of counterfeit cigarettes and overall improvement of tax administration over years. Also, for all the analyses in this paper, SEs are clustered at the country level to adjust for potential correlation between observations from the same country. According to previous evidence and economic theory, we hypothesise that tax structures other than a uniform specific

excise system will be associated with greater price variation and therefore expect these estimates to be positive.

Likewise in a second model, the effects of the share of specific component among total excise taxes are estimated as an alternative tax structure measure. The equation is similar to model (1) and in the following forms:

$$\begin{aligned} \text{Variability}_{it} = & \delta_0 + \delta_1 \% \text{Specific}_{it} + \delta_2 \text{Tiered}_i + \delta_3 Y_t \\ & + \delta_4 C_i + v_{it} \end{aligned} \tag{2}$$

In model (2), except for tax structure variables, other covariates are the same as those specified in model (1). The only difference between these two models is that tax structure in model (2) is measured using an indicator of the tiered structure and the share of the specific component among total excises. This specification allows us to detect how a gradual increase in the specific (a decrease in ad valorem) component may affect price variability. The hypothesis is that a larger share of specific component would lead to lower price variability and that a tiered tax structure would lead to greater price variability.

Furthermore, we conducted several sensitivity analyses to see whether our results are sensitive to the assignment of years and tax structure measures. First, for both models, we randomly assigned years to those waves that were surveyed across 2 years. Second, for both models, we categorised tax structure using tobacco excise structure instead of cigarette excise structure (by categorising Thailand into a mixed uniform structure and India into a mixed tiered structure).

**RESULTS**

In table 2 we report the descriptive summary statistics after adjusting for intertemporal correlations in the data. The mean statistics show that price variability measures range from 0.3 to 1.7, with larger values when variability is measured using values closer to the tails of price distribution. On average, 43.6% of the study sample (34 out of 78 country-waves) has a specific uniform tax structure, 2.8% (2/78) has a specific tiered tax structure, 9.2% (8/78) has an ad valorem uniform tax structure, 4.2% (2/78) has an ad valorem tiered structure, 32.6% (28/78) has a mixed uniform structure and 7.8% (4/78) has a mixed tiered structure. In addition, 19.9% (8/78) of the sample has a tiered tax structure. The share of specific component among total excise taxes is 63.48 (thus ad valorem share is 36.52) in percentage points. EU countries constitute 25.6% (20/78) of the sample. India, Canada and the US together comprise 21.8% (17/78) of the sample.

In table 3, we show the association between tax structure and price variability estimated using model (1). Estimates of marginal effects and corresponding elasticity are presented. The results show that, compared with the specific uniform structure, tiered (specific, mixed and ad valorem) and mixed uniform structures are positively associated with price variability (p<0.01 for at least one variability measure). The elasticity estimates show that the mixed uniform structure is associated with 40–75% greater price variability; the specific tiered structure is associated with 85–128% greater price variability; the ad valorem tiered structure is associated with 106–289% greater price variability; and the mixed tiered structure is associated with 64–250% greater price variability.

Next, we report the estimated associations between the share of the specific component among total excises and price variability estimated using model (2) in table 4. The elasticity estimates indicate that a 10% increase in the share of specific taxes among total excises is associated with a 4.3% decrease in the

**Table 2** Summary statistics of price variability measures, tax structure and other covariates, 17 ITC countries

N=78	Description	Mean	SE
Price variability measured using $\frac{\text{price difference}}{\text{median price}}$			
(75–25%)/50%	The difference between 75 and 25 centiles of the price distribution divided by the median price	0.293	0.049
(90–10%)/50%	The difference between 90 and 10 centiles of the price distribution divided by the median price	0.686	0.078
(95–5%)/50%	The difference between 95 and 5 centiles of the price distribution divided by the median price	0.996	0.138
(99–1%)/50%	The difference between 99 and 1 centiles of the price distribution divided by the median price	1.673	0.264
Indicators			
Specific uniform	Indicator equals 1 if the country applies purely specific excises in a uniform rate, 0 otherwise	0.436	0.141
Specific tiered	Indicator equals 1 if the country applies purely specific excises in differential rates, 0 otherwise	0.028	0.021
Ad valorem uniform	Indicator equals 1 if the country applies purely ad valorem excises in a uniform rate, 0 otherwise	0.092	0.066
Ad valorem tiered	Indicator equals 1 if the country applies purely ad valorem excises in different rates, 0 otherwise	0.042	0.043
Mixed uniform	Indicator equals 1 if the country applies specific and ad valorem excises in a uniform rate, 0 otherwise	0.326	0.113
Mixed tiered	Indicator equals 1 if the country applies specific and ad valorem excises with differential rates, 0 otherwise	0.078	0.059
EU	Indicator equals 1 if EU members, 0 otherwise	0.256	0.123
Tiered	Indicator equals 1 if the country applies excises with differential rates, 0 otherwise	0.199	0.095
Subnational taxes	Indicator equals 1 if India, Canada or the US, 0 otherwise	0.218	0.128
Continuous controls			
Per cent specific	The share or percentage of specific component among total excise taxes, and rescaled to percentage points by multiplying 100	63.48	9.902

All statistics are adjusted for correlation within the same country over years. 'sub-national taxes' is a dummy for India, Canada, the US where states or provinces have jurisdiction on cigarette excise taxes and cigarettes can be sold without excise taxes in First Nations/Indian reservations. EU, European Union; ITC, International Tobacco Control Policy Evaluation.

IQR-to-median ratio ( $p \leq 0.1$ ), and with a 2.8–3.6% decrease in other price variability measures ( $p \leq 0.05$  or 0.1). In addition, after keeping the share of specific taxes constant, a tiered tax structure is associated with a 147% increase in the IQR-to-median ratio ( $p \leq 0.01$ ), and with a 61–139% increase in other price variability measures ( $p \leq 0.01$  or 0.05). Sensitivity analyses were conducted for both models (1) and (2) and show that most results are robust to different year assignments of ITC waves (see online supplementary appendix table S1) and to categorising Thailand into a mixed uniform structure and India into

a mixed tiered structure (see online supplementary appendix table S2).

### CONCLUSION AND DISCUSSION

Our study provides a comprehensive analysis of the association between tax structure and price variability. Using data taken from 17 ITC countries during 2002–2013, we explicitly estimated how tax structures, including specific uniform, specific tiered, mixed uniform, mixed tiered, ad valorem uniform and ad valorem tiered structures, are associated with price variability

**Table 3** The association between tax structure (categorical variables) and price variability, 17 ITC countries

Price variability	(75–25%)/50% (1)	(90–10%)/50% (2)	(95–5%)/50% (3)	(99–1%)/50% (4)
Specific uniform	Omitted			
Specific tiered	0.192*** (0.054) [0.853]	0.598** (0.301) [1.007]	1.027*** (0.382) [1.276]	1.374*** (0.452) [1.005]
Ad valorem uniform	0.027 (0.044) [0.120]	0.008 (0.151) [0.013]	0.280 (0.230) [0.348]	0.358 (0.410) [0.262]
Ad valorem tiered	0.653*** (0.026) [2.894]	0.669*** (0.108) [1.128]	1.494*** (0.149) [1.857]	1.446*** (0.181) [1.058]
Mixed uniform	0.089*** (0.020) [0.395]	0.447** (0.197) [0.753]	0.361* (0.192) [0.449]	0.601** (0.289) [0.439]
Mixed tiered	0.387* (0.208) [1.714]	0.381 (0.482) [0.642]	0.850 (0.656) [1.057]	3.426*** (1.000) [2.506]
N	78	78	78	78

\* $p \leq 0.1$ , \*\* $p \leq 0.05$ , \*\*\* $p \leq 0.01$ . Marginal effects or coefficients are reported. SEs clustered at the country level are reported in parentheses and corresponding elasticity estimates are reported in square brackets. Stata module 'margins, eodx' was used to obtain elasticity estimates. Price variability is measured using differences between upper and lower 25, 10, 5 and 1 centiles divided by the median price. All regressions are estimated using GEE. Controls include year fixed effects, a dummy for EU countries that are subject to EU tax floor and burden, and a dummy for India, Canada, the US where states or provinces have jurisdiction on cigarette excise taxes and cigarettes can be sold without excise taxes in First Nations/Indian reservations. EU, European Union; GEE, Generalised Estimating Equation; ITC, International Tobacco Control Policy Evaluation.

**Table 4** The association between tax structure (the proportion of specific tax among total excises; an indicator for tiered tax structure) and price variability, 17 ITC Countries

Price variability	(75–25%)/50% (1)	(90–10%)/50% (2)	(95–5%)/50% (3)	(99–1%)/50% (4)
Per cent Specific among total excises in percentage points	–0.001* (0.001) [–0.431]	–0.002** (0.001) [–0.282]	–0.004** (0.002) [–0.356]	–0.006* (0.004) [–0.329]
Tiered (specific/mixed/ad valorem)	0.325*** (0.125) [1.469]	0.365** (0.179) [0.607]	0.827*** (0.239) [1.038]	1.884** (0.782) [1.385]
N	78	78	78	78

\* $p \leq 0.1$ , \*\* $p \leq 0.05$ , \*\*\* $p \leq 0.01$ . Marginal effects or coefficients are reported. SEs clustered at the country level are reported in parentheses and corresponding elasticity estimates are reported in square brackets. Stata module 'margins, eydx' was used to obtain elasticity estimates for the tiered structure and 'margins, eyex' was used for the share of specific among total excise taxes. Price variability is measured using differences between upper and lower 25, 10, 5, and 1 centiles divided by the median price. All regressions are estimated using GEE. Controls include year fixed effects, a dummy for EU countries that are subject to EU tax floor and burden, and a dummy for India, Canada, the US where states or provinces have jurisdiction on cigarette excise taxes and cigarettes can be sold without excise taxes in First Nations/Indian reservations. EU, European Union; GEE, Generalised Estimating Equation; ITC, International Tobacco Control Policy Evaluation.

measured by price ratios derived from the price distribution. We found that complicated tax structures that depart from a specific uniform structure are associated with greater price variability ( $p \leq 0.01$ ). We also estimated that a 10% increase in the share of specific components in total excises is associated with 2.8–4.3% lower price variability ( $p \leq 0.05$ ). In addition, a tiered tax structure is associated with a 61–147% increase in price variability ( $p \leq 0.01$ ) over that of a uniform tax structure.

Our findings suggest that switching to a simpler tax structure would significantly reduce price variability and thus reduce opportunities for tax avoidance. They provide compelling evidence that a specific uniform tax system is the most effective tax structure in reducing price variability and likely the most effective in reducing tobacco use and its consequences. These findings are consistent with the prediction of economic theory and other existing empirical evidence.

There are several limitations in this study. First, there are very few observations for several tax structures (ad valorem tiered/uniform, specific tiered and mixed tiered structure) in our sample. Therefore, the estimates pertaining to these tax structures from model (1) may be sensitive to country-specific unobserved factors. Second, ideally, we would like to control for the market structures (eg, market shares of tobacco companies) that are potentially related to cigarette prices and tax structure. However, the limited sample size and colinearity between country specific factors and tax structures prohibits controlling for these attributes. Moreover, this is a limitation that is not likely to be overcome, simply because surveys carried out in many countries over a long period are expensive and scarce. Finally, during the study period, very few countries have changed their tax structure, and therefore our analysis largely depends on between-country comparison instead of within-country comparison (the same country in different years). If more countries follow the guidance of WHO<sup>2</sup> to increase their reliance on specific and uniform excises, future research will be able to overcome this limitation by including more countries with changing tax structures in the analysis.

Despite the above limitations, this study assesses empirically the association between tax structure and price variability using regression analysis. Our results add to the literature supporting the long existing economic theory that a simple tax structure—a specific uniform structure—is best for increasing cigarette prices and decreasing price variability. Accordingly, countries that follow the principles of the WHO Technical Manual on Tobacco Tax to impose a specific uniform tax structure may

improve the effectiveness of increasing taxes as a tobacco control method. In addition, increasing the reliance on specific excise taxes and switching from tiered to uniform tax rates could also improve the effectiveness of increased taxes and prices as a tobacco control measure. This is particularly relevant to LMICs that impose tiered structures and EU countries where mixed tax structures have to be imposed by law. Our analysis also suggests that more opportunities for tax avoidance exist in a tax system other than specific uniform. Future research on how tax structure would ultimately impact smoking behaviours such as smoking participation, cigarette consumption and quitting is warranted.

#### What this paper adds

- ▶ This paper provides important evidence of the association between tax structure and price variability of cigarettes using regression analysis.
- ▶ Complicated tax structures that depart from a specific uniform structure are associated with greater price variability of cigarettes.
- ▶ Countries that impose a specific uniform tax structure, that increase their reliance on specific excise taxes and/or switch from tiered to uniform tax rates, will reduce price variability.
- ▶ These results support the proposition that specific uniform tax structure is the most effective tax structure for reducing tobacco consumption and prevalence.

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Appendix I

1, Duration of ITC waves (sources: ITC project website):

**Table: Duration of surveys, Countries, Date/Month/Year or Month/Year.**

**In case one wave of survey was carried out in two calendar years, the year when most respondents were (likely) surveyed is bolded.**

Wave	Australia	Canada	US	UK	The Netherlands	Malaysia	Thailand	Mexico	Uruguay	France	Germany
1	10/2002- 12/2002	10/2002- 12/2002	10/2002- 12/2002	10/2002- 12/2002	03/2008- 04/2008	01/2005- 03/2005	01/2005- 03/2005	09/2006- 11/2006	11/2006- 12/2006	12/2006- 02/ <b>2007</b>	07/2007- 11/2007
2	05/2003- 09/2003	05/2003- 09/2003	05/2003- 09/2003	05/2003- 09/2003	11/2008- 12/2008	07/ <b>2006</b> - 06/2007	08/2006- 09/2006	11/2007- 12/2007	10/ <b>2008</b> - 02/2009	09/2008- 11/2008	07/2009- 10/2009
3	06/2004- 12/2004	06/2004- 12/2004	06/2004- 12/2004	06/2004- 12/2004	03/2009- 05/2009	02/2008- 09/2008	01/2008- 03/2008	11/2008- 12/2008	10/ <b>2010</b> - 1/2011	09/2012- 12/2012	09/2011- 10/2011
4	10/ <b>2005</b> - 01/2006	10/ <b>2005</b> - 01/2006	10/ <b>2005</b> - 01/2006	10/ <b>2005</b> - 01/2006	05/2010- 06/2010	07/2009- 11/2009	04/2009- 07/2009	01/2010- 02/2010	09/2012- 12/2012		
5	10/ <b>2006</b> - 02/2007	10/ <b>2006</b> - 02/2007	10/ <b>2006</b> - -02/2007	10/ <b>2006</b> - -02/2007	05/2010- 06/2011	05/ <b>2011</b> - 04/2012	02/2011- 04/2011	04/2011- 05/2011			
6	09/ <b>2007</b> - 02/2008	09/ <b>2007</b> - 02/2008	09/ <b>2007</b> - 02/2008	09/ <b>2007</b> - 02/2008	05/2010- 06/2012	05/2013- 01/2014	10/2012- 12/2012	10/2012- 12/2012			
7	10/ <b>2008</b> - 07/2009	10/2008- 07/ <b>2009</b>	10/ <b>2008</b> - 07/2009	10/ <b>2008</b> - 07/2009	05/2010- 06/2013						
8	07/ <b>2010</b> - 31/05/2011	English: 07/ <b>2010</b> - 04/20/2011; French: 07/ <b>2010</b> - 06/11/2011	07/ <b>2010</b> - 06/2011	07/2010- 12/2010							

**Table: Duration of surveys, Countries, Date/Month/Year or Month/Year. (Continued)**

Wave	China	Mauritius	Korea	Brazil	Bangladesh	India
1	04/2006-08/2006	04/2009-05/2009	12/2005	04/2009-06/2009	02/2009-05/2009	08/2010-10/2011
2	10/2007-01/2008	08/2010-11/2010	10/2008-12/2008	10/2012-02/2013	03/2010-06/2010	
3	05/2009-10/2009	06/2011-07/2011	10/2010-12/2010			

## 2, Tax Structure Information

### 1), China and Malaysia (Mixed structures) previous to 2008

For the years previous to 2008, we obtained the information using Euromonitor country reports and WHO periodic reports on the global tobacco epidemic. Additional information about tax reform in Malaysia for earlier years is from *ITC Malaysia National Report. Findings from Wave 1 to 4 surveys (2005-5009)*. [23] The ad valorem taxes of China and Malaysia in earlier years were imputed using linear interpolation and the share of components in excise taxes were thereafter imputed.

### 2), Thailand and India

The reported tax structures of Thailand and India vary by sources. Although the WHO TFI table 9.1.0 suggests that a small amount of specific taxes exist in Thailand and a small amount of ad valorem taxes exist in India, Euromonitor and TMA reports suggest otherwise. Furthermore, a specific report about Thailand by WHO: “Tax policies on tobacco products in Thailand: The way forward” and the Thailand Euromonitor report indicate that while mixed tariff rates of specific and ad valorem taxes are applied to imported cigarettes, there is no specific excise tax imposed on domestic cigarettes. Similar conclusion is also shown in a periodic WHO report: <http://www.who.int/tobacco/economics/thailand.pdf>. Therefore, we categorize Thailand as a country with an ad valorem tax structure.

The tax structure in India is also reported to be specific only in the WHO periodic report, TMA and Euromonitor reports. Therefore, we categorize it as a country with a specific tax structure instead of a mixed structure.

### 3), EU countries



The tax structure, specific excise component, ad valorem excise component as of August of each year are obtained from EU excise duty tables, part 3, manufactured tobacco. The duty tables are published and available each year since 2001.

**Appendix Table 1, The Association between Tax Structure and Price Variability, with different assignment of years when ITC survey wave was across two calendar years.**

<b>Price Variability</b>	<b>(75%-25%)/50%</b>	<b>(90%-10%)/50%</b>	<b>(95%-5%)/50%</b>	<b>(99%-1%)/50%</b>
	<b>(1)</b>	<b>(2)</b>	<b>(3)</b>	<b>(4)</b>
<b>Model (1)</b>				
<b>Specific Uniform</b>	<b>Omitted</b>			
Specific Tiered	0.181*** (0.040) [0.800]	0.607** (0.310) [1.020]	1.060** (0.421) [1.307]	1.218*** (0.475) [0.889]
Ad Valorem Uniform	0.032 (0.047) [0.141]	0.006 (0.157) [0.009]	0.295 (0.215) [0.363]	0.336 (0.425) [0.246]
Ad Valorem Tiered	0.644*** (0.025) [2.858]	0.690*** (0.106) [1.159]	1.569*** (0.130) [1.935]	1.420*** (0.186) [1.037]
Mixed Uniform	0.085*** (0.021) [0.378]	0.442** (0.191) [0.743]	0.389** (0.172) [0.480]	0.546** (0.277) [0.399]
Mixed Tiered	0.387* (0.206) [1.717]	0.370 (0.490) [0.622]	0.917 (0.688) [1.131]	3.388*** (0.980) [2.474]
<b>Model (2)</b>				
% Specific among total Excises in percentage points	-0.001* (0.001) [-0.432]	-0.002** (0.001) [-0.274]	-0.003* (0.002) [-0.310]	-0.006* (0.004) [-0.346]
Tiered(specific/mixed/ad valorem)	0.318*** (0.121) [1.440]	0.386** (0.179) [0.638]	0.903*** (0.239) [1.115]	1.825** (0.755) [1.346]

**Appendix Table 2, The Association between Tax Structure and Price Variability, with different categorization of India and Thailand.**

<b>Price Variability</b>	<b>(75%-25%)/50%</b>	<b>(90%-10%)/50%</b>	<b>(95%-5%)/50%</b>	<b>(99%-1%)/50%</b>
	<b>(1)</b>	<b>(2)</b>	<b>(3)</b>	<b>(4)</b>
<b>Model (1)</b>				
<b>Specific Uniform</b>	<b>Omitted</b>			
Specific Tiered	0.218*** (0.069) [0.961]	1.004*** (0.227) [1.699]	1.544*** (0.261) [1.920]	1.982*** (0.449) [1.005]
Ad Valorem Uniform	-0.045 (0.036) [-0.199]	-0.120 (0.164) [-0.203]	0.402** (0.196) [0.500]	0.358 (0.410) [0.262]
Ad Valorem Tiered	0.645*** (0.034) [2.845]	0.714*** (0.104) [1.209]	1.539*** (0.317) [1.913]	1.446*** (0.181) [1.058]
Mixed Uniform	0.069*** (0.025) [0.304]	0.333* (0.177) [0.563]	0.339 (0.208) [0.421]	0.601** (0.289) [0.439]
Mixed Tiered	0.326* (0.173) [1.437]	0.377 (0.376) [0.638]	0.810 (0.521) [1.007]	3.426*** (1.000) [2.506]
<b>Model (2)</b>				
% Specific among total Excises in percentage points	-0.001* (0.001) [-0.433]	-0.002** (0.001) [-0.282]	-0.004** (0.002) [-0.361]	-0.006* (0.004) [-0.329]
Tiered(specific/mixed/ad valorem)	0.323** (0.126) [1.456]	0.361** (0.180) [0.600]	0.819*** (0.239) [1.028]	1.884** (0.782) [1.385]