



The World Health Organization's Tobacco Tax Simulation Model (WHO TaXSIM)

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1. Introduction

Taxation is known to be the most cost-effective tobacco control measure available to governments throughout the world. Higher tobacco taxes are also referred to as 'win-win' policies because they generate extra government revenue while at the same time reduce long-term tobacco consumption. Many health professionals have therefore been advocating for higher levels of tobacco taxation on public health grounds alone, while macro-economists have begun estimating the positive impact of higher tobacco taxes on government revenues, fiscal space and financial sustainability.

The major concern of Ministry of Finance (MoF) officials when designing and implementing changes to the tobacco tax system is to generate sustainably higher revenues. Other concerns such as illicit trade, domestic employment, the regressivity of tax rates, and public health all play a role to some extent. Generally speaking, public health concerns should be accorded a higher priority in many countries, especially as higher tax rates are consistent with the primary revenue generation objective.

Many high income countries and nearly all middle and low income countries still have the opportunity to substantially increase their tax revenues from tobacco products. This is because tax rates on tobacco products in these countries tend to be quite low to begin with, and consumer demand for tobacco products is relatively price inelastic - even in lower income countries. Strong tax administration is the key to designing, implementing and monitoring more effective tobacco tax systems, and this often requires the administrations to build up their level of technical and analytical capacity.

WHO has been working collaboratively with MoF colleagues in many countries to improve the efficiency and effectiveness of their tobacco tax systems and examining the means of generating sustainably higher revenues. As noted in the *WHO Technical Manual on Tobacco Tax Administration*¹, many countries have overly complicated tax systems for tobacco products that are prone to tax avoidance by manufacturers. Consequently, the actual revenue impact of a given tax policy change will be less than expected.

WHO's work in this area of technical support to countries has therefore focused first on improving the analytical capacity of tax technocrats, and second on increasing the administration

¹ http://www.who.int/tobacco/publications/tax_administration/en/

capacity to implement the excise tax system efficiently. The WHO Tax Simulation Model (WHO *TaXSiM*) has been the key analytical tool in support of this work. More generally, WHO's approach to working with MoF colleagues involves discussing and analysing the:

- Economic and political context in which MoF/tax department colleagues operate.
- Current tobacco market situation at both the supply and the demand sides.
- Strengths and weaknesses of the existing tobacco tax system.
- Viability and impact of corrective measures to the tobacco tax system.

The strength of WHO *TaXSiM* is that it is developed for each country as part of a collaborative process with input from the tax technocrats themselves. These technocrats have a much better understanding of the particular considerations and constraints that most influence decision-making within the MoF. This interaction greatly enriches the overall analysis of each country's tobacco tax system, and helps ensure that administratively realistic solutions can be developed and acted upon. The value that WHO *TaXSiM* adds to the existing knowledge base may be specified as follows:

- While projecting the impact of tax increases, the MoF officials are not only interested in the outcome for government revenue, they want to know the implications for the other major stakeholders, such as the traders and manufacturers in tobacco industry, who may have competing interests. *TaXSiM* can model their response to tobacco tax policy changes and project the repercussions on revenue and consumption, thereby bringing the politico-economic perspective to policy simulation.
- Where the market is segmented into different price bands, *TaXSiM* is able to accommodate the movements in the market by those price segments depending on consumers' price sensitivity and manufacturers' pricing strategy. These changes can be driven by consumers' brand switching behavior, brand repositioning, differential shifting of tax burden to consumers, or cross-brand price subsidy by the manufacturers.
- The tobacco tax systems in various countries range from extremely complex to very simple ones. *TaXSiM* nests all the tax systems and can deal with the shift from the complex to the simplified system thus aiding the government officials to better comprehend the benefits of simplifications of their existing complex tax structure.

2. Objective

The main objective of this work is to examine the tobacco market and the existing excise tax system to determine how to increase the efficiency and the effectiveness of the excise system that would fit the country setting in the short to mid-term, and to ensure sustainably higher tax revenues while helping to achieve public health objectives with respect to reduced tobacco consumption. The collaboration between WHO and the MoF colleagues generally focuses on the following areas:

- Ensuring short-run reductions (e.g. expected immediate impact of tax increases) in the consumption of all cigarette brands through tax policies.

- Exploring areas of tax-system induced tax avoidance and reducing it with an efficient tax system(s) across the supply chain.
- Monitoring the market and creating a database for market analysis that enables the tax officials to formulate policy and then to implement it effectively.
- Scanning current stakeholders (tobacco manufacturers) in the market and their position in the tobacco sector (their market share in different price band).
- Ensuring reduction of tax and price differentials between brands –often among cigarette price bands and across products.
- Ensuring increased tax revenues from all brands and targeted segments (e.g. premium, mid-price, economy brands).
- Looking at the impact of tax changes on stakeholders’ revenues.

WHO *TaXSiM* first describes the current market and tax situation for domestically consumed cigarettes² by each brand and market segment (e.g. economy versus premium brands), and then predicts the impact of tax changes on consumer cigarette prices, consumption volumes, and tax revenues generated by each brand and market segment for the following year. The types of tax changes assessed in WHO *TaXSiM* include different types of excise systems (e.g. specific, ad valorem, or mixed systems) and different tax bases. The objectives of this work are to:

- Create an administrative database that can be periodically updated by the tax technocrats enabling them to monitor the dynamics of the cigarette market.
- Quantify the expected impact of proposed tax policy changes on the cigarette market with an emphasis on tax revenues, under some logical assumptions about the market’s behaviour.
- Enable tax technocrats to assess the impact of tax or market changes more effectively and then to take corrective action where appropriate.

3. *TaXSiM* baseline data / information requirements

WHO *TaXSiM* is a data intensive model that requires detailed information on tax paid sales and price of different brands available for the most popular tobacco product in the consumer market, typically manufactured cigarettes in most countries. This type of data is usually available to MoF officials. However, even in the absence of such detailed data (for example if a researcher has data available on prices, sales and taxes for three broad segments of the market), the model can be a useful analytical tool. Of course, the more detailed the available data, the more precise and extensive can be the analysis.

In some countries, a variety of tobacco products are consumed including smokeless tobacco, pipe tobacco, water pipe tobacco, roll your own, bidis or kreteks. Some of these products are in part produced by informal sectors of the economy that reside outside of the tax net. Thus, even in

² This can also be applied to other tobacco products, where relevant required data are available.

these countries, cigarettes tend to generate the most significant share of tobacco excise revenues that can be more reliably estimated in *TaXSiM*.

Tax paid sales of available brands: Brand specific information is needed to understand the impact of tax changes on governments' as well as individual manufacturers' revenues. As tax systems and rates change, detailed data enables users to assess the expected revenues by the government and the manufacturers. Data also allows users to examine the impact of types of tax system changes on the likelihood of manufacturers' price strategies and product repositioning, which may jeopardize the government's expected revenues.

When brand specific data are not available, the WHO *TaXSiM* model requires total tax paid market sales to be disaggregated according to information on the market share of different brands.

In some cases, market share data lags one or two years behind total tax-paid sales data. In that case, a user may take the market shares as they are or may want to verify them with local experts such as by asking retailers what percentage of their sales consists of which brands. If the responses match the data, then it can be assumed that market shares have been roughly constant over time. Another way to verify the baseline is to estimate the excise revenues based on lagged market shares and current tax paid sales data, and then compare the result to actual excise revenues.

Price of brands: *TaXSiM* requires the retail sale price of brands found in the market. Sale prices of brands are declared and announced by manufacturers to newspapers (e.g. Turkey), or required by the tax authority (e.g. Russia, Ukraine, Bangladesh), or printed on the brands (e.g. Indonesia, Russia, Ukraine). When such data is not made available publicly or to the governments, then the tax authority can conduct market survey to determine the retail price of brands (e.g. Philippines). There are a number of companies that also collect brand specific price data and their market shares by selected brands and commercially make them available such as ERC, Euromonitor and Tobacco Merchants Association (TMA).

Excise and other applicable taxes: Information on all indirect taxes applicable to tobacco products need to be collected. These include excise taxes, value-added taxes (or sales taxes), import duties, if applicable, and other taxes (see next section for more details on different taxes).

4. Calculations and assumptions

Taxes

It is essential for the user of the model to get familiarized with the particulars of the tax system of the country of interest. For that, it is important to understand the types of taxes applied and the relevant tax base used.

a. Types of taxes:

There are two types of excise taxes, E , on cigarettes. Specific excise E_s is a specific monetary value on a defined number of sticks or pieces of cigarettes. Ad valorem excise E_a is a percentage of the value of the tobacco products. The rate of ad valorem tax is called "statutory rate" t_e and the base for the statutory rate levied varies. E_a is estimated by multiplying the statutory rate with the base, as it will be discussed below.

Countries rely on either a specific or an ad valorem tax. Some countries rely on a mixed system, which involves a specific and an ad valorem element at the same time. So the excise tax system can be either of the following three types:

$$E = (E_s + E_a), E_s, E_a \quad (1.1)$$

Most countries also levy a Value Added Tax (VAT) or a sales tax on goods and services including tobacco products (v). Some apply import duties on imported tobacco products. Some others also levy additional, dedicated duties on tobacco to fund specific programmes. For the simplicity of this exercise, we will focus only on excise taxes and VAT (or sales taxes).

b. Base for taxes:

The tax base for the specific excise is straightforward since it is defined as the quantity of cigarettes (e.g per stick, per 1000 sticks, per kg, per carton etc).

The base for the statutory ad valorem rate varies. The ad valorem tax rate may be levied on the producer's price (P_p), wholesaler's price (P_w) or consumer's (retail) price (P_R):

$$E_a = t_e P_p, E_a = t_e P_w, E_a = t_e P_R, \text{ respectively} \quad (1.2)$$

The statutory rate of VAT is often levied as a uniform rate on VAT tax-exclusive retail price where the amount of VAT per unit is:

$$V = (P_p + R_M + E) v \quad (1.3)$$

Where R_M is the supply chain margin (explained later in the document) and E is total excise taxes.

For simplicity, it is advisable to convert the statutory rate v of VAT into a percentage of retail price by using the following formula:

$$v_p = \frac{v}{(1+v)} \quad (1.4)$$

and the VAT tax per unit is estimated as:

$$V = v_p P_R \quad (1.5)$$

c. Uniform versus tiered excise tax system:

A significant number of countries levy a uniform excise for all cigarette brands or differentiate tax rates based on specified characteristics such as price (consumer or wholesale), the weight or length of cigarettes, tobacco content, production methods, and the origin of production (e.g. domestic versus imported), etc.

Total tax T on a pack of cigarettes is determined by the excise and VAT or sales tax per pack ³ as:

$$T = E + V \quad (1.6)$$

Note that *tiered tax systems* tend to be designed so that lower income groups can purchase cheap cigarettes while at the same time the Government can earn more revenue from higher price bands. A tiered system applies when different tax rates are imposed based on various factors, including product and production characteristics. Consequently, it is expected that tier tax systems have wide price gaps among price segments. They are also more prone to tax avoidance since manufacturers can differentiate their brands according to the tax base in order to qualify for lower tax brackets. Price gaps also exist in *uniform tax systems* especially under the ad valorem system which is more common in low and lower-middle income countries. A key problem here lies in determining the value for ad valorem tax base, and often, the value (producer price, whole sale price or retail price) is determined by the manufacturers (sometimes required by the government), who declare it to the tax authority.

Consumer price per pack of cigarettes

In *TaXSiM* it is assumed that the final cigarette price P_R that consumers pay has the following components:

$$P_R = P_p + R_M + T \quad (1.7)$$

Here, T represents a unit value of total taxes. R_M is the supply chain margin as described below.

Supply chain margin: After the cigarettes leave the manufacturing facilities, each transaction in the supply chain takes a certain percentage of total transaction value as a profit before handing over the supply to the next supply chain. Consequently, wholesalers, distributors, and retailers receive a certain amount of money (margin) from cigarettes. We call this supply chain margin. For the simplicity we refer to those margins as retailers' margin R_M in the calculations. The rate

³ An import duty would have to be added to the total tax if the product is imported and is subject to import duty. If two trade partner countries are under free trade agreement, import duty may not apply to the products imported from that specific partner. So, additional information about the trading arrangement between the countries may be required.

of margin received by each supply chain is often not made available to the public and the governments, unless requested. In consequence, the necessary information can be collected by surveying wholesalers, distributors and retailers. For simplicity, the margin for the supply chain can be assumed as a percentage, say $t_M = 10\%$, of the retail price. The value of supply chain margin is thus estimated as:

$$R_M = t_M * P_R \quad (1.8)$$

However, it is important to note that it is common practice for manufacturers to apply different margins to different brands unless there is a law preventing such practices. The most popular brands tend to have a lower retailer margin than the least popular brands, where popularity in this context reflects either brands with high market shares or brands that are well-known globally.

Producers' price: Producers' price is constituted by the cost of production and the producers' profit margin. WHO *TaXSiM* needs the producer's price P_p for the simulation but the information is not available in most countries. Therefore, based on the available information, *TaXSiM* estimates the producer's price for each brand taking the current retail prices as a base and deducting the total taxes and margins:

$$P_p = P_R - R_M - T \quad (1.9)$$

For example, assuming that supplier's margin is 10%, the producer's price can be estimated as:

$$P_p = P_R - (10\% * P_R) - T \quad (1.10)$$

Or:

$$P_p = (1 - 10\%) P_R - T \quad (1.11)$$

Example:

Retail Price	\$5.00	Balance
Less VAT 15% of P_R	0.75	4.25
Less R_M 10% of P_R	0.50	3.75
Less Specific \$1.25/pack	1.25	2.50
Less Ad valorem 40% P_R	2.00	0.50
Producer Price = $P_R - R_M - T$	0.50	

Formula (1.11) can be modified according to the relevant tax base and excise structure in place for cigarettes in each country. For example, if the country does not have specific excise or ad valorem excise in place, then $E_s = 0$ or $E_a = 0$, respectively. When the country has a tier specific or ad valorem excise, then the corresponding rate applies to the brand.

Cigarette market segments

When consumption, price and tax data have been entered for each specific brand, the next step is to determine relevant or common price segments within the aggregate market. It is common to find at least three basic price segments (e.g. high-price or premium brands k_1 , mid-price brands k_2 and low-price or economy brands k_3). Note in some countries the segments partly reflect the structure of the existing tax system particularly if a tiered structure is in place.

Using tax paid domestic sales data for n number of brands θ , we calculate the average retail price $\overline{P_{Rk}}$ and the average excise tax $\overline{E_k}$ per pack for each price segment k as:

$$\overline{P_{Rk}} = \frac{\sum_{\theta=1}^n P_{Rk\theta} Q_{k\theta}}{\sum_{\theta=1}^n Q_{k\theta}} \quad \text{and} \quad \overline{E_k} = \frac{\sum_{\theta=1}^n E_{k\theta} \times Q_{k\theta}}{\sum_{\theta=1}^n Q_{k\theta}} \quad (1.12),$$

where $Q_{k\theta}$ is the sales quantity of brand θ in segment k and $k = 1, 2, 3$.

Similarly, total excise revenue, total sales/consumption, and total tax revenue are calculated as follows:

$$ER = \sum_{\theta=1}^n E \times Q_{\theta}, \quad TQ = \sum_{\theta=1}^n Q_{\theta}, \quad TR = \sum_{\theta=1}^n T \times Q_{\theta} \quad (1.13)$$

where ER is total excise revenue, TQ is the total quantity of cigarettes sold, T is total tax value per unit (pack or piece or kg) and TR is total tax revenue (excise and VAT).

Price segments serve to describe the size and shape of the overall cigarette market, while brand-wise data offers important information such as most popular brands within each segment, competitor brands and companies, and the market penetration of domestic and imported brands/companies. Importantly, the process also makes it easy to analyse tax incidence within the aggregate market.

5. Simulating the Impact of Tobacco Tax Policies

TaXSiM first describes the current market and tax situation for cigarettes at a detailed level by brand and market segment. This current situation provides the baseline against which the impact of different tax policies on key market parameters (consumer prices, consumption volumes, tax revenue, producer revenue, and tax incidence) can be quantified. The types of tax changes assessed in *TaXSiM* include different types of excise systems (specific, ad valorem, or mixed systems), different tax bases, and higher tax rates according to market segment.

As outlined below, a relatively small number of assumptions are necessary for the *TaXSiM* model to function.

a. *Smokers' income and market segments*: It is assumed that there is a positive relationship between the smokers' income and their preferred brand or price segment. For example, premium

brands k_1 are more likely to be smoked by higher income smokers, mid-level brands k_2 by medium income smokers and the low price economy brands k_3 by low income smokers.

b. Smokers' income and price-elasticity: It is assumed that each price segment exhibits a different price-elasticity of demand μ_k reflecting the income strata of smokers within that segment. The own price-elasticity of demand by price segment k is expressed as the following:

$$\mu_k = \frac{dQ_k}{dP_{Rk}} \frac{\bar{P}_{Rk}}{\bar{Q}_k} = \frac{\% \Delta Q_k}{\% \Delta P_{Rk}} \quad (1.14)$$

We prefer to use empirically estimated price elasticity by income group when this information is available. However, this information does not exist in many countries. In practice, therefore, we often assume that smokers of premium brands have a price-elasticity similar to that of smokers in high income countries at $\mu_{k_1} = -0.2$ to -0.4 , while smokers of economy brands have a price-elasticity similar to that of low income countries between $\mu_{k_3} = -0.8$ to -1.0 . The price-elasticity of mid-price brand smokers is taken to be the average of these two groups at around $\mu_{k_2} = -0.5$ to -0.7 .

c. Tax pass-through: We assume that tax increases are ultimately fully passed-on to smokers through an increase in the consumers' price P_R . Note the producers' price may also change depending on market characteristics. Users can adopt various scenarios in the simulation. Increases in producers' price depend on their profit maximization plan subject to market characteristics (e.g. higher market share of economy brands versus high-price brands), types of excise system, political economy with respect to the government's revenue expectations, the governments' concern on public health, strength of tobacco control environment etc.

The post-tax consumer price for brand θ in price segment k will therefore be estimated by the following formula (note subscripts θ and k are omitted for brevity), where the superscript $*$ denotes the new situation:

$$P_R^* = P_p^* + R_M^* + T^* \quad (1.15)$$

The new producer price is estimated as:

$$P_p^* = P_p(1 + t_p) \quad (1.16)$$

where t_p represents the percent increase in producer price.

The new value of retailer's margin is expressed as:

$$R_M^* = t_M P_R^* \quad (1.17)$$

The new VAT tax per pack is also expressed as:

$$V^* = v_p P_R^* \quad (1.18)$$

When a uniform specific is levied and the rate is increased, then the new retail price will be estimated by replacing (1.16), (1.17) and (1.18) into (1.15) as:

Or

$$P_R^* = P_p(1 + t_p) + t_M P_R^* + v_p P_R^* + E_s^*$$

$$P_R^* = \frac{P_p(1 + t_p) + E_s^*}{(1 - t_M - v_p)} \quad (1.19)$$

where E_s^* is the new specific excise tax per unit.

When uniform ad valorem rate is levied based on retail price and the rate is increased to t_e^* , then the WHO *TaXSiM* will estimate the new retail price by the following formula:

$$P_R^* = P_p(1 + t_p) + t_M P_R^* + v_p P_R^* + t_e^* P_R^*$$

Or

$$P_R^* = \frac{P_p(1 + t_p)}{(1 - t_M - v_p - t_e^*)} \quad (1.20)$$

However, if the increased uniform ad valorem rate is levied based on the producer's price, then the new retail price will be estimated as:

Or

$$P_R^* = P_p(1 + t_p) + t_M P_R^* + v_p P_R^* + t_e^* P_p(1 + t_p)$$

$$P_R^* = \frac{P_p(1 + t_p)(1 + t_e^*)}{(1 - t_M - v_p)} \quad (1.21)$$

Under mixed system, when both specific and ad valorem excise taxes are levied and the rates are increased then the new total excise tax per unit will be expressed as:

$$E^* = E_s^* + t_e^* P_R^* \quad (1.22)$$

where the ad valorem tax base is assumed to be the (tax inclusive) consumer price. The new retail price will be estimated by replacing (1.16), (1.17), (1.18) and (1.22) into (1.15):

$$P_R^* = P_p(1 + t_p) + t_M P_R^* + v_p P_R^* + E_s^* + t_e^* P_R^*$$

Or

$$P_R^* = \frac{P_p(1 + t_p) + E_s^*}{(1 - t_M - v_p - t_e^*)} \quad (1.23)$$

We estimate the percentage change in consumer price for brand θ in price band k as:

$$\% \Delta P_{Rk\theta} = \left(\frac{P_{Rk\theta}^* - P_{Rk\theta}}{P_{Rk\theta}} \right) * 100 \quad (1.24)$$

where $P_{Rk\theta}^*$ is the post-tax increase consumer price and $P_{Rk\theta}$ is the pre-tax increase consumer price for brand θ in price segment k .

By using the above formula, we can estimate the percentage change in sales by brand θ in price segment k as $\% \Delta Q_{k\theta} = \mu_k * \% \Delta P_{Rk\theta}$ where μ_k is the price elasticity corresponding to price segment k . Then, we can estimate the total reduction in sales as:

$$\hat{Q} = \sum_{\theta=1}^n (\% \Delta Q_{k\theta} \times Q_{k\theta}) \quad (1.25)$$

d. *Trading-down by smokers:* As cigarette prices increase, some smokers will reduce their average daily level of consumption of their preferred brand, some will quit outright, while others will more likely choose to "trade-down" to lower priced cigarettes reflecting the cross-price elasticity of demand for cigarette brands. We do not have internationally consistent data on the cross-price elasticity of demand for brands belonging to different price segments and therefore we assume that those smokers who substitute their brand with a cheaper one will partly trade-down to cigarettes from the next lowest price segment.

For example, the tax-induced reduction in sales for cigarettes in price segment k_1 measured as \hat{Q}_{k_1} may be due to quitting smoking, reducing the level of consumption and also switching down to brands in the next lowest price segment.

The user needs to make assumption about trading down. For example, one assumes that a percent (α) of \hat{Q}_{k_1} might be reduced due to quitting and reduced current smoking level, and the rest is traded down given by $\check{Q}_{k_1} = \hat{Q}_{k_1}(1 - \alpha)$.

TaXSiM can distribute the level of total traded down volume \check{Q}_{k_1} from higher price segment, let's say k_1 to each brands into the next lower price segment k_2 based on each brand's market share $\beta_{k_2\theta}$ within their price segment k_2 .

Consequently, the post-tax increase sales level $Q_{k_2\theta}^*$ for brand θ in the lower price segment k_2 deducts the tax-induced reduction of demand for brand θ in segment k_2 and adds the total quantity of demand traded down from price segment k_1 to k_2 (and depending on its market share) to the pre-tax increase sales level $Q_{k_2\theta}$. The formula for calculating the post-tax increase sales level $Q_{k_2}^*$ for brand θ in price segment k_2 is then:

$$Q_{k_2\theta}^* = Q_{k_2\theta} (1 + \% \Delta Q_{k_2\theta}) + (\check{Q}_{k_1} * \beta_{k_2\theta}) \quad (1.27)$$

The total decline in sales for price segment k_2 is then calculated:

$$\hat{Q}_{k_2}^* = \sum_{\theta=1}^n (Q_{k_2\theta}^* - Q_{k_2\theta}) \quad (1.28)$$

Similarly, the same trading down process can be carried out from other price segments, except for the lowest price segment.

In sum, we assume that consumers in the premium and mid sector will replace their demand for cigarettes by trading down their demand for the next lower price segment. Therefore, it is only consumption within the lowest price segment (\hat{Q}_{k_3}) that records the full decline in demand since these smokers do not have cheaper-priced options available to trade down to. In many low and middle income countries, however, the cheapest cigarette brands also compete with traditional tobacco products such as bidis, roll-your-own and chewing tobacco. Trading down from cigarettes to these product types can occur. This relationship can be incorporated into *TaXSiM* by the inclusion of an additional market segment representing these traditional products below the economy price segment of the cigarette market.

e. *Illicit trade and tax revenue*: Tax administrators are often concerned that higher taxes will encourage smuggling and illicit trade with a negative impact on tax revenue. It is a very difficult task to explicitly estimate this link. However, in order to address this concern, *TaXSiM* adopts two approaches when estimating sales and revenue outcomes.

In the first instance, we assume that $\alpha_1 \hat{Q}_{k_1} + \alpha_2 \hat{Q}_{k_2} + \alpha_3 \hat{Q}_{k_3} = \alpha \hat{Q}_k$ will move out of the legal market either because the consumers quit altogether or they begin to purchase from illicit market sources (i.e. there are zero trading-down effects). *TaXSiM* then calculates excise and total revenues generated from those fewer consumers that remain in the legal market.

The second approach is to assume that the decline in sales within the premium and middle price segments fully shifts to the next lowest price segment (i.e. consumers fully trade down) and that it is only sales in the lowest segment that records the full decline as trade-down to traditional alternatives or shifts to the illegal market. The *TaXSiM* model then calculates expected excise and total tax revenues accordingly.

The total decline in consumption under the first approach is higher than under the second approach because it includes the quantity that is assumed to go to the illicit market. Consequently the total tax revenue estimates using the first approach are lower than under the second approach.

We assume that the first approach (i.e. with zero trading-down effects) will likely be the worst case scenario for the estimation of revenues, and for this reason we describe it as the "lowest expected revenue boundary" while the second approach reflects the "maximum expected revenue boundary" in the *TaXSiM* model.

6. Limitations

The *TaXSiM* modelling process incorporates most of the expected behavioural responses to a given change in tobacco taxes. One exception is that producers may choose to withdraw/replace certain brands in response to a tax change. However, this response is constrained by the fact that consumers are able to shift to other brands subject to their budget constraints. In addition, it is costly for producers to replace brands and this is unlikely to occur for popular and well established brands. Note the bulk of excise revenue is also typically generated from such brands so that the risk of revenue fluctuations from brand replacement is usually minimal. Nonetheless, there is a risk this might occur particularly for imports with only a small foothold in the market and for this reason WHO often advises MoFs to establish a mechanism to monitor the price of brands produced in key trade partner countries.

The primary focus of WHO *TaXSiM* is to quantify the financial impact of tobacco tax policies in terms of excise revenue and so it does not currently include the impact on public health outcomes such as reductions in long-term mortality due to smoking-related diseases. It is very difficult to include such calculations as an automatic or standard feature of *TaXSiM* because such estimates require considerably more detailed information on the specific epidemiological situation in each country. However, WHO *TaXSiM* does calculate the expected change in total cigarette sales, and this can be used in combination with parameters from other studies to calculate the associated health or economic impact of suggested tax policies. Please refer to the WHO Economics Toolkit *An Assessment of the Economic Costs of Smoking*⁴ for further information on the calculation of these health and economic impacts.

In addition to tobacco excise, national tax systems include personal and corporate income taxes as well as other consumption taxes. Broader considerations such as the optimal balance between income and consumption taxes are often discussed with MoF colleagues, but they are not directly incorporated into *TaXSiM* except where they affect the consumer price of tobacco products (e.g. VAT or sales tax rates). Discussions of the impact of tobacco taxes on wider macro-economic variables tend to focus on the creation of fiscal space and the potential to earmark tobacco tax revenues for the health sector. However, it is also worth noting that tobacco excise - as a form of consumption tax - creates less distortion to the macro-economy than income taxes since labour supply, saving and investment decisions are not as directly affected by them.

⁴ http://whqlibdoc.who.int/publications/2011/9789241501576_eng.pdf

7. Conclusion

WHO *TaXSiM* has proven to be a very useful tool for strengthening the technical and analytical capacity of the tax technocrats WHO has worked with. The key strength of WHO *TaXSiM* is that it provides a robust analytical framework relevant to tax administration across different settings and situations. The baseline calculations, such as the analysis of tax incidence across brands, provide a very rich source of information for further policy dialogue. Similarly, it is critically important for MoF colleagues to be able to confidently assess the impact of tax policy and market changes on the Government's revenue stream.