

Economic Research on Tobacco Taxes

Price Elasticity of Tobacco
Demand

How Do Economists Study Demand for Tobacco

Economists measure how people respond to a change in the market: change in tobacco prices, change in income, change in TC policies

Reaction to tobacco price increase or decrease is called PRICE ELASTICITY

Reaction to income increase or decrease is called INCOME ELASTICITY

Economists are Interested in Real Changes, not Nominal

Example:

$$\text{Price}_{2003} = 90$$

$$\text{Price}_{2004} = 115$$

Nominal change in price = 25, or 27.8% ($=25/90$)

Real change in price takes into account inflation.

$$\text{If } r \text{ (inflation rate)} = 5\% = 0.05, \text{ real Price}_{2004} = \\ 115/(1+r) = 115/1.05 = 109.5$$

Real change in price = 19.5, or 21.7% ($=19.5/90$)

Tax as % of Tobacco Price

How do we measure level of tax?

International standard is to express tax as % of retail price

In some countries the tax law expresses tax as % of value on which tax is levied.

This value does not have to be retail price. In that case we need to calculate tax as % of retail price

Tax as % of Retail Price

$$P_{\text{retail}} = P_{\text{wholesale}} (1 + t_{\text{wholesale}})$$

$$\begin{aligned} (P_{\text{retail}} - P_{\text{wholesale}}) / P_{\text{retail}} &= [P_{\text{wholesale}} (1 + t_{\text{wholesale}}) - P_{\text{wholesale}}] / P_{\text{wholesale}} (1 + t_{\text{wholesale}}) \\ &= t_{\text{wholesale}} / (1 + t_{\text{wholesale}}) = t_{\text{retail}} \end{aligned}$$

$$t_{\text{wholesale}} = 25\% \rightarrow t_{\text{retail}} = 20\%$$

Example (1)

Cambodia has different tax structure for local and imported cigarettes

Local cigarettes:

10% excise tax (ex-factory price) +

10% VAT (ex-factory price with excise tax) + 3% public tax (ex-factory price with excise tax and VAT)

This is 24.6% of factory price, but 19.8% of retail price

Example (2)

Cambodia tax on imported cigarettes:

7%, 15%, 35% import duty (CIF value= costs + insurance + freight) +

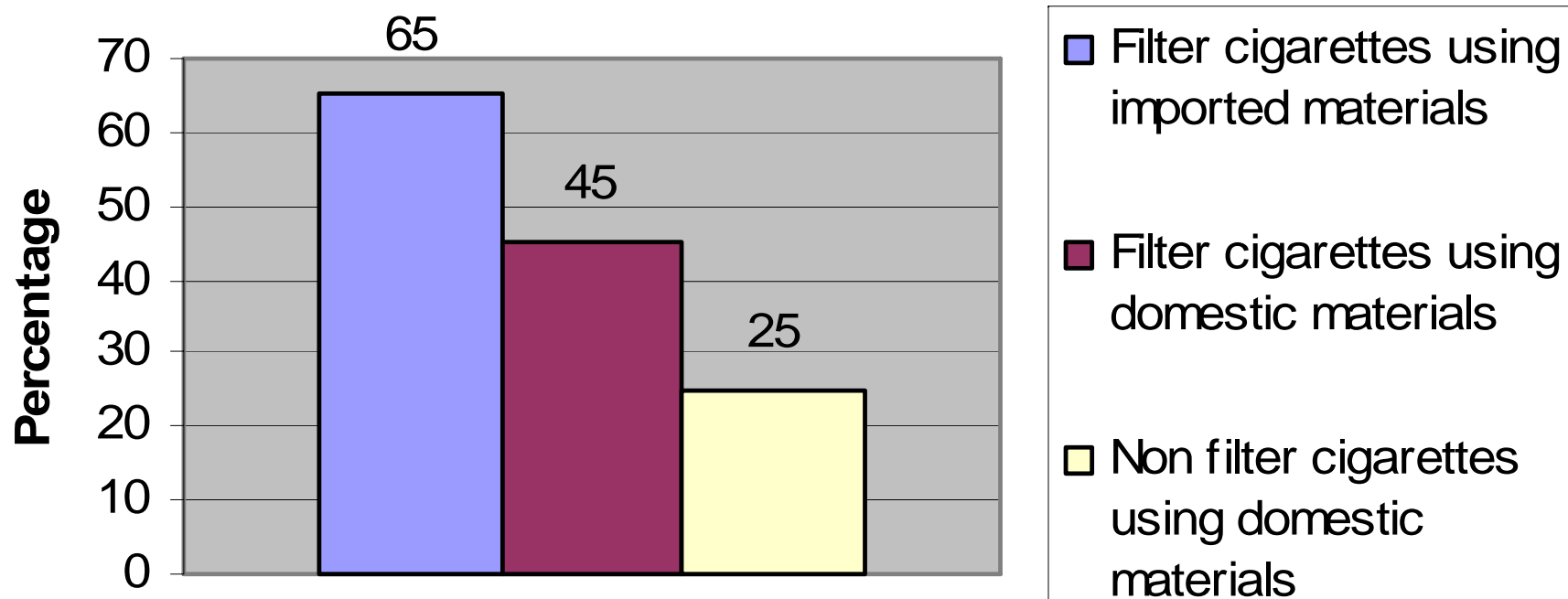
10% excise tax (CIF with import duty) +

10% VAT (CIF with import duty and excise tax) + 3% public tax (CIF with import duty and excise tax and VAT)

This is 33%, 43%, 68% of CIF, but

25%, 30%, 41% of retail price

Cigarette Tax in Vietnam: Three levels



Source: Ministry of Finance, 2004

Tax as % of Retail Price

$$P_{\text{retail}} = P_{\text{wholesale}} (1 + t_{\text{wholesale}})$$

$$(P_{\text{retail}} - P_{\text{wholesale}}) / P_{\text{retail}} = t_{\text{wholesale}} / (1 + t_{\text{wholesale}}) = t_{\text{retail}}$$

$$t_{\text{wholesale}} = 25\% \rightarrow t_{\text{retail}} =$$

$$t_{\text{wholesale}} = 45\% \rightarrow t_{\text{retail}} =$$

$$t_{\text{wholesale}} = 65\% \rightarrow t_{\text{retail}} =$$

Tax as % of Retail Price

$$P_{\text{retail}} = P_{\text{wholesale}} (1 + t_{\text{wholesale}})$$

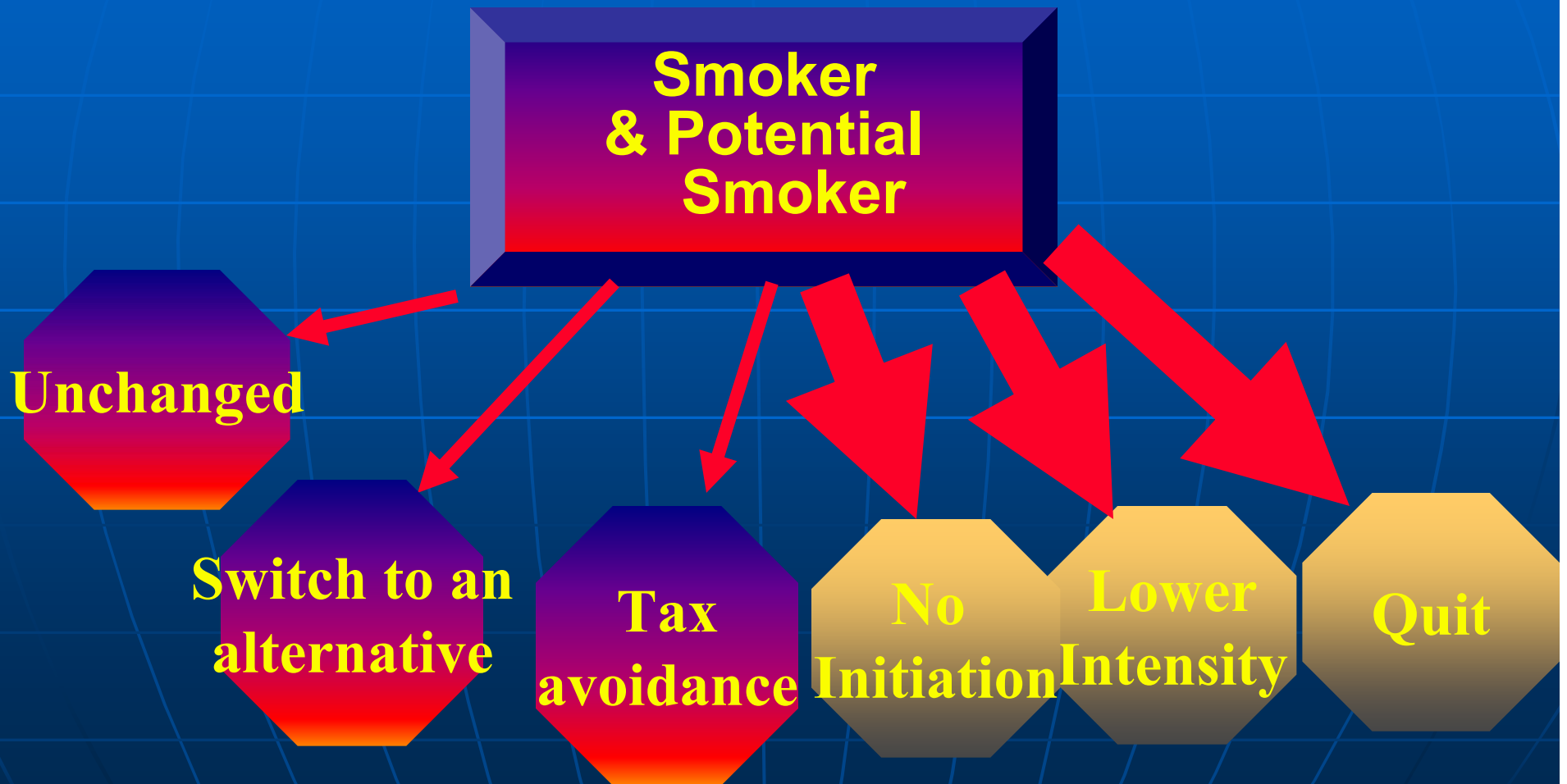
$$(P_{\text{retail}} - P_{\text{wholesale}}) / P_{\text{retail}} = t_{\text{wholesale}} / (1 + t_{\text{wholesale}}) = t_{\text{retail}}$$

$$t_{\text{wholesale}} = 25\% \rightarrow t_{\text{retail}} = 20\%$$

$$t_{\text{wholesale}} = 45\% \rightarrow t_{\text{retail}} = 31\%$$

$$t_{\text{wholesale}} = 65\% \rightarrow t_{\text{retail}} = 39\%$$

Possible Change in Behavior After Change in Tobacco Price



Skills Needed to Analyze Tobacco Demand

- **Data search and data collection**
- **Assess quality of data**
- **Prepare data for an analysis**
- **Perform an economic analysis**
- **Interpret and communicate the results**

Data Search and Data Collection

Data on consumers behavior

(demand side, macro and micro)

1. consumption (from survey),
2. sale (from government statistics, from industry statistics)
3. initiation, cessation, illegal purchase, spending pattern, brand choices

Data on tobacco market

1. tax (level, structure, revenue)
2. prices for various tobacco products
3. production costs

Aggregate Data Analysis

- **Questions it can answer**
 1. overall impact of average retail price on total demand
 2. overall impact of disposable income on total demand
 3. overall impact of public policies, health knowledge, etc. on total demand

Aggregate Data Analysis

■ Weaknesses

1. price can be affected by both demand and supply and it is not possible to separate these two effects
2. difficult to cross-border shopping is masked (overestimating of price elasticity)
3. smokers' characteristics and preferences are hidden
4. change in # of smokers from change in # of cigarettes smoked by smokers cannot be distinguished
5. causal link between tobacco control policies and consumption may be disguised

Individual Level Data Analysis

■ Strengths over Aggregate Analysis

1. Price cannot be affected by one individual, a change in demand must be due to price, or income or change in preferences, or a combination of these
2. Individual characteristics are less correlated with price and policy measures
3. Can evaluate the impact on both smoking rate and # cigarettes to consumed
4. Different population subgroups (age, gender, education, etc) can be evaluated

Individual Level Data Analysis

■ Weaknesses

1. Cross-border shopping is masked and this may lead to underestimating of price elasticity
2. Ecological bias - omitted variables correlated with those included in a model (e.g. anti-smoking sentiment)
3. Self-reporting bias – assumption: the bias is proportional to true consumption, results not affected

Example: Simple analysis using data from Vietnam 1998

Retail price
2,493 VND

*

Quantity
(macro data)
2,340 m

=

Consumption
5.8 trillion VND*

Average
expenditure
(micro data)
616,000 VND

*

Number of
smokers
10.65m
0.3455*30.84m

=

Consumption
6.6 trillion VND

Aggregate Analysis

Minimum Data Required

- Quantities of tobacco consumed or sold within the particular time periods (year, quarter, month)
- Price of tobacco products (e.g. average price per pack, price index; can be proxied by price for the most popular brand, tobacco tax, total expenditures on tobacco products)
- Income (e.g. aggregate personal disposable income, national product per capita, etc)
- Also of an interest are prices of other tobacco products (to assess substitution and/or complementarity)

How to Estimate Price Elasticity

Formula for price elasticity

(% change in demand resulting from a one percent change in price)

$$\% \Delta Q / \% \Delta P = [d(Q) / d(P)] \times [\text{mean } P / \text{mean } Q]$$

How to Estimate Income Elasticity

Formula for income elasticity

(% change in demand resulting from a one percent change in income)

$$\% \Delta Q / \% \Delta I = [d(Q) / d(I)] \times [\text{mean } I / \text{mean } Q]$$

Price Elasticity – Macro Approach with Limited Data (1)

$$Q = N \times q$$

Q = quantity demanded (e.g. consumption of cigarettes in whole country per certain period, e.g. per year)

N = population size (both smokers and nonsmokers, only youth and adults)

q = cigarette consumption per capita

$$q = Q/N$$

Price Elasticity – Macro Approach with Limited Data (2)

Price elasticity of cigarette demand concerns with an increase or a decrease in price in % ($\Delta \%$) and its impact on cigarette demand, also expressed as an increase or a decrease in %

$$\Delta \%Q = \Delta \%N + \Delta \%q$$

Price Elasticity – Macro Approach with Limited Data (3)

Change in per capita consumption (q) depends on change in real income (I) and change in real price (P).

$$\Delta \%q \cong e_I \times \Delta \%I + e_p \times \Delta \%P$$

e_I – measure of sensitivity to I changes
(income elasticity)

e_p – measure of sensitivity to P changes
(price elasticity)

Price Elasticity – Macro Approach with Limited Data (4)

$$\Delta \%Q \cong \Delta \%N + \Delta \%q$$

$$\Delta \%q \cong e_I \times \Delta \%I + e_p \times \Delta \%P$$

$$\Delta \%Q \cong \Delta \%N + e_I \times \Delta \%I + e_p \times \Delta \%P$$

$$(\Delta \%Q - \Delta \%N - e_I \times \Delta \%I) / \Delta \%P = e_p$$

Price Elasticity – Macro Approach with Limited Data (5)

Data needs

$$(\Delta \% Q - \Delta \% N - e_I \times \Delta \% I) / \Delta \% P = e_p$$

$\Delta \% Q$: consumption of cigarettes in whole country (per certain period) in two points in time

$\Delta \% N$: population size in two points in time

$\Delta \% I$: income (GDP) in two points in time

$\Delta \% P$: price of cigarettes/tobacco in two points in time
(average price or price of a representative product)

Price Elasticity – Macro Approach with Limited Data (6)

Example from Indonesia

$$\Delta \%Q (1998 - 2002) = - 11.06$$

$$\Delta \%N (1998 - 2002) = + 5.68$$

$$\Delta \%I (1998 - 2002) = + 6.49 \text{ (real)}$$

$$\Delta \%P (1998 - 2002) = + 32.66 \text{ (real)}$$

$$(\Delta \%Q - \Delta \%N - e_I \times \Delta \%I) / \Delta \%P = e_p$$

Price Elasticity – Macro Approach with Limited Data (7)

$$(\Delta \%Q - \Delta \%N - e_I \times \Delta \%I) / \Delta \%P = e_p$$

Assume $e_I = + 0.4$

$$e_p = (- 11.06 - 5.68 - 0.4 \times 6.49) / 32.66 = -0.59$$

Assume $e_I = + 0.6$; $e_p = ?$

Assume $e_I = + 0.8$; $e_p = ?$

Price Elasticity – Macro Approach with Limited Data (8)

$$(\Delta \%Q - \Delta \%N - e_I \times \Delta \%I) / \Delta \%P = e_p$$

$$\text{Assume } e_I = + 0.6$$

$$e_p = (- 11.06 - 5.68 - 0.6 \times 6.49) / 32.66 = -0.63$$

$$\text{Assume } e_I = + 0.8$$

$$e_p = (- 11.06 - 5.68 - 0.8 \times 6.49) / 32.66 = -0.67$$

Change in Tax vs Change in Price (1)

Tax represent only certain % of final price.

E.g. in Cambodia tax is only 20% of final price.

If tax is increased 10%, the final price will be increased by 2% ($0.1 \times 0.2 = 0.02$) if passed fully to consumers

Change in Tax vs Change in Price (2)

Compute price elasticity using tax increase

$$\% \Delta Q / \% \Delta P = d(Q) / d(T) \times d(P) / d(T) \times \text{mean } P / \text{mean } Q$$

If $d(P)/d(T)=1$, then the change in Q due to change in T is multiplied by the same expression as in the formula for price elasticity

Interpreting Results

Let assume:

price elasticity = - 0.8; (usual estimates are from -0.14 to -1.23)

10% tax increase causes 2% increase in cigarette price (tax represents 20% of final price)

Price elasticity = % quantity / % price

$$-0.8 = \% \text{ quantity} / 0.02$$

$$\% \text{ quantity} = - 0.8 \times 0.02 = - 1.6\%$$

Result: 10% tax increase leads to 1.6% decline in consumption

Interpreting Results

Exercise

Let assume:

price elasticity = - 0.5;

20% tax increase

Tax represent 30% of retail price

? % increase in cigarette price

Price Elasticity = % quantity / % price

? % decline in consumption

Interpreting Results

Exercise

Price elasticity = - 0.5;

20% tax increase

Tax represent 30% of retail price

$0.2 \times 0.3 = 6\%$ increase in cigarette price

Price Elasticity = % quantity / % price

$$-0.5 = \% \text{ quantity} / 0.06$$

$$\% \text{ quantity} = - 0.5 \times 0.06 = - 3.0\%$$

Result: 20% tax increase leads to 3% decline in consumption

Impact of Tax Increase on Tax Revenue (1)

Current tax revenue =

tax base (# cigarette packs) x current tax rate (tax per pack)

E.g. $3,000,000 \times \$0.02 = \$60,000$

Percentage increase in price =

proposed tax increase (%) x tax as % of retail

E.g. $0.1 \times 0.3 = 0.03$

New tax rate =

current tax rate x proposed tax increase (%) + current tax rate

E.g. $(\$0.02 \times 0.1) + \$0.02 = \$0.022$

Impact of Tax Increase on Tax Revenue (2)

Change in demand after tax increase =
current demand(tax base) x price elasticity x
percentage increase in price

E.g. $3,000,000 \times -0.5 \times 0.03 = -45,000$

New tax revenue =

new demand * new tax rate

E.g. $(3,000,000 - 45,000) \times \$0.022 = \$65,010$

Increase in revenue:

$\$65,010 - \$60,000 + \$5,010$, or 8.35%

Simulation of Tax Increase Indonesian Example

Tax increase	% price change	% demand change	% tob. tax revenue change	Revenue change as % of GDP
10% ↑	3% ↑	1.5% ↓	8% ↑	0.26
50% ↑	18% ↑	9% ↓	36% ↑	0.33
100% ↑	36% ↑	18% ↓	63% ↑	0.40

Interpreting Results

Price and income elasticities

- can be different for different SES groups – e.g. the poor are more price sensitive compared to the rich
- can change over time (careful with time series data) – our estimates can be sensitive to which years we include to our analysis