

# 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) +

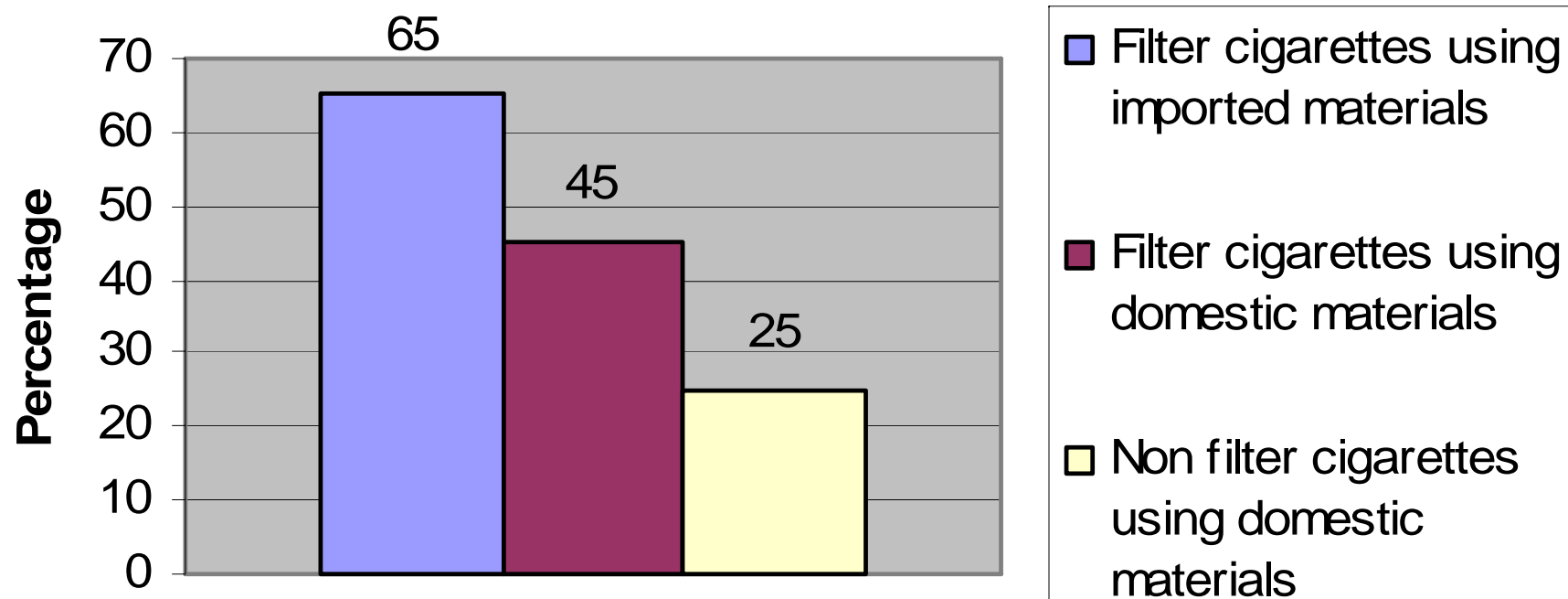
10% excise tax (CIF with import duty) +

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

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

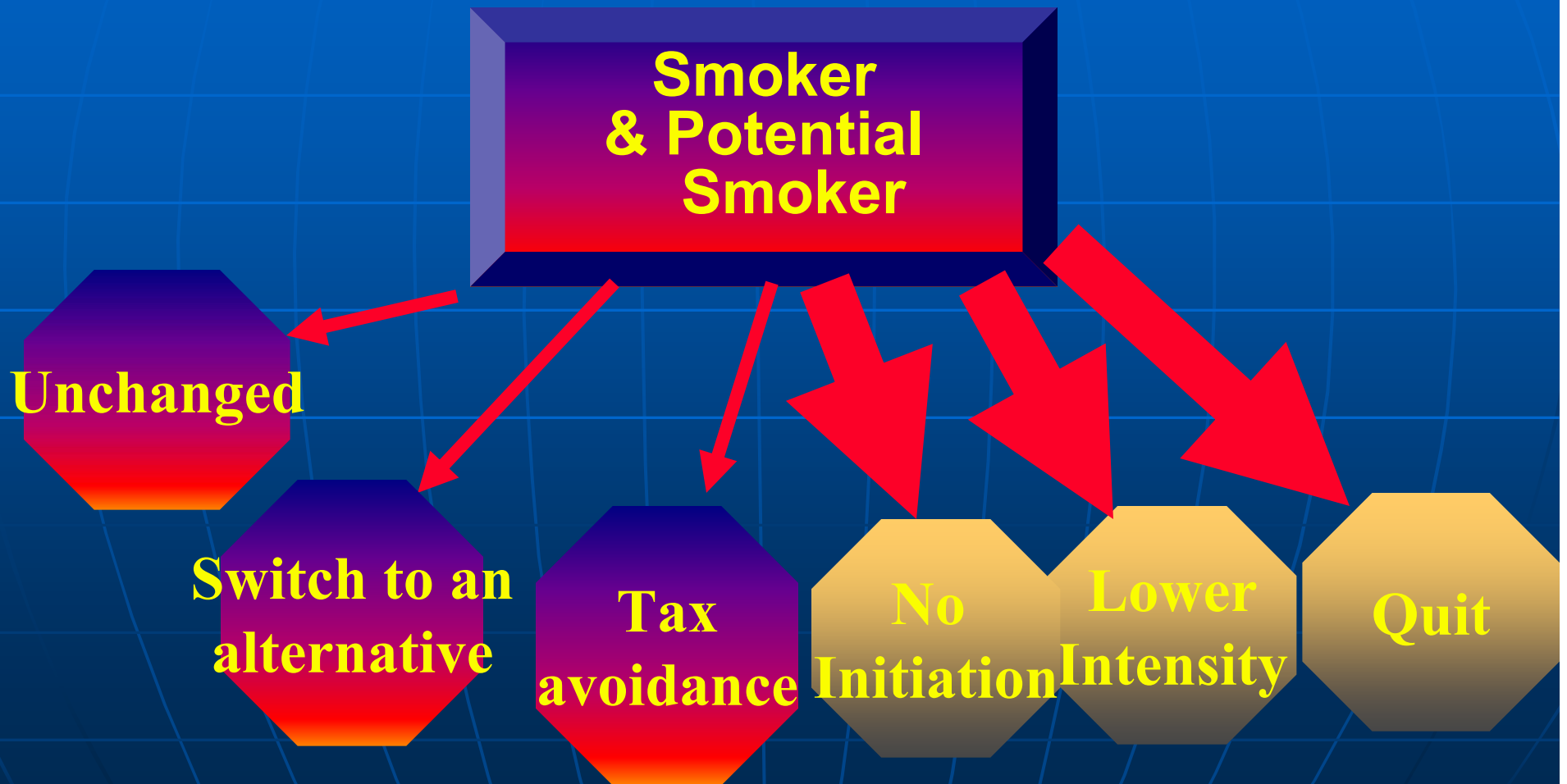
$$(P_{\text{retail}} - P_{\text{wholesale}}) / P_{\text{retail}} = t_{\text{wholesale}} / (1 + t_{\text{wholesale}}) = t_{\text{retail}}$$

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

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

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

# 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