



<http://www.tobaccoevidence.net>

Demand for Tobacco & Tax Policy

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Shall Government Intervene in the Tobacco Market?

Yes, because there are market failures

Externalities:

- **physical or financial costs imposed on non-smokers**
- **inadequate information about the health risks of tobacco**
- **inadequate information about the risks of addiction**

Lower labor productivity, lower economic growth

Internalities (costs smokers impose on themselves)

How Can Public Policies Intervene?

Demand Side Interventions

- **Alter economic incentives for smoking behavior (decrease the utility of smoking by using tools such as price, access, consumption and advertising limits)**
- **Improve information dissemination**
- **Reduce social acceptance of smoking**

How Can Public Policies Intervene?

Supply Side Interventions

- **Alter economic incentives for tobacco farmers and manufacturers (increase cost of production)**
- **Reduce access to tobacco products (youth)**
- **Advertising restrictions**
- **Crack down on smuggling measures**

Tobacco Tax and Economics

- **Public health** – will higher taxes improve health of the nation?
- **Budget** – will higher taxes increase or decrease budget income?
- **Economy/development** – is there any negative effect? Employment? Smuggling?
- **Poverty** – will higher taxes burden low income groups? How about individual welfare?
- **Reaction of the tobacco industry** to new taxes

Taxation is the Most Effective Measure

- Higher taxes induce quitting, reduce consumption and prevent starting
- A 10% price increase reduces demand by:
 - 4% in high-income countries
 - 8% in low or middle-income countries
 - About half of the effect is on amount and half on initiation
 - Long-run effects may be greater
- Young people and the poor are the most price responsive

Source: Chaloupka *et al.*, 2000

Analyzing Tobacco Demand

- **Economic theory gives us a framework**
 - **theory of demand assumes an individual utility function (but also rational behavior)**
 - **utility from smoking = # cigarettes, utility from other goods, and individual tastes**
 - **utility maximization subject to budget constraint (price of cigarettes, income, prices of all other goods)**

Price of Tobacco

Price Based Interventions

Non-Price Interventions

The Full Price of Smoking = **Monetary Cost** + **Cost of Obtaining** + **Consumption Cost**

Market Price of Cigarettes (taxes)

- Restrictions on access/purchasing
- Bans on advertising and/or sponsorship

- Restrictions on Use
- Health Information

Questions of Interest

- Does price/tax affect tobacco consumption, and to what extent? (**price/tax elasticities**)
- Does smoking depend on personal income? (**income elasticity**)
- Can **public policies** change smoking behavior?
- Can **advertising** encourage tobacco use?
- Will **globalization, trade liberalization, and/or privatization** change the demand for tobacco products?

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

Collecting Data

- **What to look for**

Data on consumers behavior (demand side, macro and micro) - e.g. consumption, sale, initiation, cessation, illegal purchase, spending pattern, health knowledge.

Data on tobacco farming and manufacturing (supply side, macro) - e.g. amount produced, exported, imported, market share, extend of smuggling.

Data on tobacco regulations (legislation environment, macro) - e.g. tax (level, structure, revenue), advertising, labeling, cig. content, smuggling.

Aggregate Data Analysis

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

Aggregate Data Analysis

- **Weaknesses**
 - simultaneity problem (perfectly elasticity of supply must be assumed)
 - cross-border shopping is masked (overestimating of price elasticity)
 - smokers' characteristics and preferences (e.g. for low tar/nicotine products) are hidden
 - change in # of smokers from change in # of cigarettes smoked by smokers cannot be distinguished
 - causal link between tobacco control policies and consumption may be disguised

Individual Level Data Analysis

- **Strengths over Aggregate Analysis**
 1. **Simultaneity bias is less likely (an individual cannot affect market price)**
 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**
 - 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

$$\begin{array}{l} \text{Retail price} \\ 2,493 \text{ VND} \end{array} * \begin{array}{l} \text{Quantity} \\ \text{(macro data)} \\ 2,340 \text{ m} \end{array} = \begin{array}{l} \text{Consumption} \\ 5.8 \text{ trillion VND*} \end{array}$$

$$\begin{array}{l} \text{Average} \\ \text{expenditure} \\ \text{(micro data)} \\ 616,000 \text{ VND} \end{array} * \begin{array}{l} \text{Number of} \\ \text{smokers} \\ 10.65\text{m} \\ 0.3455*30.84\text{m} \end{array} = \begin{array}{l} \text{Consumption} \\ 6.6 \text{ trillion VND} \end{array}$$

Aggregate Analysis

- **Type of the data**
 - aggregate time-series (most common)
 - aggregate cross-sectional data (small variation in prices)
 - pooled time-series
 - panel cross-sectional data
 - (longitudinal data)

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. total expenditures on tobacco products, average price per pack, price index) - can be proxied by tobacco **taxes**
- **Income** (e.g. aggregate personal disposable income, national product per capita, etc)

Aggregate Analysis

Other Data of Interest

- Prices of other tobacco products (to assess substitution/complimentarity)
- Extent of smuggling (proxy: taxes among neighbors)
- Health knowledge
- Advertising and promotion expenditures/restrict
- Smoking restrictions (place and timing)
- Degree of privatization
- Degree of trade liberalization
- Degree of openness to foreign direct investment

Econometric Models

- **Conventional models (static)**
 - only by current characteristics considered
- **Addictive models (dynamic)**
 - * **Myopic models**
 - demand is affected by past consumption
 - * **Rational addiction models**
 - demand is affected by past and future consumption
 - * **Hyperbolic discounting models**

Functional Form

- **Linear**
 - plot against time resembles a line
- **Semi-log** (log-lin or lin-log)
 - plot against time resembles a logarithmic curve and a line (either dep. and indep. variables)
- **Double-log** (log-log)
 - plot against time resembles a logarithmic curve
 - coefficients represent elasticities
 - assumes constant price elasticity over time

Demand Equation

Aggregate Analysis

- **Dependent variable (Y):**
 - cigarette sale/consumption (per capita or aggregate)
 - tobacco weight (per capita or aggregate)
- **Independent variables (X) (min required)**
 - price per unit (deflated; unit = Y)
 - personal disposable income (per capita or aggregate (time trend); deflated)

Demand Equation

Aggregate Analysis (cont.)

- **Other Independent variables (examples)**
 - **dummy** for years when counter-advertising exists
 - **ratio** of tobacco specific to total advertising & promotional expenditures
 - **index** of smoking restrictions

Specification error (bias unknown) v. error in variable (bias towards 0)

Examples of Aggregate Econometric Models

- Annual aggregate time-series data
 - usually small number of observations, therefore use limited # of indep. vars
 - usually high collinearity between independent variables

Example of conventional linear demand:

$$Q_t = b_0 + b_1 P_t + b_2 Y_t + b_3 T_t + b_4 SR_t + b_5 D_m + \varepsilon_t$$

Performing Aggregate Econometric Analysis

- Document every step (any changes in data or use of a different estimation technique)

1. Ordinary Least Square (OLS)

regress y x_1 x_2 x_3 x_4 x_5 x_6

2. Test price for exogeneity

(Hausman's test).

If price is endogenous, OLS estimates are bias.
Instrumental variable for price must be found.

Performing Aggregate Econometric Analysis (cont.)

3. Find instrumental variable for endogenous price
 - must be correlated with price but cannot affect consumption
 - examples: excise tax, lagged price/tax, real cost of tobacco, average salary in tobacco manufacturing
4. Test smoking restrictions for exogeneity (Hausman's test)

Individual Level Data Analysis

Required Data

- **Tobacco consumption** by individuals during a specified period (e.g. week, month)
- **Price** of tobacco products (tax can be a proxy for price) at the time of survey; **real source of variation** in cross-section required

Individual Level Data Analysis

Other Data of Interest

- Public policies - laws, restrictions (national, local)
- Socio-demographic data:
 - Per capita disposable income
 - Education, religiosity
 - Age
 - Gender, race
 - Area of residence (urban, rural)

Individual Level Data Analysis

Consumption must be correctly measured

Specify the type of tobacco being used.

Example of standardized questions from WHO :

Have you ever smoked?

Have you smoked at least 100 cigarettes in your lifetime?

Do you smoke *daily, occasionally or not at all?*

On average, what number of *cigarettes, hand-rolled cigarettes, cigars, etc.* do you smoke per day if you smoke that day?

Individual Level Data Analysis

Definition of Current Smoker

Consumes any tobacco product either daily (*a daily smoker*) or occasionally (*an occasional smoker*) at time of survey

Definition of Non-Smoker

Does not smoke at all at time of survey:

Never-smoker or Ex-smoker

Definition of Lifetime Smoker

Smoked at least 100 cigarettes during lifetime (assumed to be addicted)

Interpreting results

Price results

- Compute price elasticity

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

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

1.1. Linear demand function

$$e_{P_t} = b_1 \times P_t / Q_t$$

1.2. Log-log demand function

Price coefficient = price elasticity (elasticity is constant)

Interpreting results (cont.)

Tax results

- Compute price elasticity using tax increase

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

If $d(P)/d(T)=1$, then tax coefficient is multiplied by the same expression as the price coefficient

Expected values of price elasticities:

–0.14 to –1.23 (higher in low- and middle-income countries)

Example How to Use Price Elasticity Results

- **Population: price elasticity = - 0.8;**
tax increase causes in cigarette prices to double (e.g from \$ 4 to \$ 8)
 - **There is 100% increase in price**
 - **Formula for Price Elasticity**
Price Elasticity = % quantity / % price
-0.8 = % quantity / 100
% quantity = - 0.8 * 100 = - 80%
- **Result: doubling the price leads to 80% decline in consumption**

Policy Implications

Impact of a tax increase on tax revenue

Current tax revenue = tax base(# cigarette packs) *
tax rate(tax per pack)

Percentage increase in price = proposed tax
increase/current price*100

Change in demand after tax increase = current
demand(tax base) * price elasticity * percentage
increase in price/100

New tax revenue = new demand * new tax rate

Tax Incidence Issues

Regressivity:

A tax that is disproportionately falls on the poor and raise income inequality

Progressivity:

A tax takes a larger proportion of the income of the rich than it does of the poor and reduces inequality

Do the poor really pay more taxes when tobacco tax is increased?

It depends on:

- **Relative price elasticity**
- **Price paid**
- **Amount of smoking**

Additional Tax Burden

$$\begin{aligned}\Delta R &= Q\Delta t - t\Delta Q - \Delta t\Delta Q \\ &= Q\Delta t [1 + E\{(t + \Delta t)/P\}]\end{aligned}$$

ΔR = Changing in tax paid

Q = current quantity; ΔQ = Change in quantity after Δt

P = price before tax increase

t = current tax per unit

$\Delta t = \Delta P$ = proposed change in tax

E = Price elasticity

Examples: Compare the Poor and the Rich

$$P = \$1.00 \quad t = \$0.50 \quad \Delta t = \$0.10$$

and

$$Q_P = 100 \quad Q_R = 100$$

$$E_P = -0.8 \quad E_R = -0.40$$

$$\Delta R_P = \$5.2 \quad \Delta R_R = \$7.6$$

The rich pays more by 46%, \$2.4

What if $Q_P=60$ $Q_R=100$?

What if $P_P=\$.80$ $P_R=\$1.00$?

Impact on the Poor

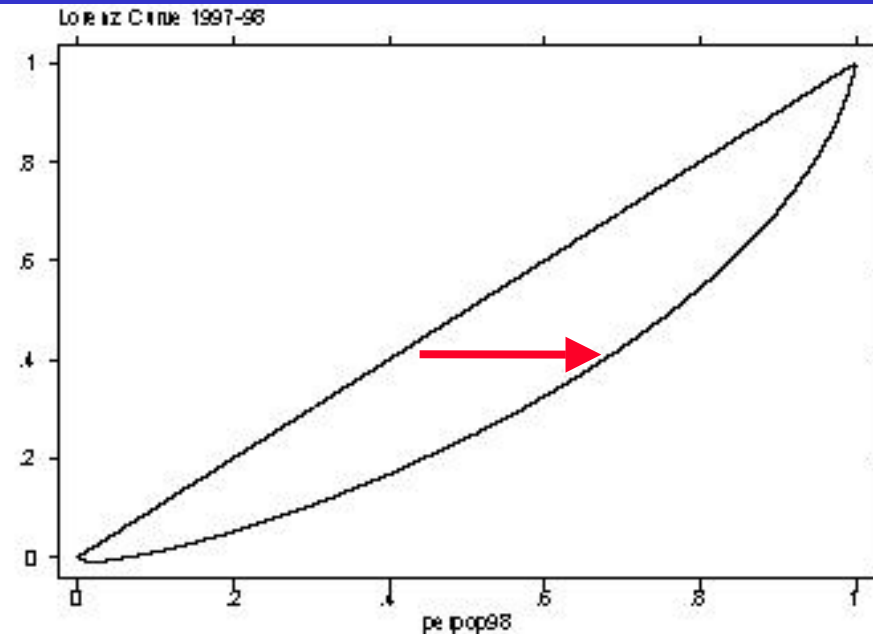
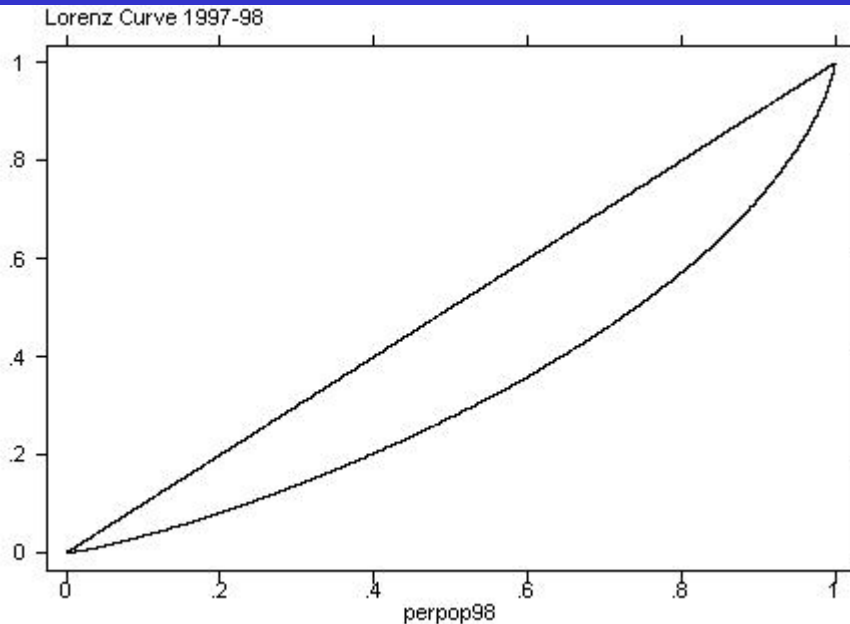
- **Tax increases can be progressive**
 - **Greatest sensitivity to price in lowest income populations**
- **Tobacco taxes should be considered in context of overall tax and spending system**
 - **Revenues generated from tax can be used to support programs targeting the poor**
- **Health benefits of tobacco control are progressive**
 - **Tobacco accounts for about half of health gap between the rich and poor**

Source: Chaloupka et al., 2000; Bobak et al., 2000

Equality - Lorenz Curve

Including tobacco

Excluding tobacco



Source: Hoang Van Kinh et al. *calculation from VLSS 1997-98*

Note: Inequality increases when removing taking tobacco spending from household spending

Interpreting regression results (cont.)

Results for income

- **Compute income elasticity**

Apply the same methods as for price elasticity replacing price with income.

If the elasticity is positive, tobacco product is a superior good.

if the elasticity is negative, tobacco product is an inferior good.

Interpreting results (cont.)

Results for advertising

- If annual data used, expect statistically not significant coefficient due to diminishing marginal product of advertising expenditures.
- Advertising expenditures can be endogenous, i.e. affected by cigarette sales.
- Effect of advertising ban may be small or insignificant, if other media are still available to the industry.

Interpreting results (cont.)

Results for health information and counter-advertising

- Account for diminishing influence over time.

Results for smoking restrictions

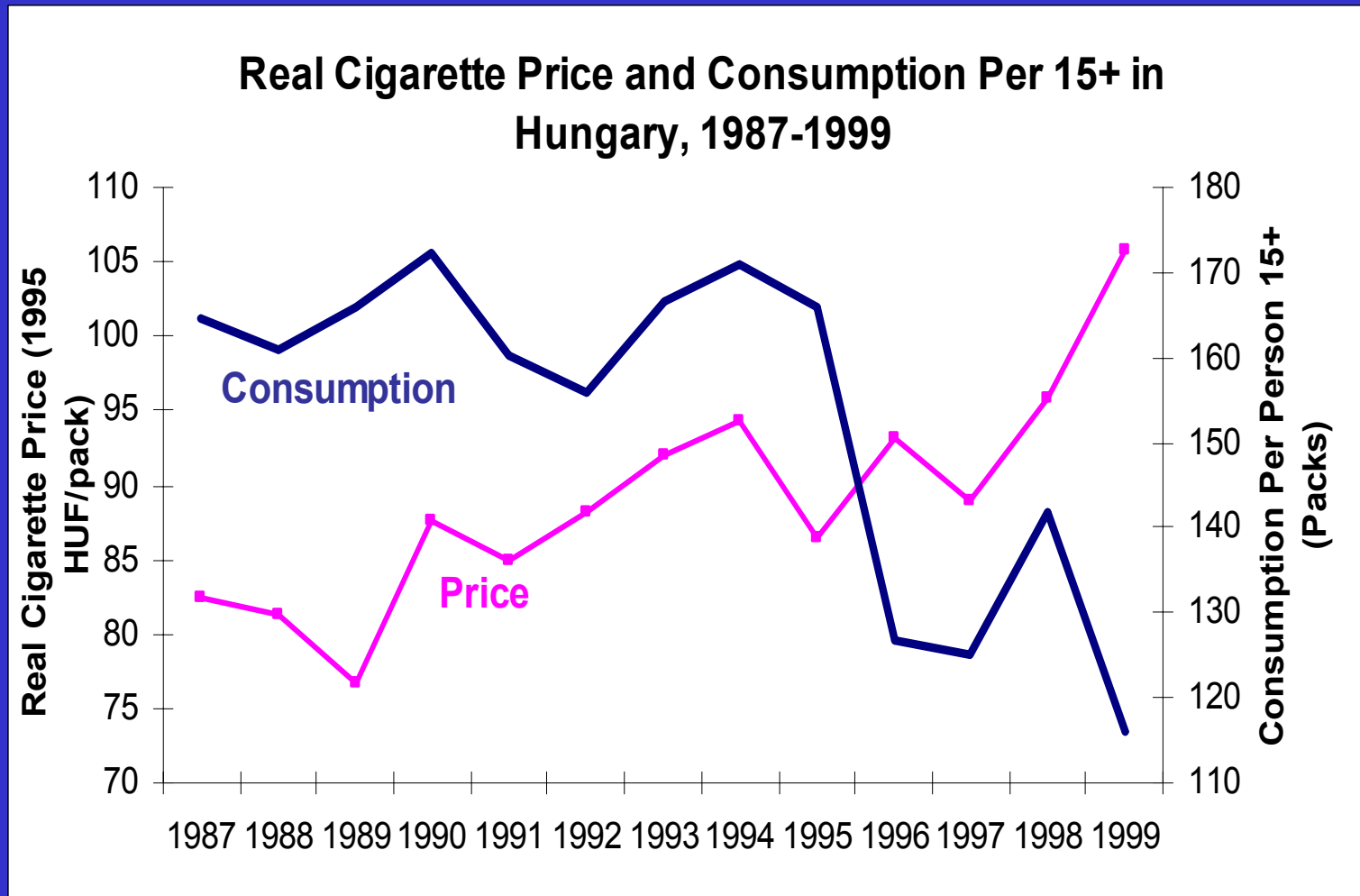
- Account for possible endogeneity with respect to cigarette consumption (anti-smoking sentiment), and enforcement.

Results for price of other tobacco products

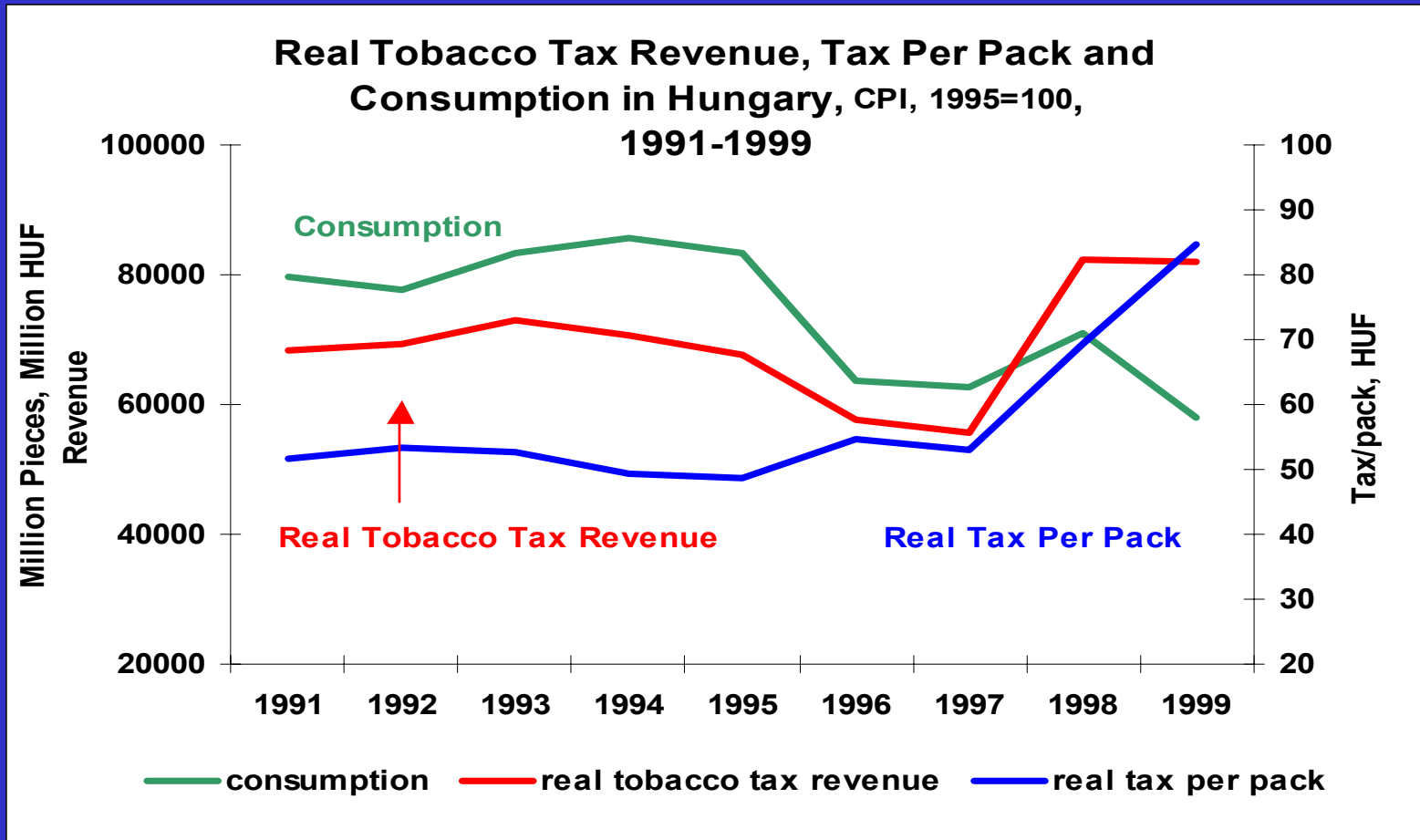
- Compute cross-price elasticity. If positive, substitution exists; if negative, complementary exists.

Price Elasticity Evidence

As tax increases, consumption decreases



Evidence from Hungary: Since 1997 the tax rate has increased, and so has total revenue (in real terms)

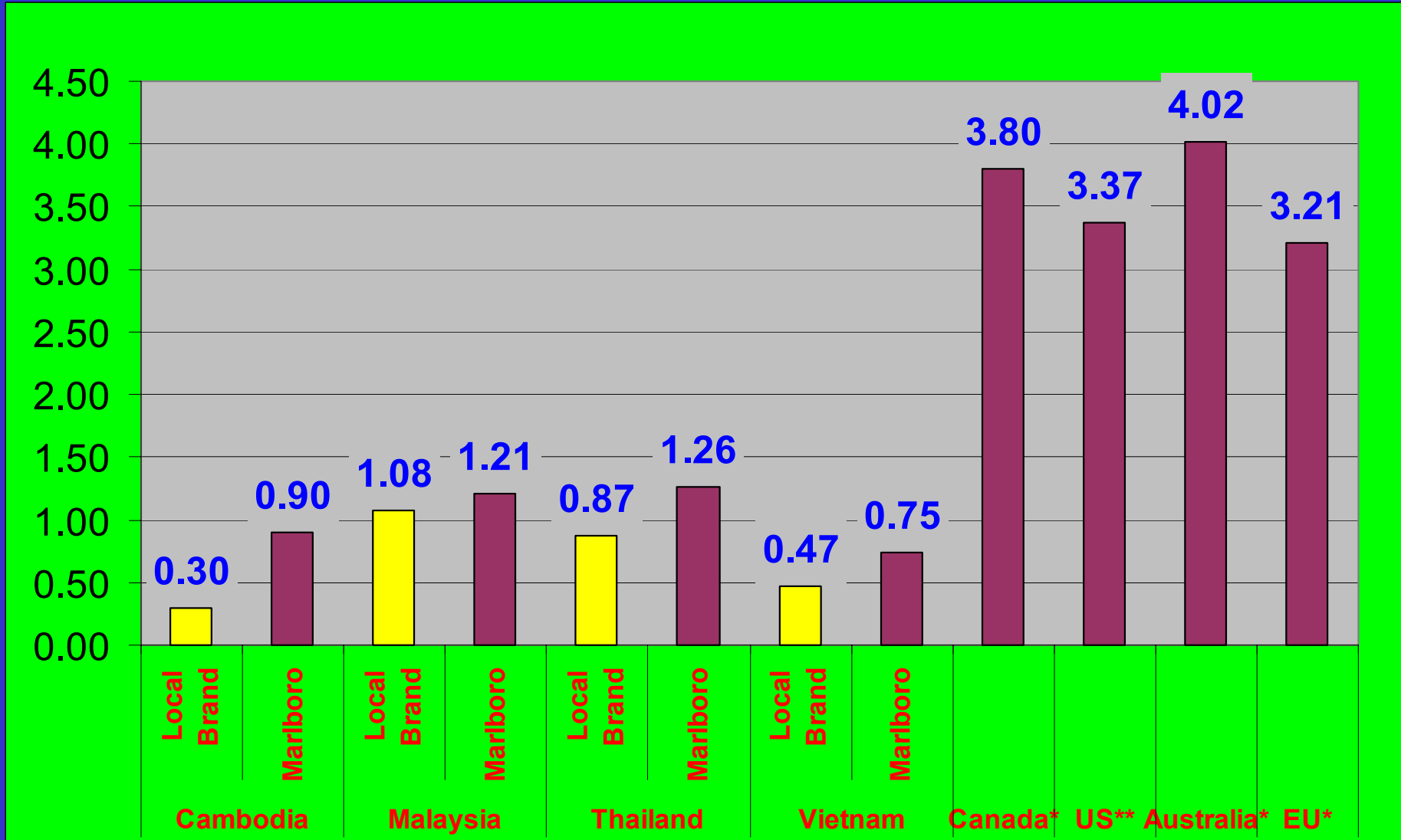


Hypothetical tax increase

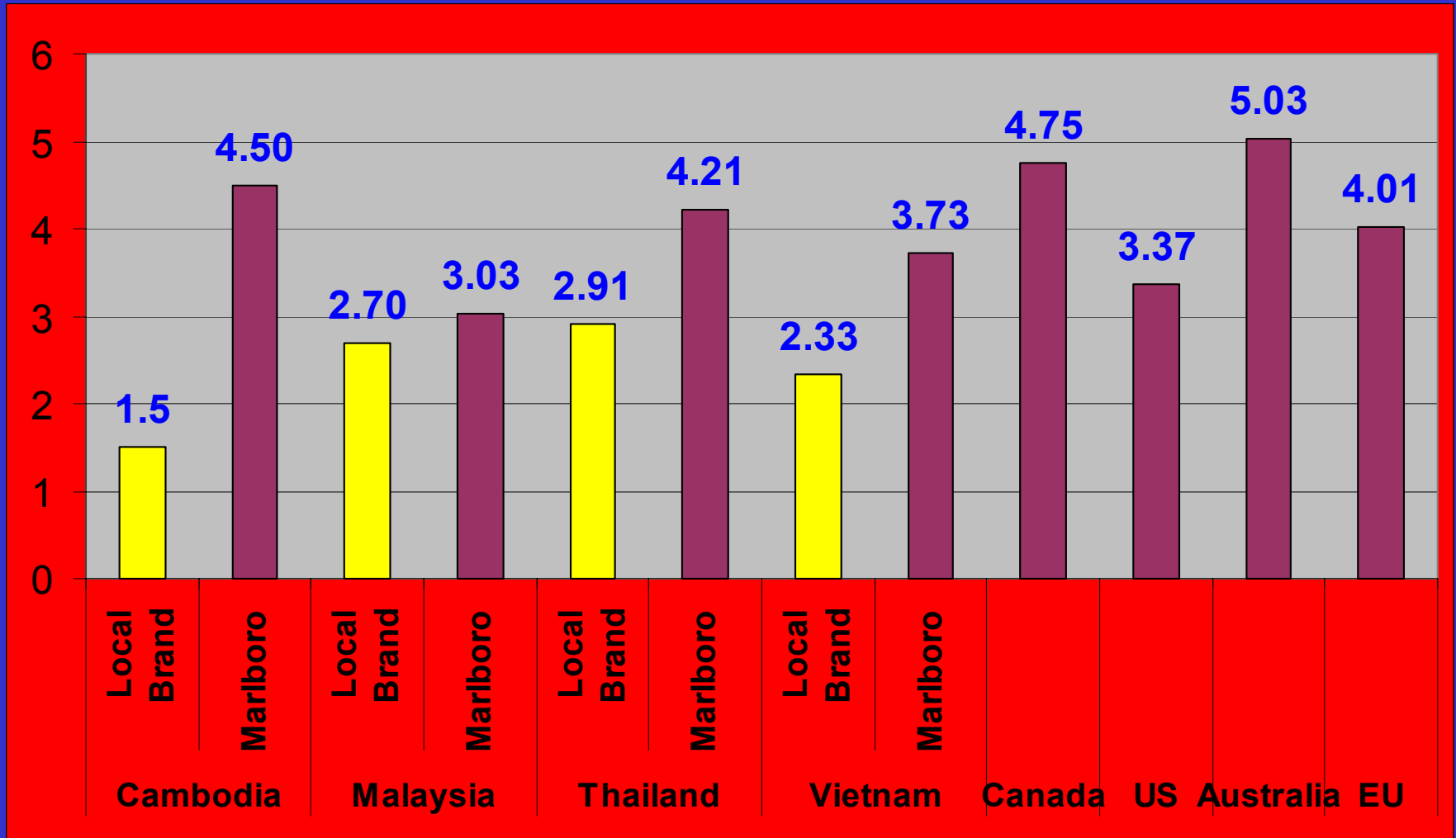
Indonesian Example

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

Cigarette Prices in \$, 2001

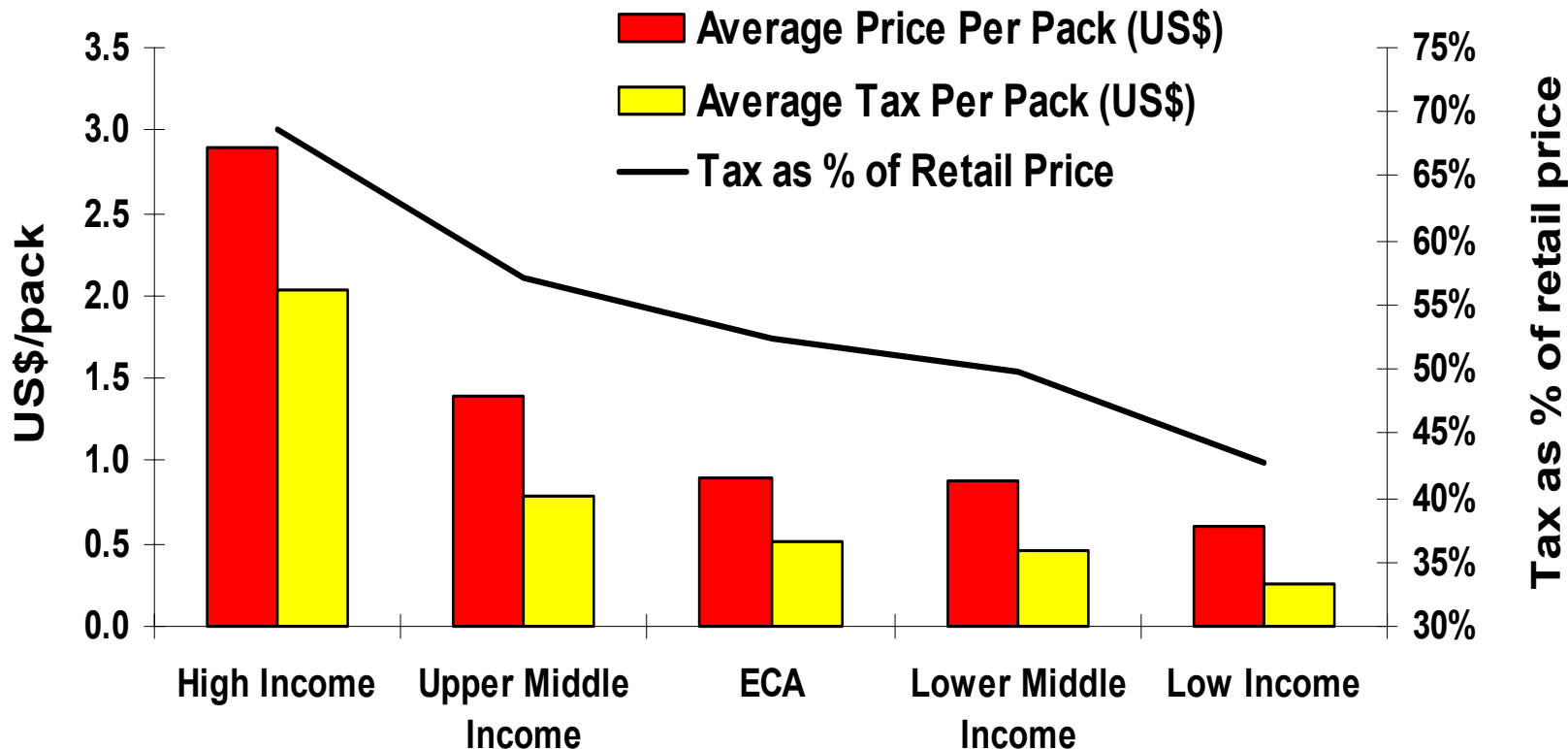


Cigarette Prices in PPP \$, 2001



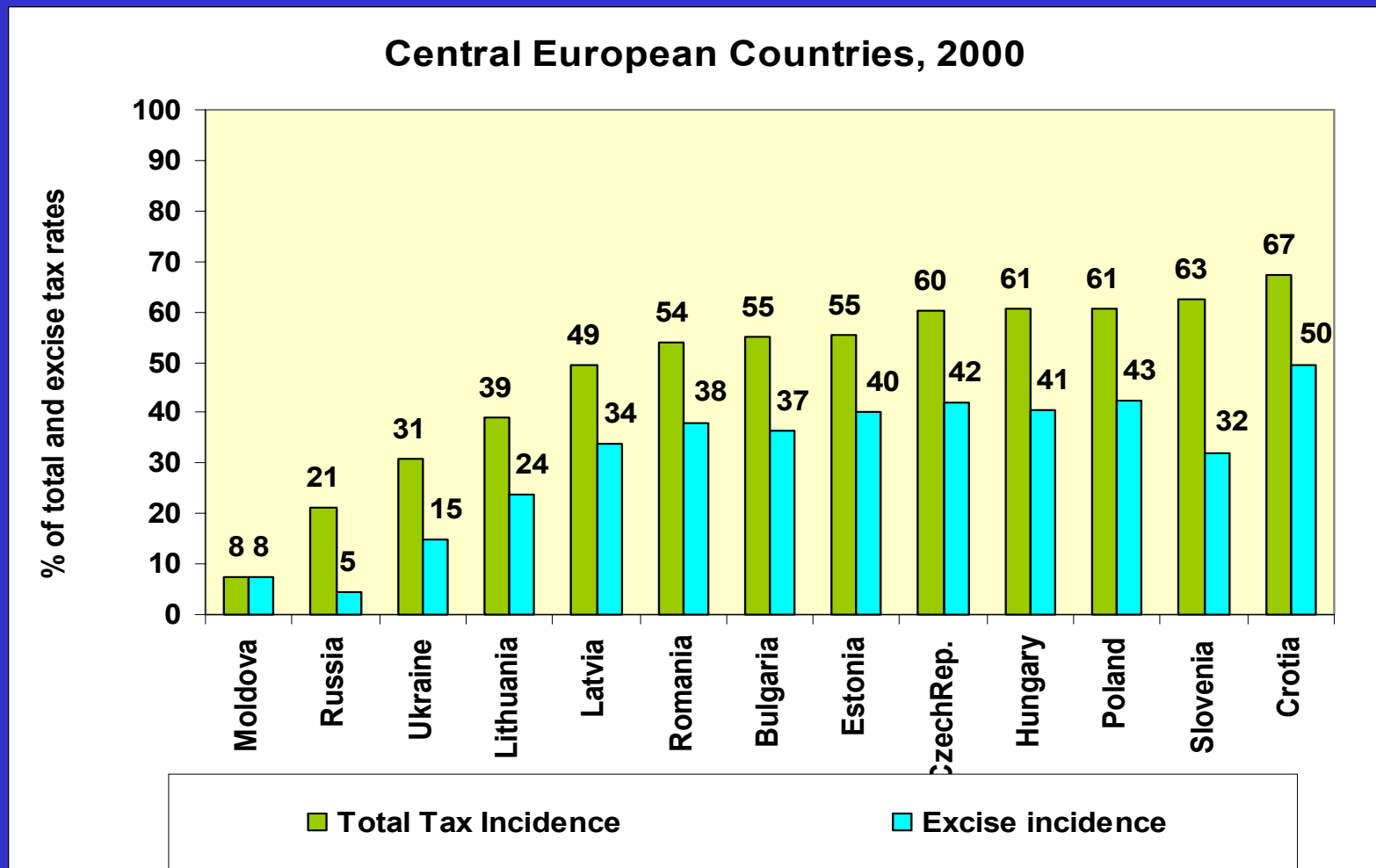
Tobacco Tax Rates and Prices: Europe and C. Asia vs. Rest of the World

Cigarette Prices and Taxes, 1999



Regional Evidence: ECA

Total and Excise Tobacco Taxes as % of Retail Price



What is the “right” level of tax?

- **Complex question**

Depends on various factors, such as degree to which society wishes to **protect children**, **revenue** considerations, health care costs, state of public health & **development**, etc.

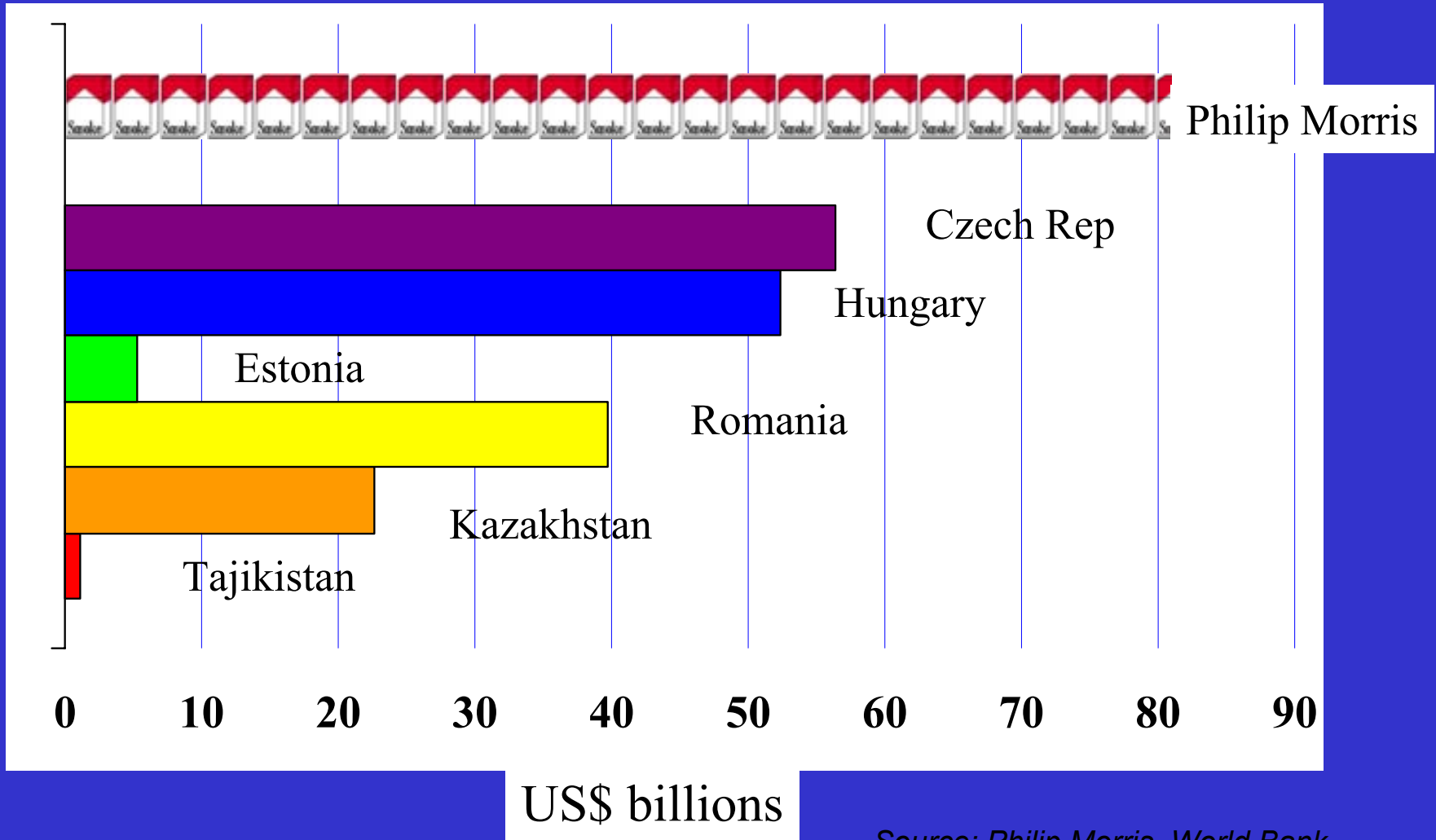
- **Useful yardstick:** where comprehensive programs used, tax is at least $2/3$ to $4/5$ of retail price.

Source: Chaloupka *et al.*, 2000

Summary

- **Revenue loss?** likely to have revenue gains
 - a 10% tax increase would raise revenue by 7%
- **Job loss?** temporary, minimal, and gradual
- **Possible smuggling?** crack down on criminal activity, not lower taxes
- **Costs to individuals, especially the poor?** partially offset by lower consumption

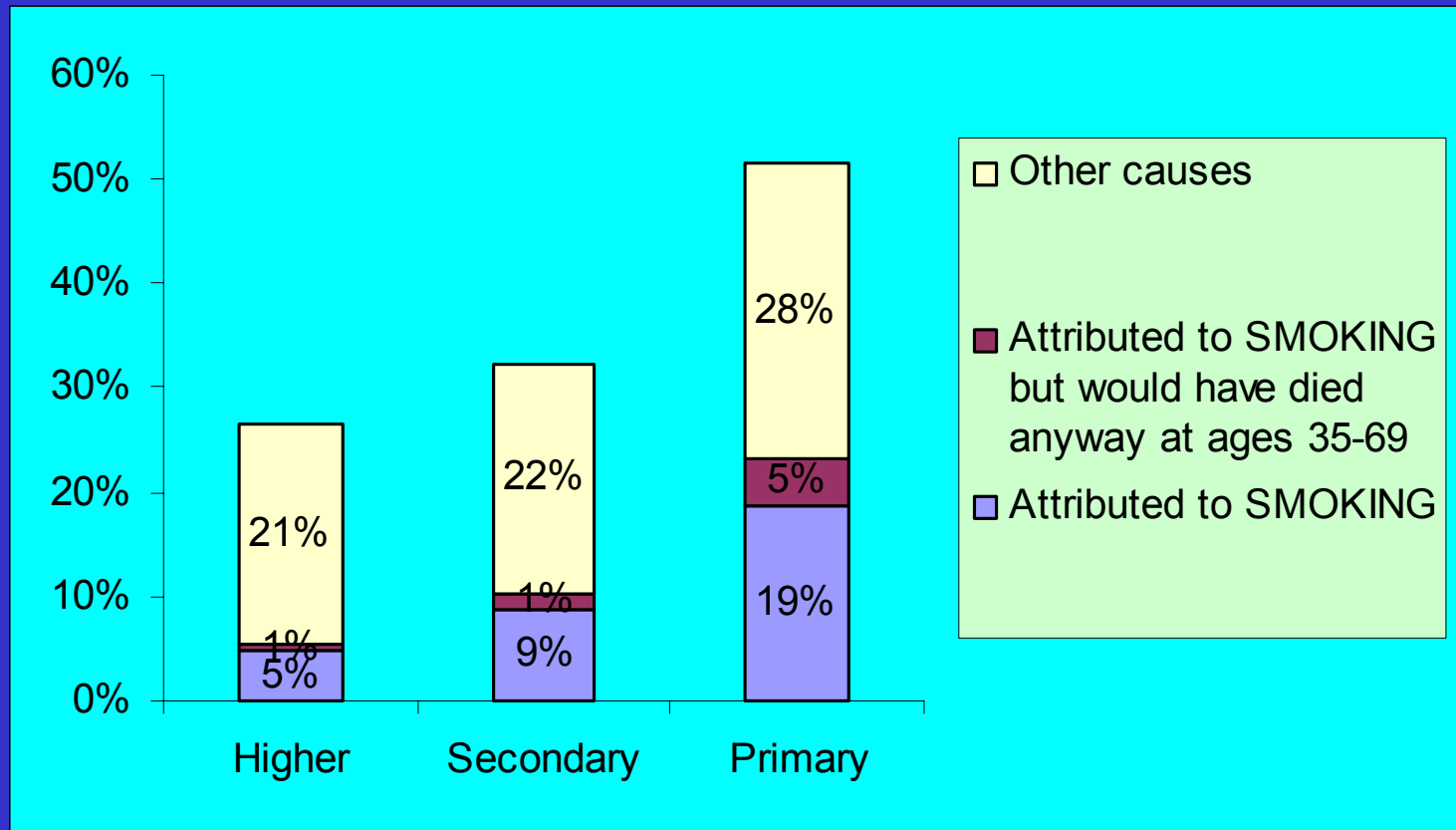
Philip Morris/Altria Revenue & Selected Country GDPs (2001)



Source: Philip Morris, World Bank

Smoking accounts for much of the mortality gap between rich and poor

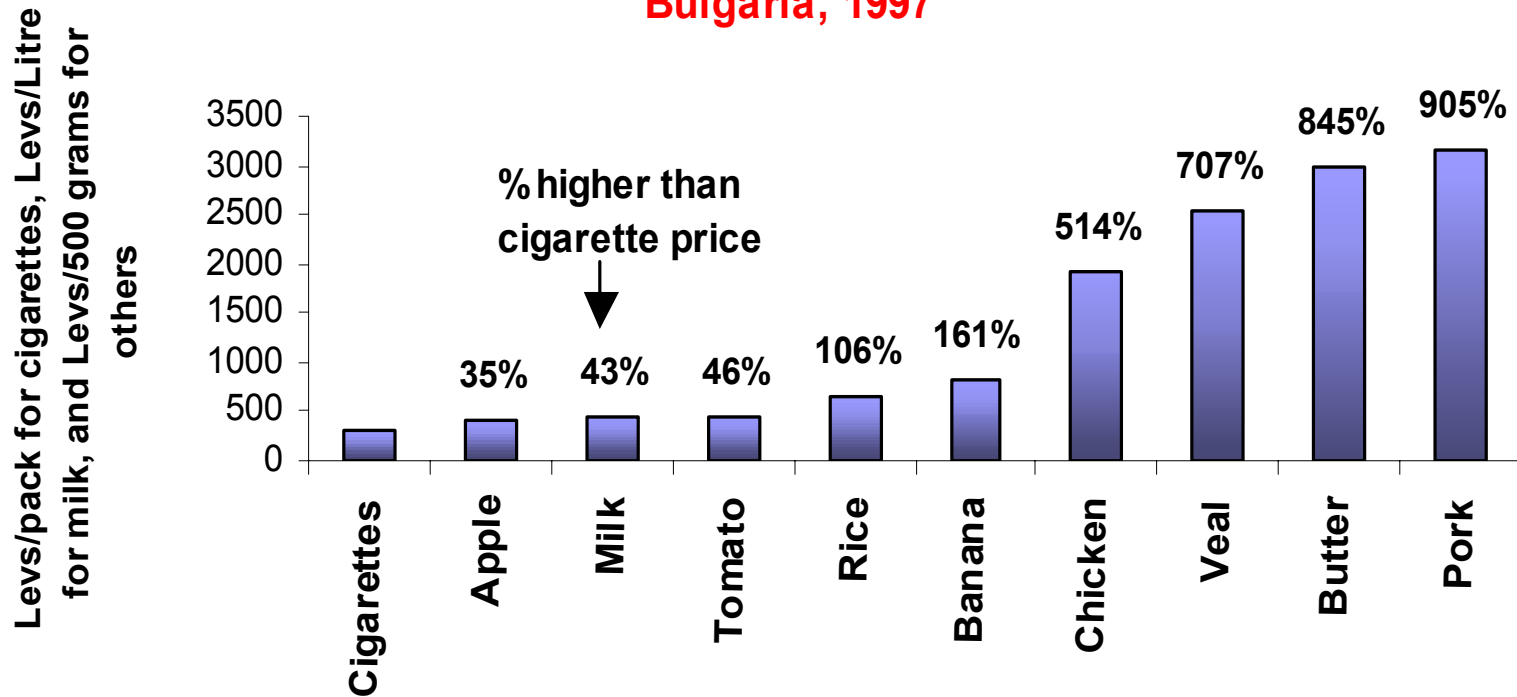
Risk of death of a 35 year old male before age 70,
by education levels in Poland, 1996



Source: Jha et al, 2002, Bobak *et al.*, 2000

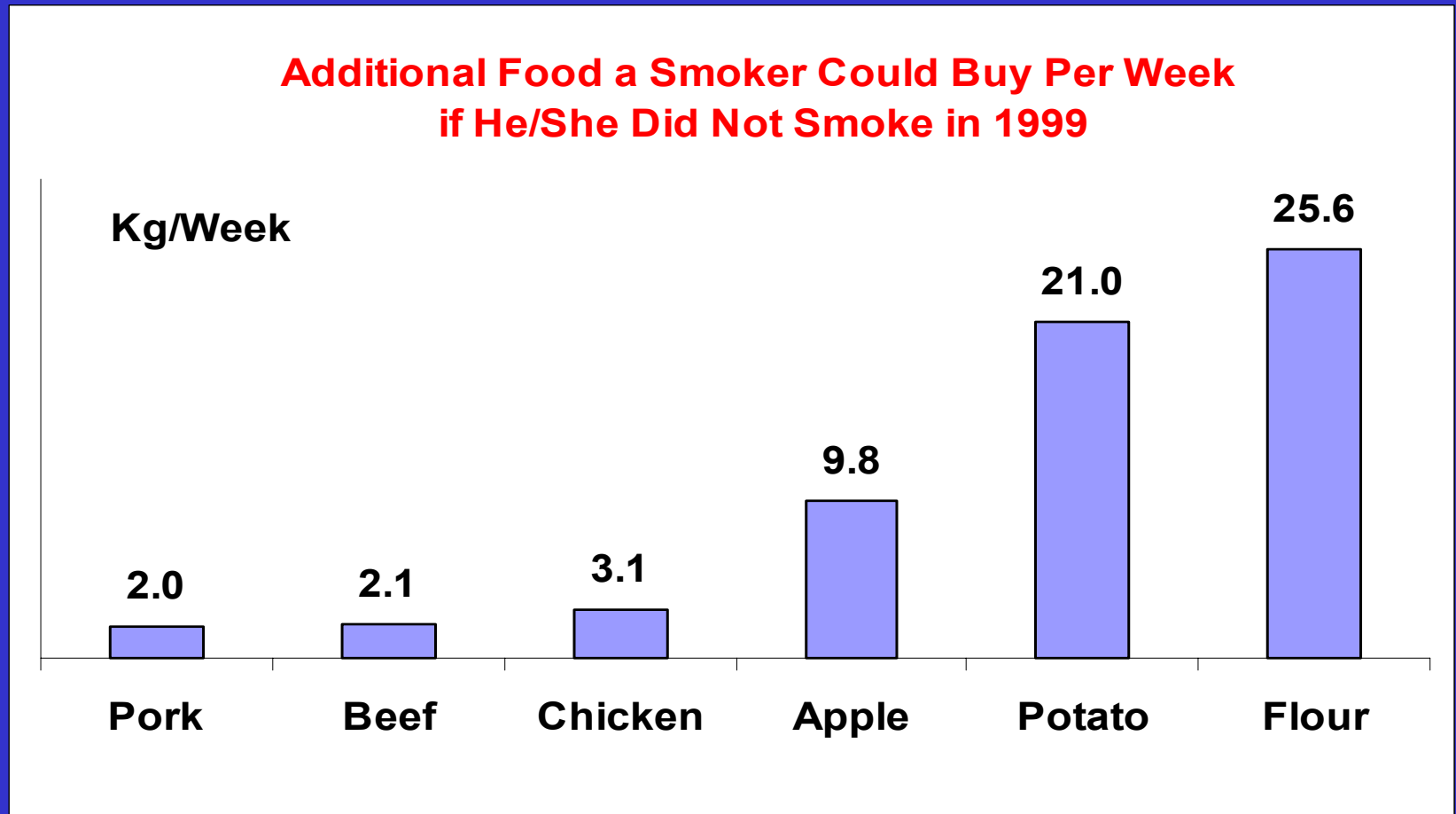
Cigarette prices lower than most food products in Bulgaria

Prices of Cigarettes and Other Consumer Commodities in Bulgaria, 1997

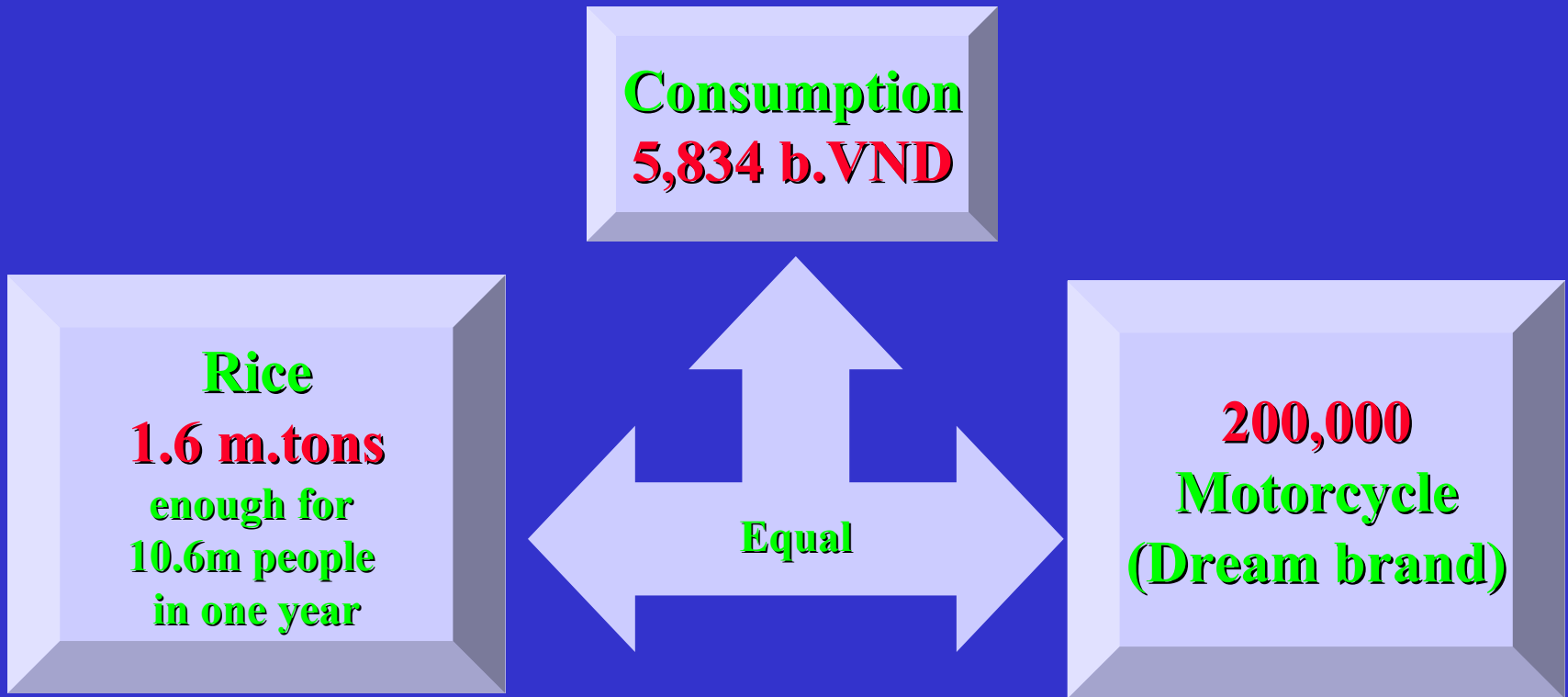


Allocating Tobacco Expenditure to Other Goods and Services

Better Nutrition, Better Health: Evidence from Hungary



New Evidence from Vietnam



Source: Background paper of National Tobacco Control Policy 2000

The financial cost of tobacco use

- **1994 World Bank estimates: tobacco use results in a global net loss of \$200 billion per year.^{1,2}**
- **Half of these losses were occurring in developing countries.¹**
- **Costs come from:**
 - **direct medical care**
 - **absenteeism from work**
 - **fire losses**
 - **reduced productivity**
 - **lost income due to early mortality**

1. World Health Organisation. Tobacco or Health Programme. Guidelines for controlling and monitoring the tobacco epidemic. 1996; Chapter 1.

2. Barnum H. The economic burden of the global trade in tobacco. (Outline of a paper presented at the *9th World Conference on Tobacco and Health*, 10–14 October 1994, Paris, France.)

Costs of Tobacco Use - Concept

- **What is counted depends on the question asked**
- **Whose costs?**
 - **Costs for the society**
 - **Cost for an individual – smoker**
 - **non-smoker**
 - **Cost for the government**

Type of Costs Related to Tobacco Use

- **Direct Costs** – related to health care
(preventive care, outpatient, inpatient, transportation, etc.)
- **Indirect Costs** – morbidity related
(e.g. lost income)
– mortality related
(e.g. lost pension)

Type of Cost Estimates

- **Prevalence Based** (a given year) – reflect historical trend, impact on prevalence change cannot be estimated
- **Incidence Based** (over lifetime) – impact on prevalence change can be estimated, but sensitive to assumptions about future costs, technology change, etc.

Healthcare costs from smoking

- **Annual (gross) healthcare costs (prevalence based):**
 - **0.1-1.1% of GDP, or 6 -15% of total health costs in high-income countries**
 - **proportionally similar in lower-income countries**
- ***However*, in the absence of smoking, the elderly population would grow, as would old-age chronic disease costs. On balance, costs likely would fall, but only modestly. Net savings would be small.— incidence based, transfer payments considered. TC community should stick to the real reason to combat smoking: its devastating health effects.**

What Was Wrong With the PM Study in Czech Republic?

- **Narrow view of costs of smoking – government (budget) perspective, prevalence based estimates.**
- **It counts collected taxes as benefits - however, there is an alternative tax bases available**
- **If taxes left out from the calculation, there is no net benefit, and smoking costs the government 13-times more than its savings (on pensions and housing for elderly)**

Impact of Smoking on Medical Expenditures and Productivity

- **Epidemiological approach**
- **Human capital approach
(calculating indirect costs)**
- **Econometric approach**

Epidemiological Approach

- **Smoking Attributable Fraction (SAF)** for related disease (cancer, heart, and lung)
- **Medical services use**, mortality rate, morbidity
- **Costs** of services and wages
- **Rice study (1986)** \$53.7 billion (\$23.3 billion direct costs, \$30.4 billion indirect costs)

Contribution of Smoking to Risk of Premature Death Among Males, Age 35-69, by Social Class, England and Wales, 1991, in thousands

	Attributed to Smoking	Attrib to Smoking, but would have died anyway	Other Cause	Total Risk
Highest Class	5	1	17	23
Non-Manual Class	8	1	22	31
Middle Manual Class	13	2	21	36
Lower Class	21	4	24	49

Source: Jha et al. BMJ

Econometric Approach

- Use **econometric model** to estimate smoking attributable amount
- **Two-part model/negative binomial model**
- Manning (1990)/L. Miller(1998), V. Miller (1999), \$53.4 billion medical expenditures

General Model Specification

Dependent Variables:

medical expenditures, days lost work, day in bed, mortality, conditions of illness

Independent Variables:

smoking status, gender, age, education, income, insurance status

Probability of Medical Expenses

	<u>Medication</u>	<u>Ambulatory</u>
Current light smokers	0.011	-0.069
Current heavy smokers	0.082***	0.013
Former light smokers, quit <15 yrs	0.086	0.106
Former heavy smokers, quit <15 yrs	0.373***	0.340**
Former light smokers, quit 15+ yrs	0.144	0.448**
Former heavy smokers, quit 15+yrs	0.334***	0.417**

Estimated income growth from better adult health

- Among 52 countries, adult male survival between ages 15 to 60 rose from 70% to 80% between 1965 and 1990
- Better survival raised income growth by 0.23% per year between 1965 and 1990
- Adjustment for changes in physical capital, education, fertility, economic openness, and technical progress

Estimated income growth from better adult health

- If adult male **survival in FSE** were that of OECD countries, annual growth rates over the last three decades would have been about **1.4% vs. 1%**
- **1990 per capita income:**

Actual	\$2,700
With better male survival	\$3,000
-12% higher	
- \$140,000,000,000 greater	

Opportunity cost – example from Vietnam

2340million packs * 20 = 46800 m.cigarettes

Minimum

$46800m * 7min = 327,600,000,000 \text{ minute} = 5,460,000,000\text{hours}$
 $5,460,000,000\text{hours} / (365\text{days} * 24\text{hours}) =$

623,288 years

(without sleeping)

Source: Calculation by author based on standard time smoking of one cigarette by WHO.

Additional Tax Burden

$$\begin{aligned}\Delta R &= Q\Delta t + t\Delta Q \\ &= Q\Delta t[1 + E\{[t/(P+t)]\}]\end{aligned}$$

ΔR = Changing in tax paid

Q = current quantity; ΔQ = Change in quantity after Δt

P = current pre-tax price

t = current tax per unit

Δt = proposed change in tax

E = Price elasticity

Examples: Compare the Poor and the Rich

$$P = \$1.00$$

$$t = \$0.50 \quad (\Delta t = \$0.10)$$

and

$$Q_P = 100$$

$$Q_R = 100$$

$$E_P = -0.8$$

$$E_R = -0.40$$

$$\Delta R_P = \$7.33$$

$$\Delta R_R = \$8.67$$

The rich pays more by 18%, \$1.34

What if $Q_P=60$ $Q_R=100$?

What if $P_P=\$.80$ $P_R=\$1.00$?

Impact of Higher Taxes on Household Expenditure

$$\Delta B = a * (1 + E) \Delta T$$

ΔB = additional fraction of income spent on non-tobacco products

a = fraction of income spent on tobacco

E = Price elasticity (negative)

ΔT = fraction change in the original tobacco price ($\Delta t/P$)

Example

$a = 0.024$ (spend 2.4% income on tobacco)

$E = -0.8$

$\Delta t = \$0.3 \Rightarrow \Delta T = \$0.3/\$3.0 = 0.1,$

$\Delta B = 0.024(1-0.8) \times 0.1 = 0.00048 = 0.048\%$

(non-tobacco expenditure will fall by 0.048% if $\Delta t = \$0.30$)

What if $a = 0.050$

if $E = -0.4$