Tobacco taxes and Laffer Curve
Theoretical background and empirical applications

Sophia Delipalla
University of Macedonia, Thessaloniki, Greece

2nd Regional Policy Dialogue on Tobacco Economics in Southeastern Europe
Skopje, December 12-13, 2019

Taxes, revenues and the Laffer curve

- Are taxes an effective tool for financing government expenditure?

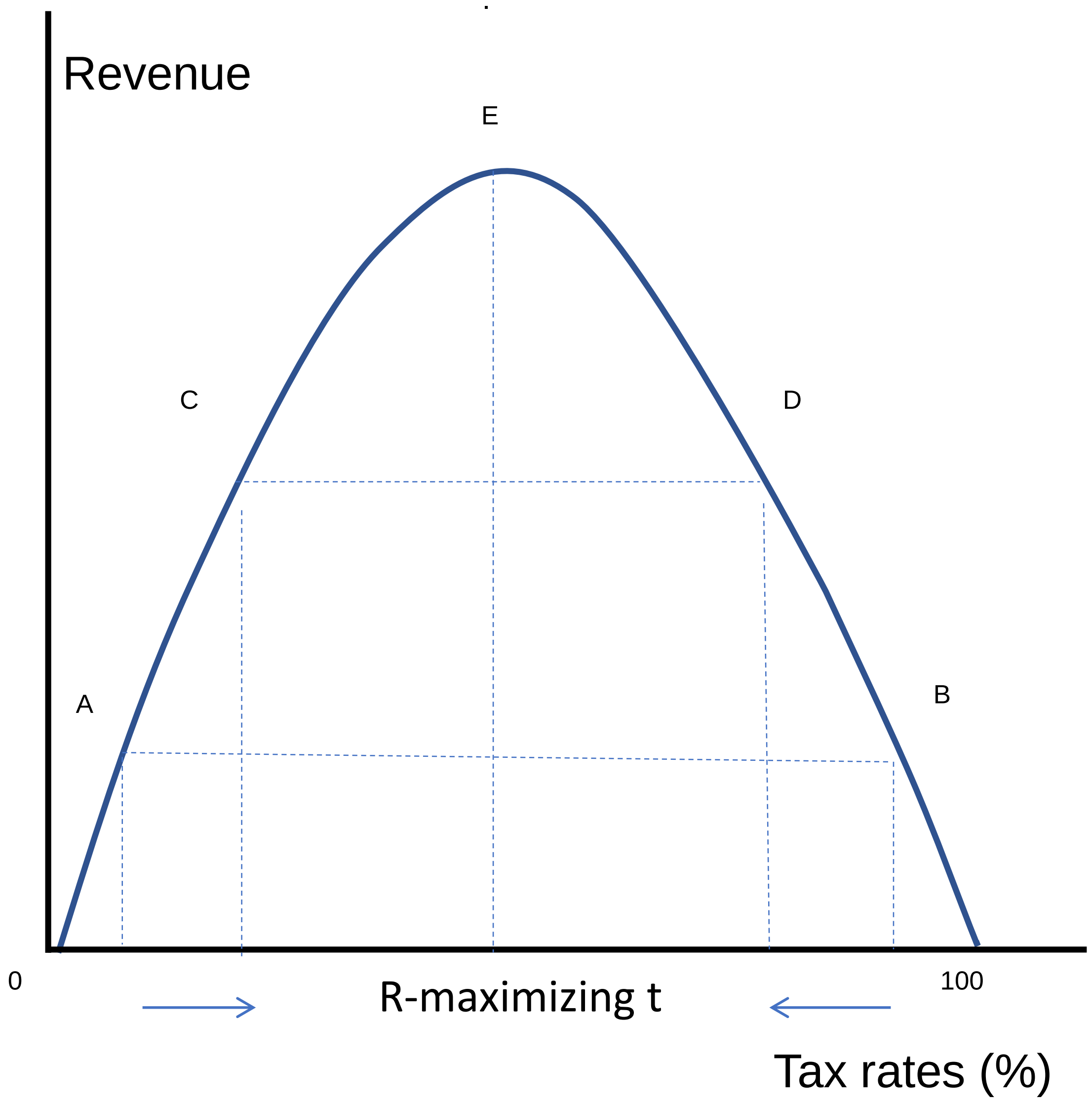
- The Laffer curve provides an evaluation

  - reflects a non-linear relationship between tax rate and tax revenue:
    - when tax rate is zero, tax revenue is zero as well
    - as tax rate increases, tax revenue increases but up to a point where it reaches its maximum value
    - after the revenue-maximizing tax rate, any tax rate increase implies decreases in tax revenue
    - revenue becomes zero again when tax rates are so high that they eliminate the tax base.

  - easy to calculate revenue-maximizing tax rate.

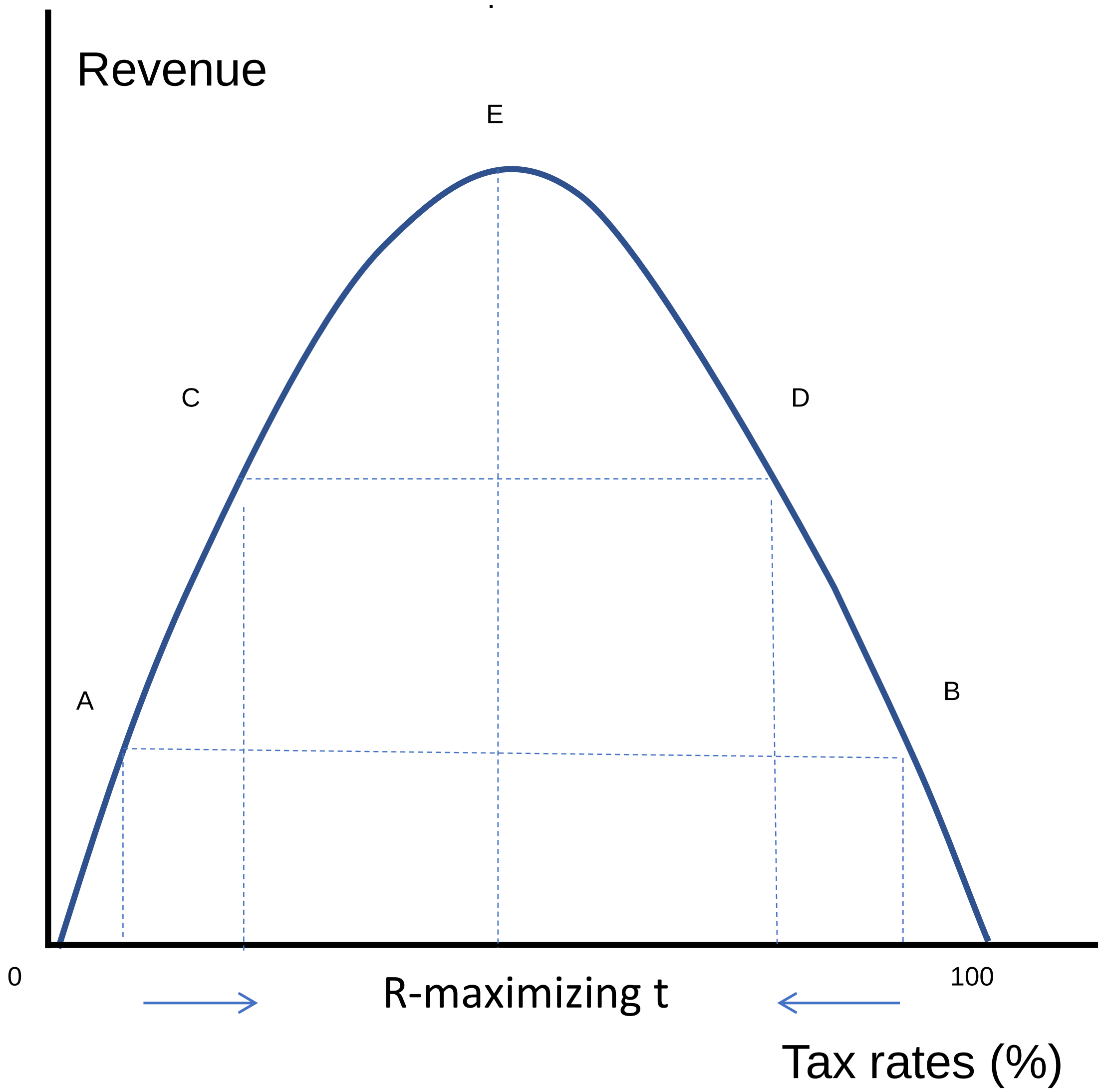
The Laffer curve

- Starting from a zero tax rate, raising the rate up to E increases revenue.
- A and B yield same level of revenue but point A represents a low tax rate with high consumption and point B a high tax rate with low consumption.
- Starting from a 100% rate, reducing tax rate up to E implies revenue increases.
- Revenue is maximized at E.



The Laffer curve: The prohibitive range

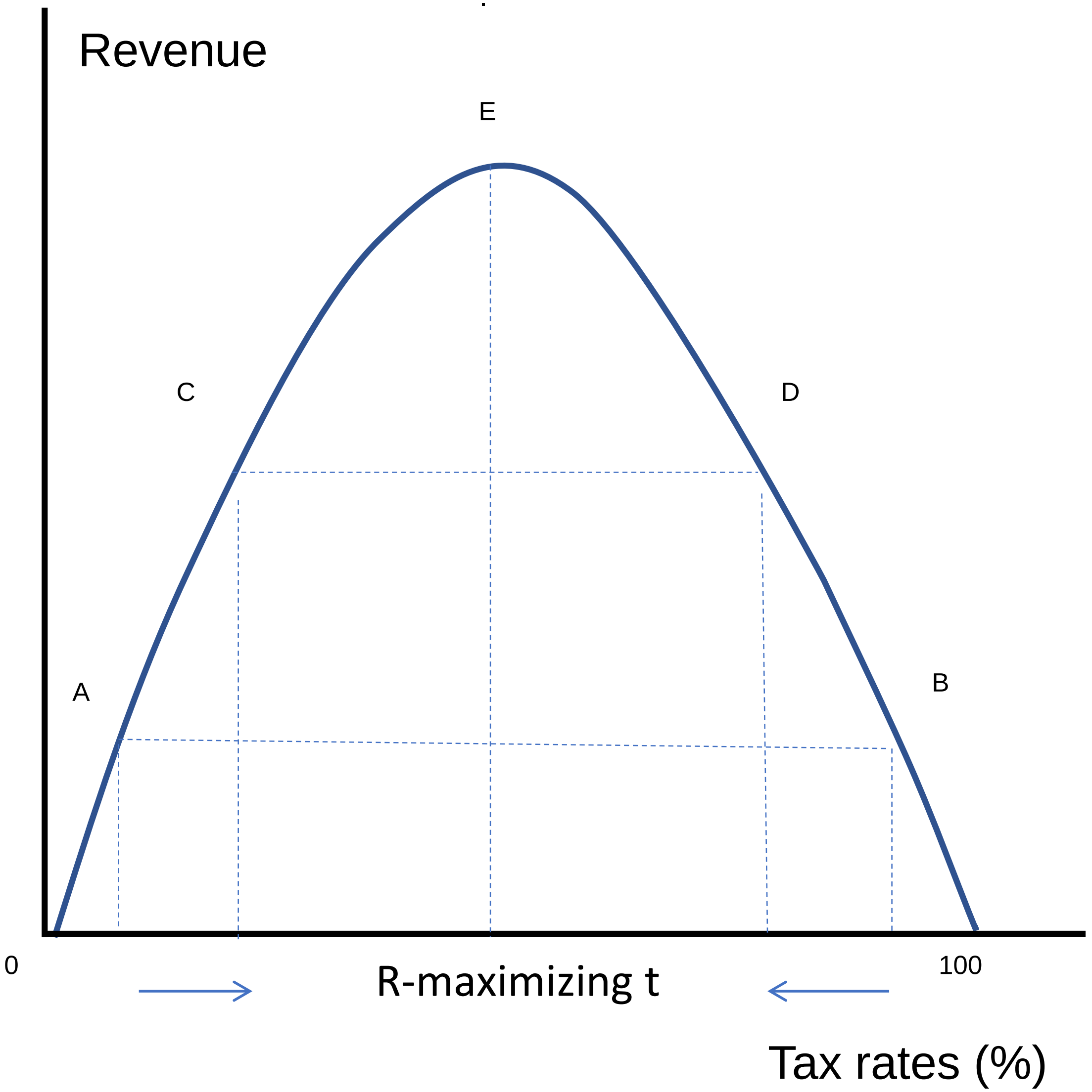
- Starting from a 100% rate, reducing tax rate up to E implies revenue increases.
- Why is this a <u>prohibitive</u> range for tax rate increases?
  - Due to behavioural responses
  - Consumers may shift to informal market due to
    - reduction in purchasing power
    - perceived benefits from use of tax revenue being lower than its cost
  - Firms may price strategically to convert extra tax revenue into profit
    - over-shift tax increase leading to prices much higher than intended



The Laffer curve: Shape and location

Shape and location of Laffer curve depends on

i. tax (type and) rate
ii. demand elasticity
iii. firms’ response to tax increase

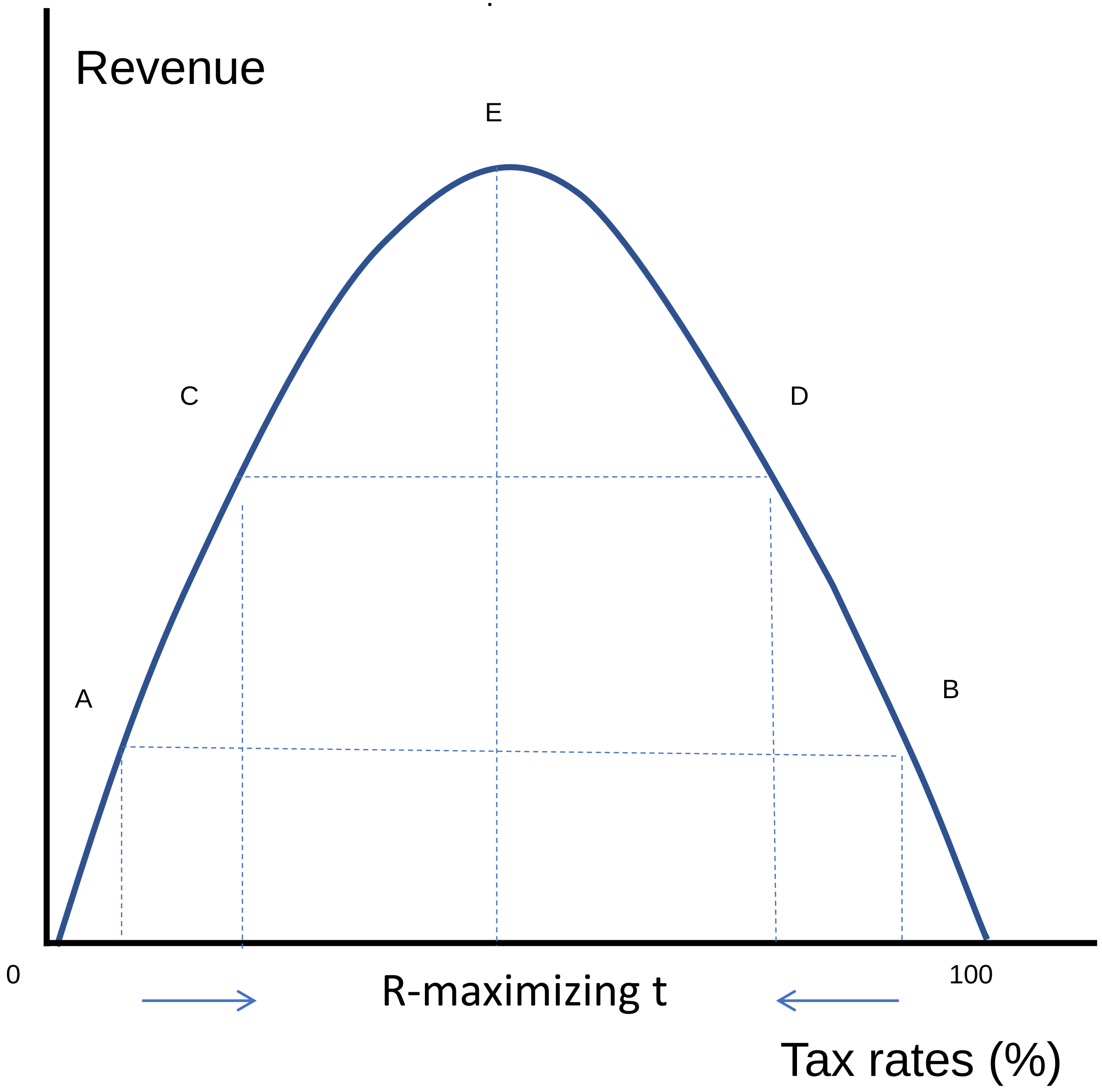


The Laffer curve: Shape and location

- A change in level of tax rate, with all other factors influencing consumption being constant, is represented by a movement along the Laffer curve.

- As tax rate changes, so does the elasticity of tax base
    - at each point on Laffer curve corresponds a different elasticity.

- For a given tax rate, various demand and supply factors shift the curve and tax base elasticity changes at a given tax rate (see slide 12).

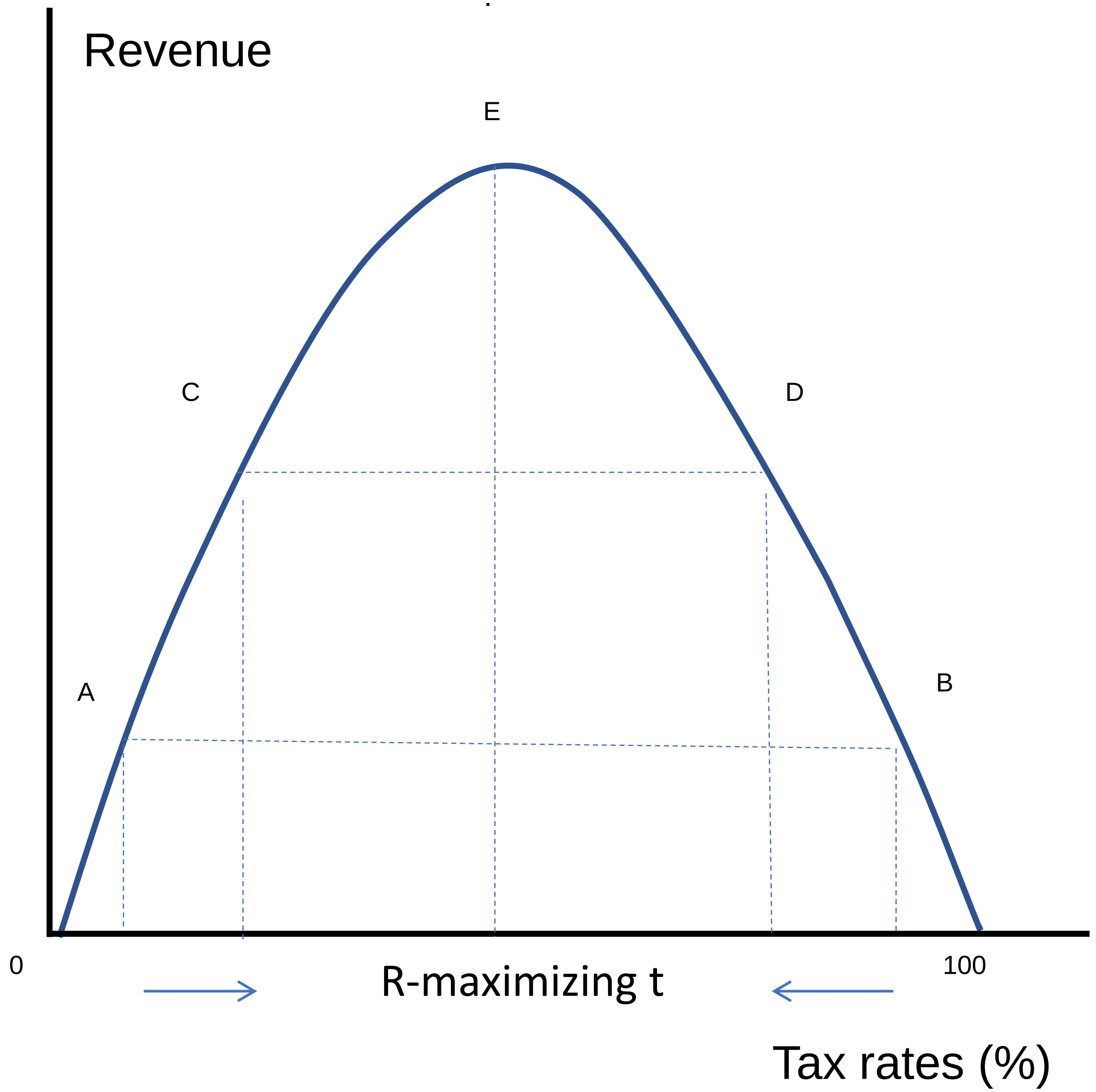


The Laffer curve: Shape and location

Shape and location of Laffer curve depends on

i. tax (type and) rate
ii. demand elasticity
iii. firms' response to tax increase

- The more price inelastic the demand, the higher the tax rate at which the turning point occurs



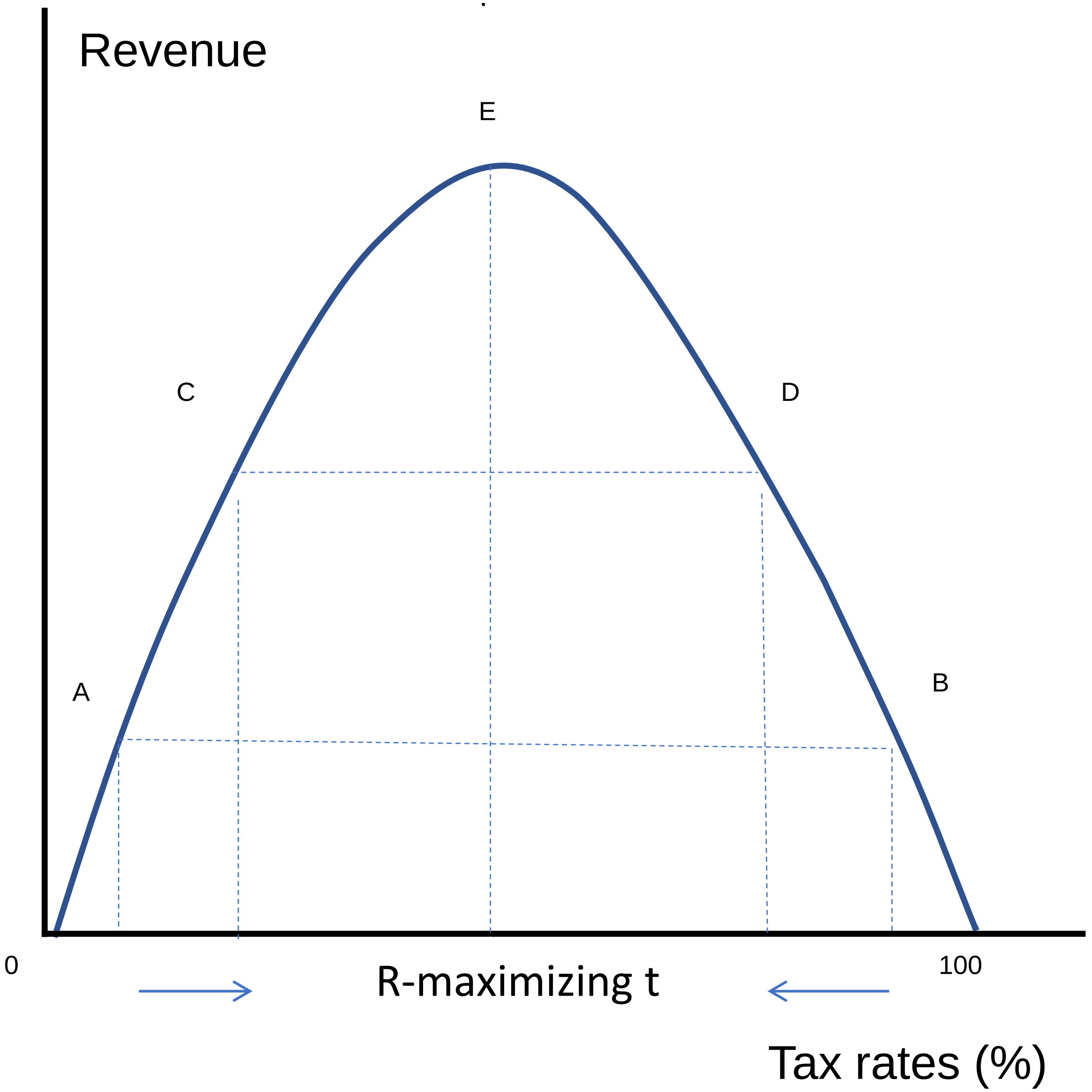
The Laffer curve: Shape and location

Shape and location of Laffer curve depends on

i. tax (type and) rate
ii. demand elasticity
iii. firms' response to tax increase

➢ strategic pricing:

- may over-shift tax increase leading to prices much higher than intended
- may absorb tax increase to limit its effect on final price

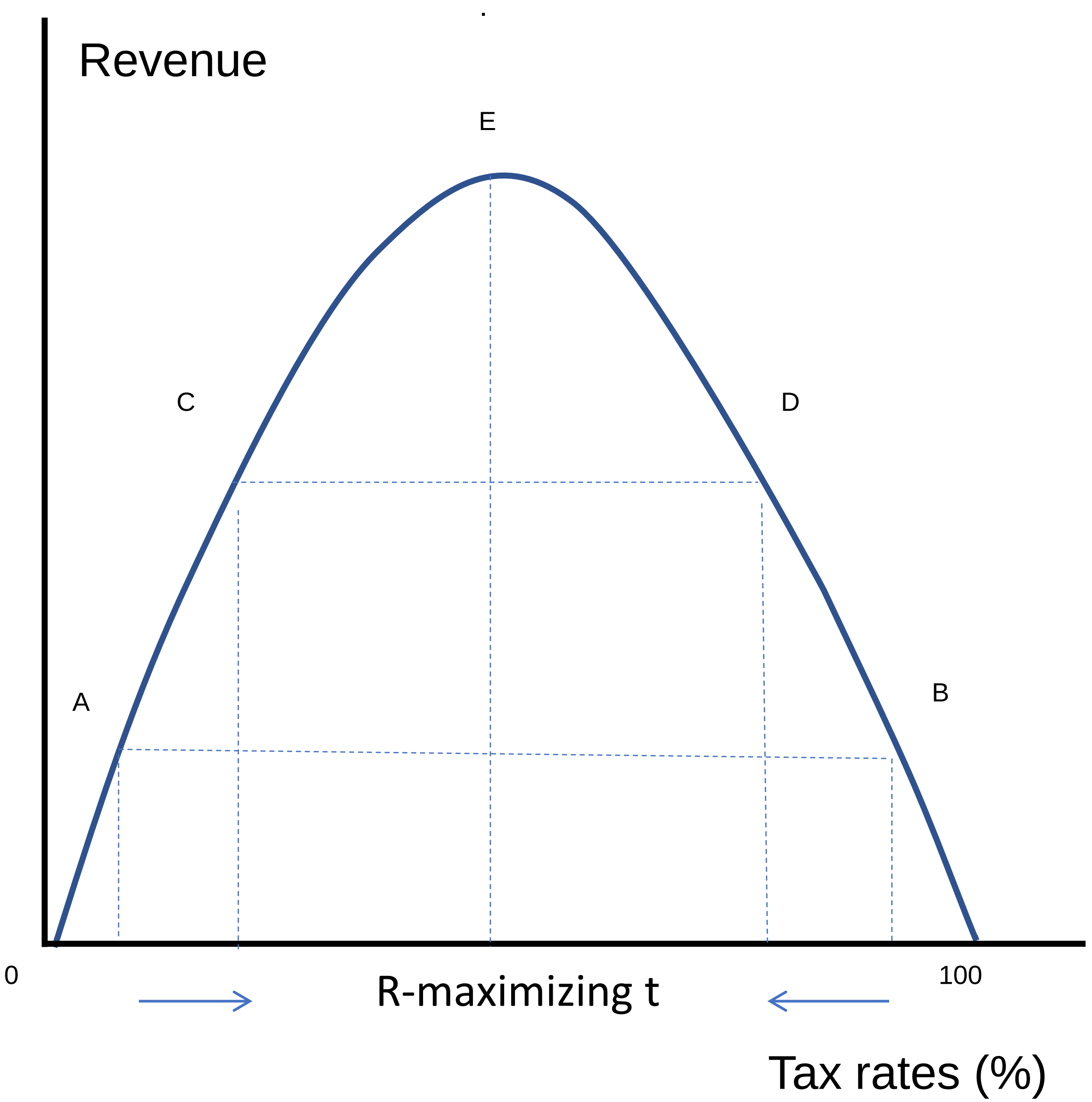


The Laffer curve: Shape and location

Shape and location of Laffer curve depends on

i. tax (type and) rate
ii. demand elasticity
iii. firms' response to tax increase

- strategic pricing
- may over-shift tax increase leading to prices much higher than intended
    - tax rate and price response strategic complements
- may absorb tax increase to limit its effect on final price
    - tax rate and price response strategic substitutes

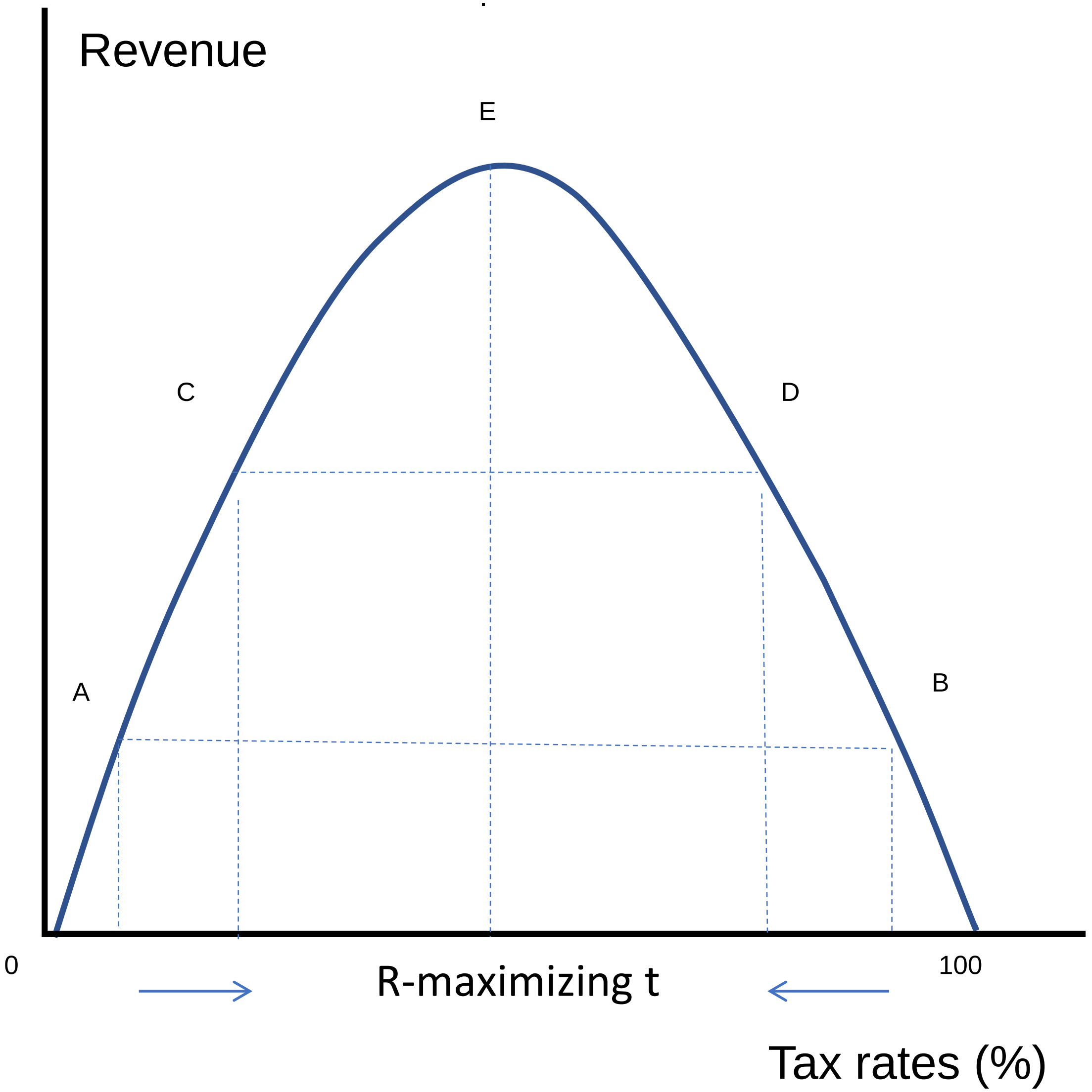


The Laffer curve: Shape and location

Shape and location of Laffer curve depends on

Depends on (i) and (ii)

- tax (type and) rate
- demand elasticity
- firms' response to tax increase
  - strategic pricing
  - may over-shift tax increase leading to prices much higher than intended
    - tax rate and price response strategic complements
  - may absorb tax increase to limit its effect on final price
    - tax rate and price response strategic substitutes

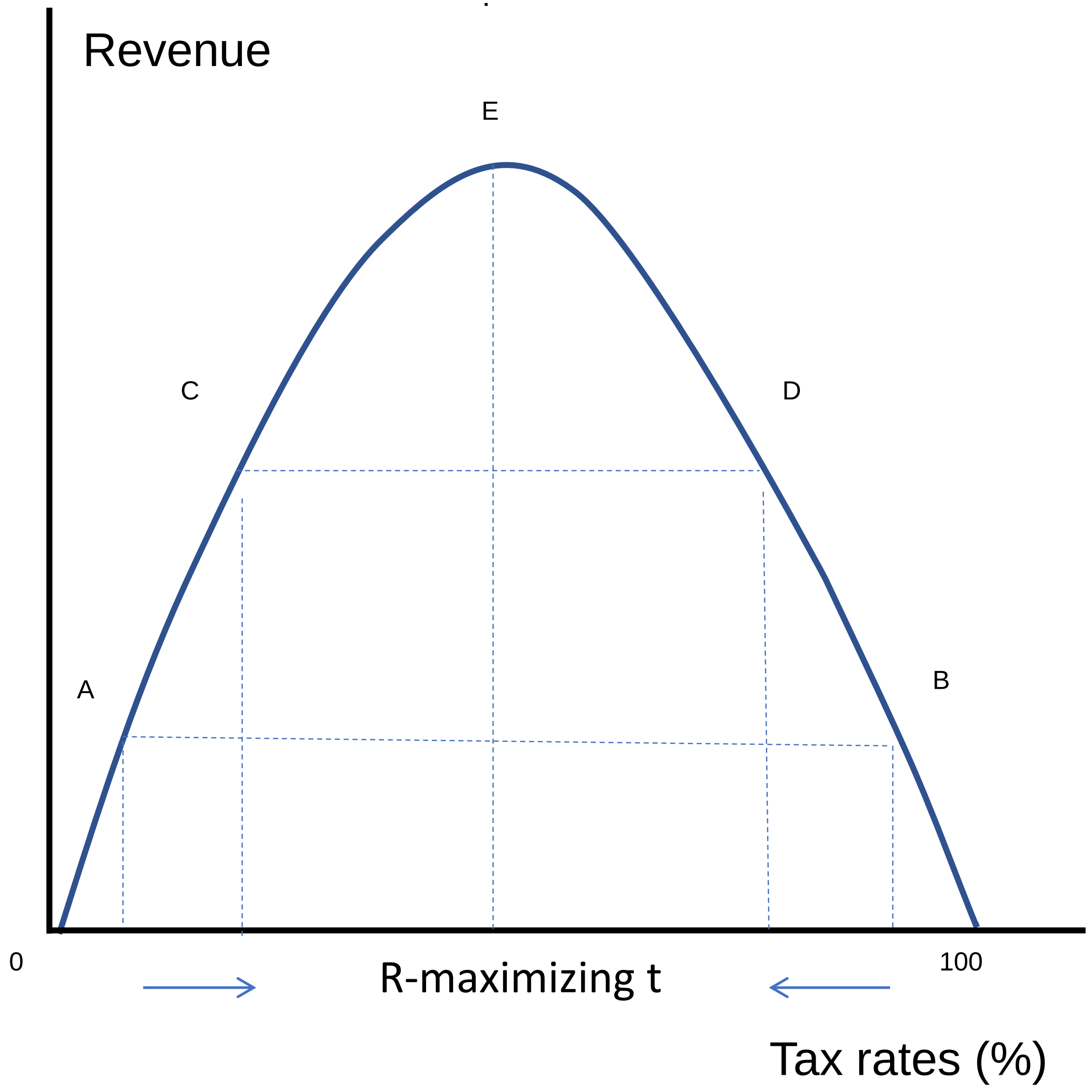


The Laffer curve: Shape and location

Shape and location of Laffer curve depends on

i. tax (type and) rate
ii. demand elasticity
iii. firms' response to tax increase

- The higher the tax shifting elasticity, the lower the tax rate at which turning point occurs

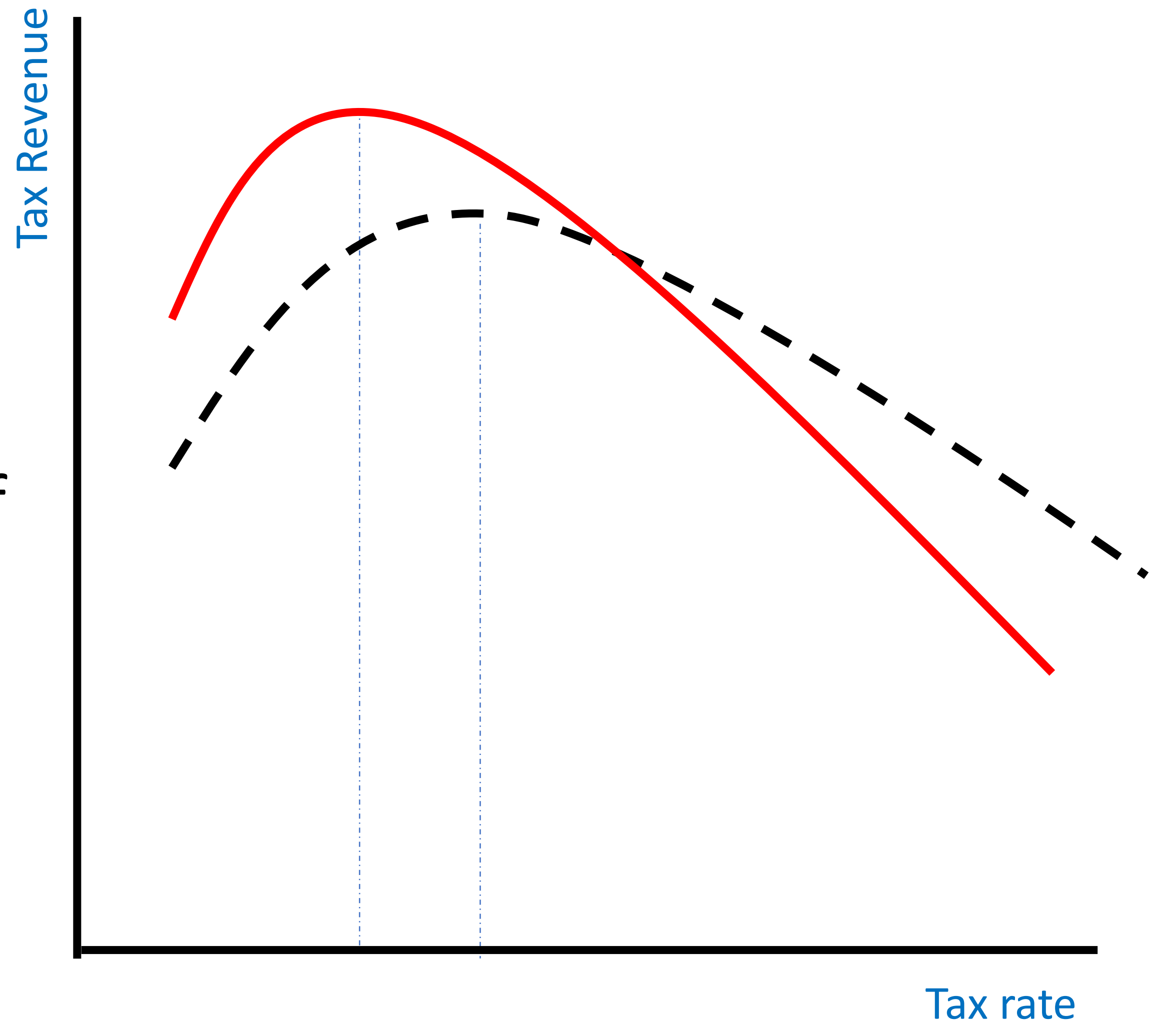


Firm responses and the Laffer curve

- When manufacturers move wholesale prices in opposite direction of tax changes
  - after a tax increase, firms choose a lower pass-through to limit reduction in quantity demanded

➢ Revenue agency chooses a higher optimal tax rate relative to situation of ignoring firm's response (red curve)

- Market power among firms causes Laffer curve to flatten out and shift downwards and to the right
  - reflecting not only less extra tax revenue but also a higher R-maximizing tax rate.



More on Laffer curve and behavioural effects

Matters are more complicated since

- there is a different curve for each product category
- there is a different curve for each income group
  - social attitudes, concerns over public health and redistribution, and perceptions about revenue uses differ across individuals or socioeconomic groups and across countries
- Consumers’ response is not the same for the same tax rate change at different points in time because economic conditions change (e.g. income growth, inequality increase, more efficient tax collection).
- There is an inherent time lag involved between tax changes and their impact on consumption and hence revenue.

The analytics of Laffer curve: specific taxation

- Tax revenue: *R= t Q(t)*
  - where t=specific tax rate and Q= quantity demanded
- Tax base is (legal) quantity consumed
- A change in the tax rate *t* leads to a change in tax revenue collected:

$$\frac{\partial R}{\partial t} = \underbrace{Q}_{\substack{\text{mechanical} \\ \text{effect} \\ (+)}} + \underbrace{t\,\frac{\partial Q}{\partial t}}_{\substack{\text{behavioural} \\ \text{effect} \\ (-)}}$$

- The two effects go to opposite directions and net effect of tax increase on revenue depends on which of the two effects dominates.

The analytics of Laffer curve: specific taxation

- $$\frac{\partial R}{\partial t} = \underbrace{Q}_{\substack{\text{mechanical effect} \\ (+)}} + \underbrace{t\,\frac{\partial Q}{\partial t}}_{\substack{\text{behavioural effect} \\ (-)}}$$

Mechanical effect: is simply the tax base

e.g. if Q=100 units and ∆t=1 cent, then change due to mechanical effect is ΔR=100 cents

However, this assumes initial quantity consumed remains fixed

The analytics of Laffer curve: specific taxation

- $$\frac{\partial R}{\partial t} = \underbrace{Q}_{\substack{\text{mechanical effect} \\ (+)}} + \underbrace{t\,\frac{\partial Q}{\partial t}}_{\substack{\text{behavioural effect} \\ (-)}}$$

Behavioural effect: net effect of two kind of responses due to tax change:

- Consumers react to higher prices
  - Demand less (depending on elasticity)
- Firms react to changes in profit margin
  - Reset prices
    - increase price by more than tax increase, when market power increases
    - absorb part of the tax increase, when profit margin falls
      - Strategic pricing

The analytics of the Laffer curve: specific taxation

Revenue elasticity with respect to tax

$$\frac{\Delta R/_R}{\Delta t/_t} = (1 + \eta_t) \gtreqless 0 \;\; iff \;\; |\eta_t| \lesseqgtr 1$$

where η_t is tax base elasticity: proportionate reduction in tax base (consumption) when tax rate increases by 1%

$$\eta_t = \frac{\Delta Q/_Q}{\Delta t/_t} < 0$$

- Increasing the tax rate will reduce the level of tax revenue collected only

  if tax base is elastic

  that is, consumption is sensitive to tax changes and behavioural effect dominates

The analytics of the Laffer curve: specific taxation

- But, is tobacco tax base likely to be elastic?
- Tax base elasticity can be written as

$$\eta_t = \frac{\Delta P}{\Delta t}\frac{t}{P}\varepsilon \ < 0$$

- Magnitude of tax base elasticity depends on

  - ❑ magnitude of price elasticity of demand $\varepsilon = \frac{\Delta Q}{\Delta P}\frac{P}{Q}$,
  - ❑ degree of tax shifting on consumer price $\frac{\Delta P}{\Delta t}$,

    (both depend on form of demand function)
  - ❑ tax-price ratio $\frac{t}{P}$.

Tax shifting elasticity

The analytics of the Laffer curve: specific taxation

- Evidence suggests *price* elasticity of demand for tobacco is usually higher than zero but less than one in absolute value (e.g. WHO, 2010; IARC, 2011).

➢ tobacco consumption is tax-inelastic
  - unless there is tax over-shifting and its magnitude is sufficiently high to more than offset the inelastic demand and the (smaller than one) tax-price ratio.

- Most recent empirical studies provide evidence of cigarette tax under-shifting or at most full-shifting (e.g. Harding et al. (2012) and Espinosa and Evans (2012) respectively).

- $\eta_t = \underbrace{\frac{\Delta P}{\Delta t}}_{\leq 1} \underbrace{\frac{t}{P}}_{<1} \underbrace{\varepsilon}_{<1} < 0$

$\rightarrow$ Tax base (tobacco consumption) is expected to be tax inelastic

- What if magnitude of (any of) these factors change?
  - Level of revenue collected changes.

The analytics of the Laffer curve: ad valorem taxation

- Tax revenue: $R = v\,P\,Q(v)$
  - where v=ad valorem rate, P= consumer price and Q= quantity demanded

- Tax base now is total consumer expenditure (or, equivalently, industry sales revenue) on (legal) tobacco consumption.

- A change in tax rate *v* leads to a change in tax revenue collected:

$$\frac{\partial R}{\partial v} = \underbrace{PQ}_{\substack{\text{mechanical} \\ \text{effect} \\ (+)}} + \underbrace{\left[vQ \frac{\partial P}{\partial v}(1+\varepsilon) \right]}_{\substack{\text{behavioural} \\ \text{effect} \\ (?)}} = PQ \left[1 + \underbrace{\frac{\partial (PQ)}{\partial v} \frac{v}{(PQ)}}_{\substack{\text{Tax base elasticity} \\ (?)}} \right]$$

The analytics of the Laffer curve: ad valorem taxation

- Sign of tax base elasticity depends on magnitude of price elasticity of demand.

- Relationship between ad valorem tax rate and tax base can be either negative or positive.

- $\eta_v = \dfrac{\Delta(PQ)}{\Delta v}\dfrac{v}{(PQ)} = \dfrac{\Delta P}{\Delta v}\dfrac{v}{P}(1+\varepsilon)$

$$\gtreqless 0 \quad iff \quad |\varepsilon| \lesseqgtr 1$$

The analytics of the Laffer curve: ad valorem taxation

- When demand is price-inelastic ($|\varepsilon| < 1$), tax base elasticity is positive ($\eta_v > 0$):
  - an ad valorem tax rate increase leads to a higher level of revenue, at all rates.

- $\eta_v = \frac{\Delta(PQ)}{\Delta v}\frac{v}{(PQ)} = \frac{\Delta P}{\Delta v}\frac{v}{P}(1+\varepsilon)$

  $\gtreqless 0 \quad iff \quad |\varepsilon| \lesseqgtr 1$

- $\frac{\Delta R}{\Delta v}\frac{v}{R} = (1+\eta_v) \gtreqless 0 \quad iff \quad |\eta_v| \lesseqgtr 1$

The analytics of the Laffer curve: ad valorem taxation

- When demand is price-elastic ($|\varepsilon| > 1$), tax base elasticity is negative

- However, as long as $|\eta_v| < 1$, tax revenue increases with a tax rate increase, even if demand is price-elastic

- $\eta_v = \frac{\Delta(PQ)}{\Delta v}\frac{v}{(PQ)} = \frac{\Delta P}{\Delta v}\frac{v}{P}(1+\varepsilon)$

  $\gtreqless 0 \quad iff \quad |\varepsilon| \lesseqgtr 1$

- $\frac{\Delta R}{\Delta v}\frac{v}{R} = (1+\eta_v) \gtreqless 0 \quad iff \quad |\eta_v| \lesseqgtr 1$

How can we change the magnitude of tax base elasticity? (1)

Through measures that **change**

$$\eta_t = \frac{\Delta P}{\Delta t}\frac{t}{P}\varepsilon$$

- **demand elasticity** of tobacco products
  - changing consumer preferences (through health awareness campaigns and other non-price tobacco control measures), and consumers' perception of detection probability and tax enforcement, eliminating opportunities for tax evasion and tax avoidance (availability of licit and illicit substitutes)
- tobacco **tax share** in price
  - such as EU regulations or WHO recommendations on cigarette tax-price ratio

❑ EU regulations regarding harmonization of tax share in prices aimed - at least initially - at reducing price differentials; however, this is also a tool towards the public health objective.

How can we change magnitude of tax base elasticity? (2)

On the other hand,

$$\eta_t = \frac{\Delta P}{\Delta t} \frac{t}{P} \varepsilon$$

- Manufactures affect tax base elasticity through their pricing policy
  - e.g. **degree of tax-shifting**.
- Industry behaviour, however, is itself affected by government tax policy and regulations
  - specific versus ad valorem taxes
  - large versus small tax increases
  - non-price measures affecting elasticity
  - …
- Governments can effectively manipulate tax base elasticity through their policies.

Summarizing up to now

- Tobacco consumption is expected to be tax-inelastic

- If, after successful tobacco control, prices reach levels where demand is elastic, tax base is still most likely to be inelastic due to tax under-shifting
  - over-shifting is not a good pricing policy when demand is elastic
  - taxation serves as an instrument for both fiscal and public health objectives.

- In other words, a tax rate increase in combination with non-price tobacco control measures, which make consumers more sensitive to price (tax) increases, leads to declining but still positive marginal revenues
  - we remain on the left-hand (normal) side of the Laffer curve.

Empirical applications

Simulating tax changes

Laffer curve simulations

Make use of

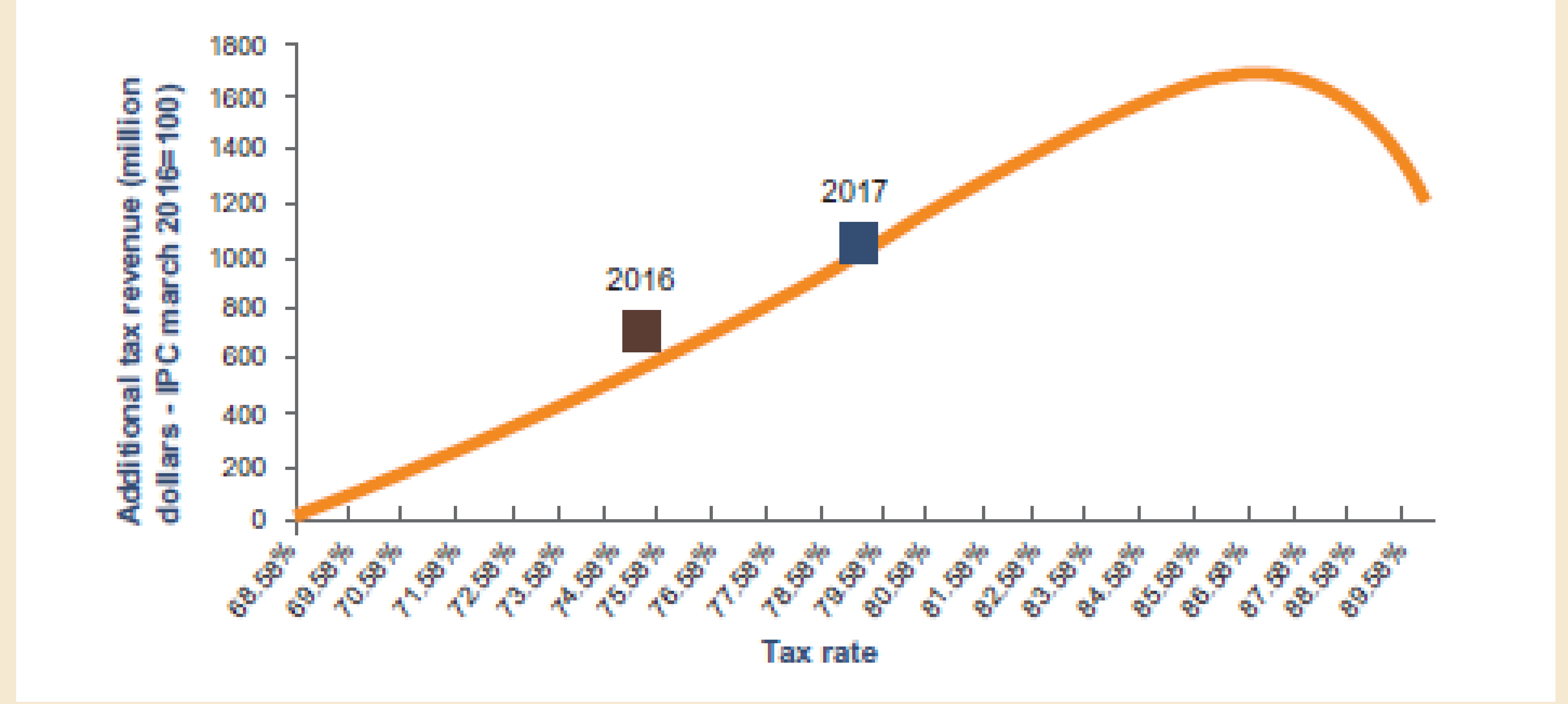
- Tax elasticity of revenue

$$\frac{\Delta R}{\Delta t}\frac{t}{R} = (1+\eta) = \left(1 + \frac{\partial P}{\partial t}\frac{t}{P}\varepsilon\right)$$

$$\rightarrow \ \Delta R = Q(1+\eta)\Delta t$$

- Usually assume full tax shifting

Laffer curve simulations in Argentina



Source: Tobacconomics (2018). Policy Brief: Tobacco taxes and government revenues.
Rodriguez-Iglesias et.al. (2017). Analysis of cigarette demand in Argentina: the impact of price changes on consumption and government revenues. Salud Publica de Mexico.

Tax revenue simulations for LIC, MIC and HIC

The WHO calculations using 2018 data from the WHO Report on the Global Tobacco Epidemic 2019, show that

- under various elasticity scenarios, and
- assuming full-shifting of tax rate

even when demand is unit-elastic and with a 100% increase in excise tax rates, tax revenue increases, in all country income groups

Country income group	Total tax as % of retail price	Excise tax as % of retail price	Excise tax increases by:	% increase in excise revenue when price elasticity of demand is			
				-0.4	-0.6	-0.8	-1.0
Low Income	38%	22%	25%	22%	20%	19%	17%
			50%	43%	39%	36%	33%
			75%	63%	57%	52%	46%
			100%	**82%**	**74%**	**66%**	**59%**
Middle Income	58%	41%	25%	19%	17%	14%	11%
			50%	37%	31%	26%	20%
			75%	54%	45%	36%	27%
			100%	**71%**	**57%**	**45%**	**34%**
High Income	68%	55%	25%	18%	15%	11%	8%
			50%	35%	27%	21%	14%
			75%	50%	39%	29%	19%
			100%	**65%**	**50%**	**36%**	**23%**

Empirical applications

Econometric estimation of parameters

Estimating the non-linear relationship between tax revenue and tax rate

$$R = T\,B(T)$$

where

$$B = \alpha - \beta T$$

$\rightarrow$

$$\boldsymbol{R = \alpha T - \beta T^2}$$

The tax revenue maximizing tax rate satisfies

$$\frac{dR}{dT} = \alpha - 2\beta T = 0 \quad \rightarrow T^* = \frac{\alpha}{2\beta}$$

and

$$\frac{d^2R}{dT^2} = -2\beta < 0$$

Laffer curve estimation in Malaysia

$$R = -183.7221 + \overset{\alpha}{28.1669}T_t - \overset{\beta}{0.6532}T_t^2 - 4.3147T_{t-1} + 20.8322lnY_t$$

$$\frac{dR}{dT} = 28.1669 - 2(0.6532)T = 0$$

$\rightarrow$

$$T^* = \frac{28.1669}{2(0.6532)} = 21.56$$

- Higher than actual rate T=18.5

Source: Nor et. al. (2013). An optimal cigarette tax in Malaysia. Int. Journal of Economics and Management 7(2): 205-220.

Predicting changes in consumption & revenue

- $\Delta T = 21.56 - 18.5 = 3.06$ $\qquad \frac{\Delta T}{T} = 16.54\%$

- $\varepsilon^{SR} = \frac{\Delta Q/_{Q}}{\Delta P/_{P}} = -0.199$ and $\varepsilon^{LR} = -0.93$

- $\eta^{SR} = \frac{\Delta Q/_{Q}}{\Delta t/_{t}} = -0.39$ and $\eta^{LR} = -0.704$

- When above are known, we can calculate change in demand and tax revenue (as well as degree of tax shifting) due to change in tax rate

Demand predictions

- $\frac{\Delta T}{T} = 16.54\%$

- $\eta^{SR} = \frac{\Delta Q/_Q}{\Delta t/_t} = -0.39 \rightarrow \frac{\Delta Q}{Q}^{SR} = (-0.39)(0.1654) = -6.4\%$

- $\eta^{LR} = -0.704 \rightarrow \frac{\Delta Q}{Q}^{LR} = (-0.704)(0.1654) = -11.64\%$

Revenue predictions

- $\frac{\Delta R/_R}{\Delta T/_T} = (1+\eta) \rightarrow \frac{\Delta R}{R} = \frac{\Delta T}{T}(1+\eta)$

Given

$\frac{\Delta T}{T} = 16.54\%\,;\quad \eta^{SR} = \frac{\Delta Q/_Q}{\Delta t/_t} = -0.39$ and $\eta^{LR} = -0.704$

$\rightarrow$

- $\frac{\Delta R}{R}^{SR} = 0.1654\,(1-0.39) = 10\%$
- $\frac{\Delta R}{R}^{LR} = 0.1654(1-0.704) = 4.9\%$

Concluding : Tobacco control and Laffer curve

- Tobacco tax policy aiming at decreasing the use of tobacco products whilst raising public revenue must take into account all behavioural effects due to tax changes

- When evaluate suggested tax reforms, need to predict not only the behaviour of consumers but also of firms – a practice known as dynamic scoring

- Firms with market power change their pricing when taxes change

- Tax effects on consumption and revenue not the predicted ones, unless all behavioural effects are taken into account.

THANK YOU!

sd@uom.edu.gr