EPFL

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LEURE

ECOLOGICAL ECONOMICS
Env-610

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Catch a parrot and teach him to say ‘supply and demand’, and you have an excellent economist

Popular joke in 19th century

Basics

PREFERENCES AND DEMAND

Willingness to pay (WTP)

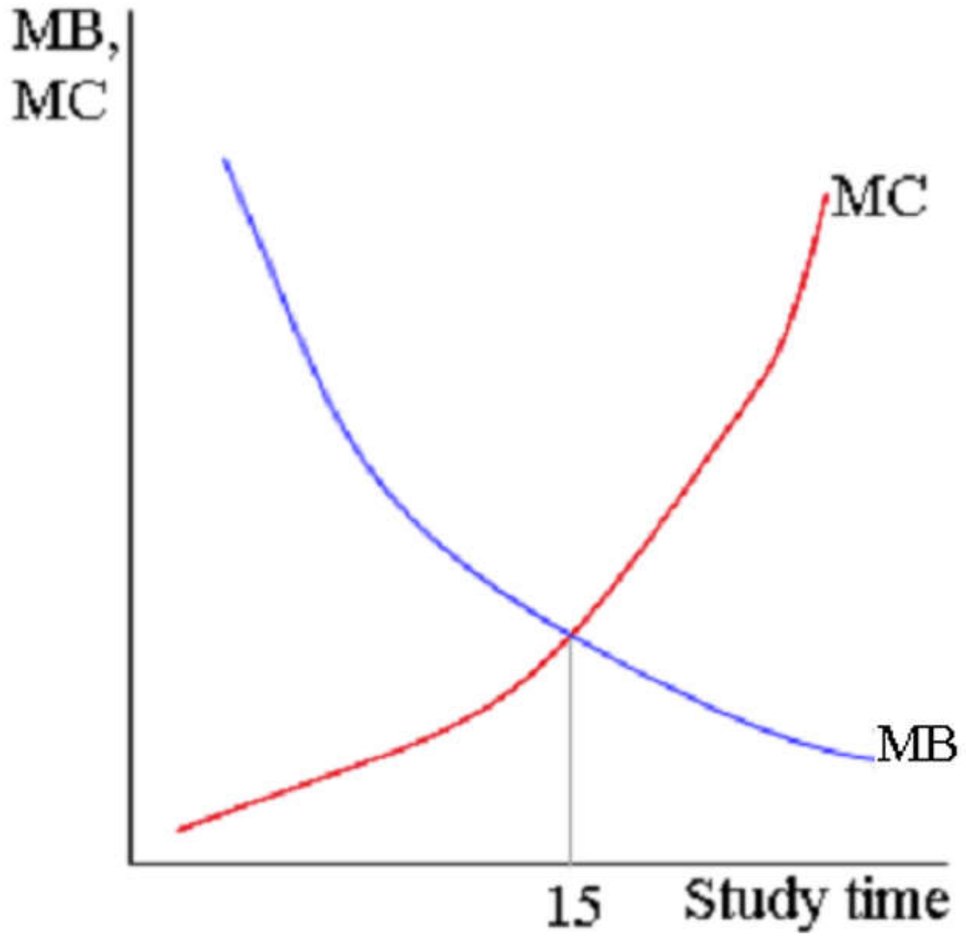
Determinants of willingness to pay (WTP)

- Potential buyers ("demanders") are willing to buy an item for a maximum price = "**willingness to pay**"
- Demanders bid at or below their willingness to pay, depending on strategic considerations (e.g., what will other buyers bid?)

Determinants of willingness to pay (WTP)
Personal assessment of the item's qualities: performance, design, label
Personal assessment of the terms of purchase (e.g. seller's reputation, speed of delivery, warranties, down-payment required)
Personal alternatives: other sellers, other products, later purchase (arbitrage)
Speculation: planning to resell the item with a profit
Possible gains from influencing the seller: related deals
Personal capacity to pay: income, savings, access to credit, means of payment

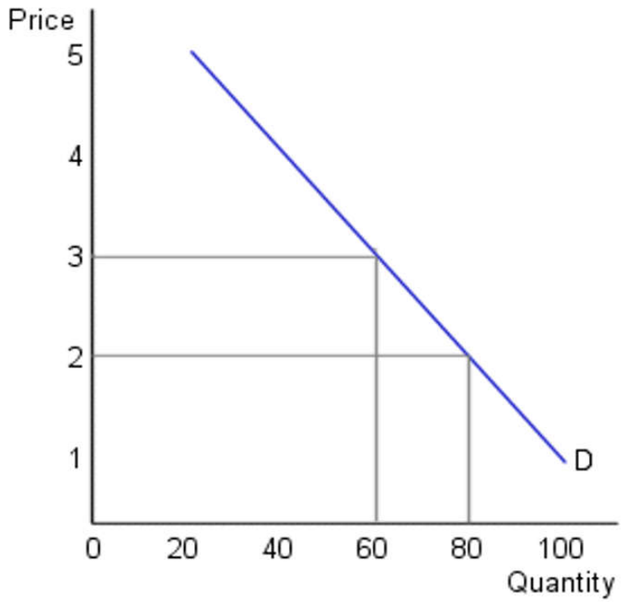
Marginalism

- **Marginal benefit/cost:** additional benefit/cost resulting from a one-unit increase in the level of an activity
- **Net benefit:** benefit minus cost
- **Optimality condition** for maximum net benefit: MB = MC
- **Example:** study time for exam 1 when you also have to study for exam 2
  - total time available is given
  - utility depends on the grades
  - law of diminishing returns

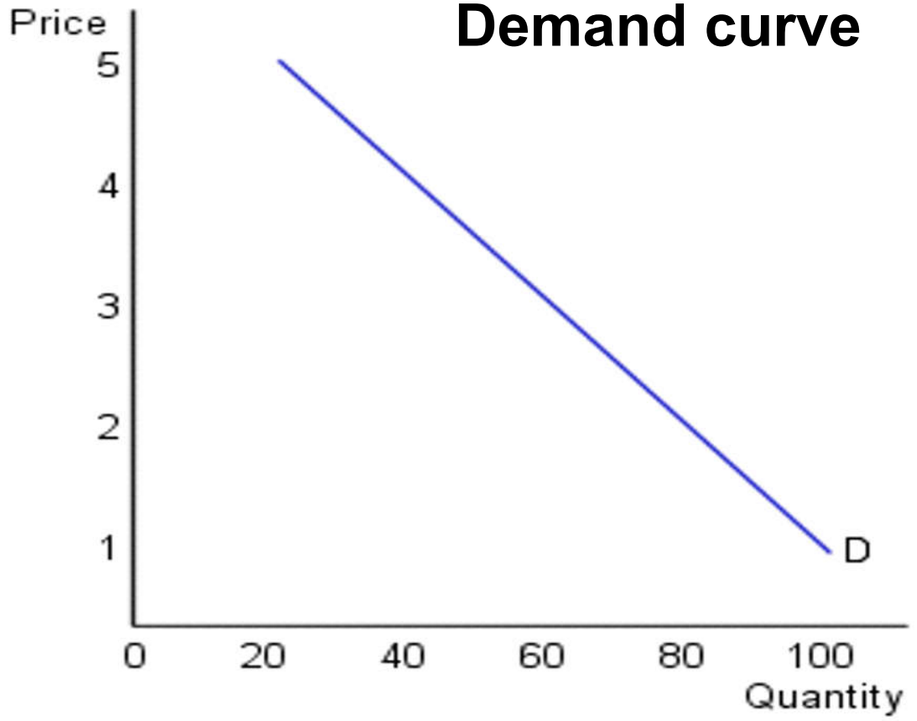


Individual demand

- **Definition:** Relationship between price and quantity demanded in a given time period, *ceteris paribus*.
- Usually an **inverse relationship**, because of:
  - substitution effect
  - income effect
- **Change in quantity demanded vs. shift in demand:**



Demand curve



Individual demand function

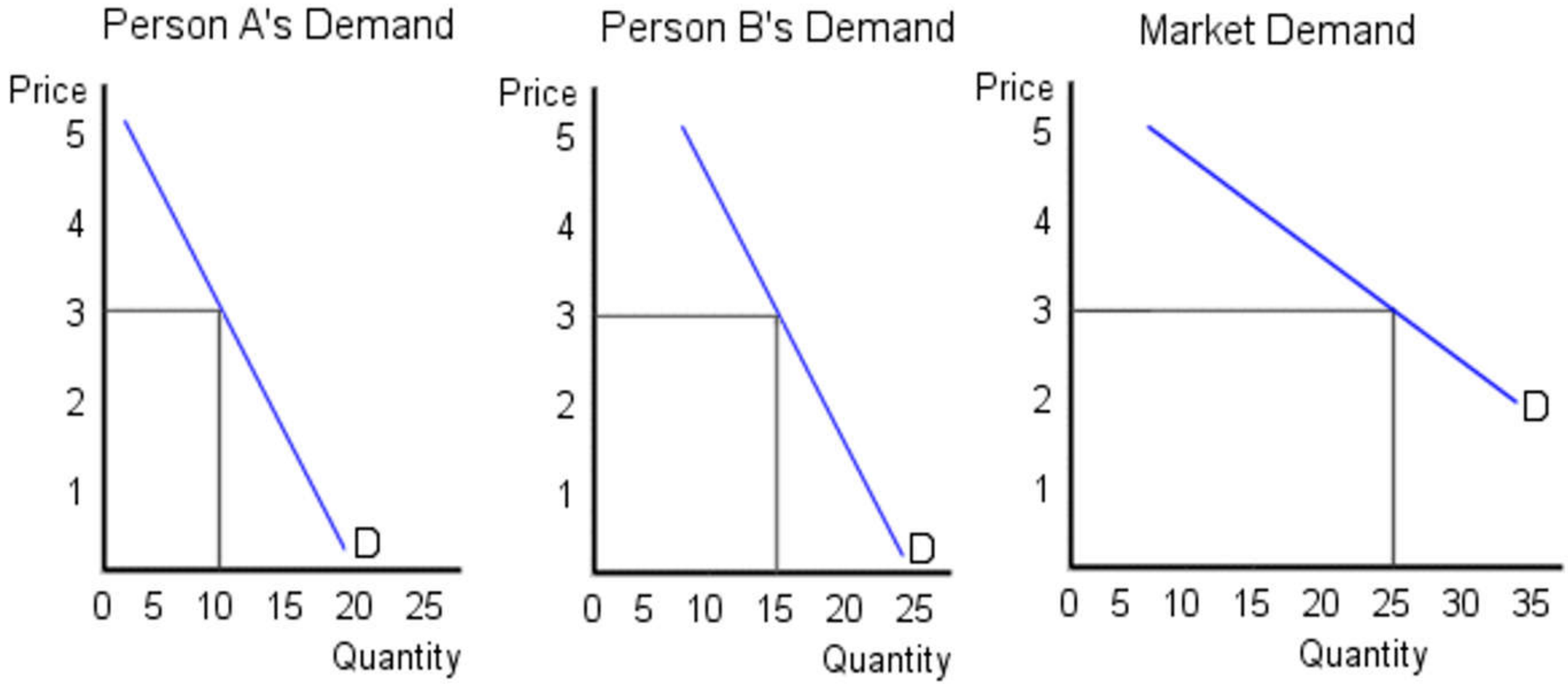
$$Q_{ijt}^{D} = f(\alpha_i, p_{jt}, p_{-jt}, R_{it}, p_{jt+1}, p_{-jt+1}, R_{it+1})$$

The demand by potential buyer *i* of good *j* at date *t* is a function of:

- her tastes and preferences, α_i
- the price of good *j*, p_j
- the prices of related goods and services (substitutes, complements), p_{-j}
- her income, R_i
- expectations of future prices and income

Market demand

Horizontal summation of individual consumer demand curves



Market demand function

$$Q_{jt}^{D} = f(\alpha, p_{jt}, p_{-jt}, R_t, p_{jt+1}, p_{-jt+1}, R_{t+1})$$

The demand by all potential buyers of good *j* at date *t* is a function of:

- aggregate preferences, including number of potential buyers, α
- the price of good *j*, p_j
- the prices of related goods and services (substitutes, complements), p_{-j}
- aggregate incomes and their distribution, *R*
- expectations of future prices and income

Simplified representation (*ceteris paribus*): $Q_{jt}^{D} = f(p_{jt})$ with $Q_{jt}^{D\prime} < 0$

Underlying assumption about goods' allocation

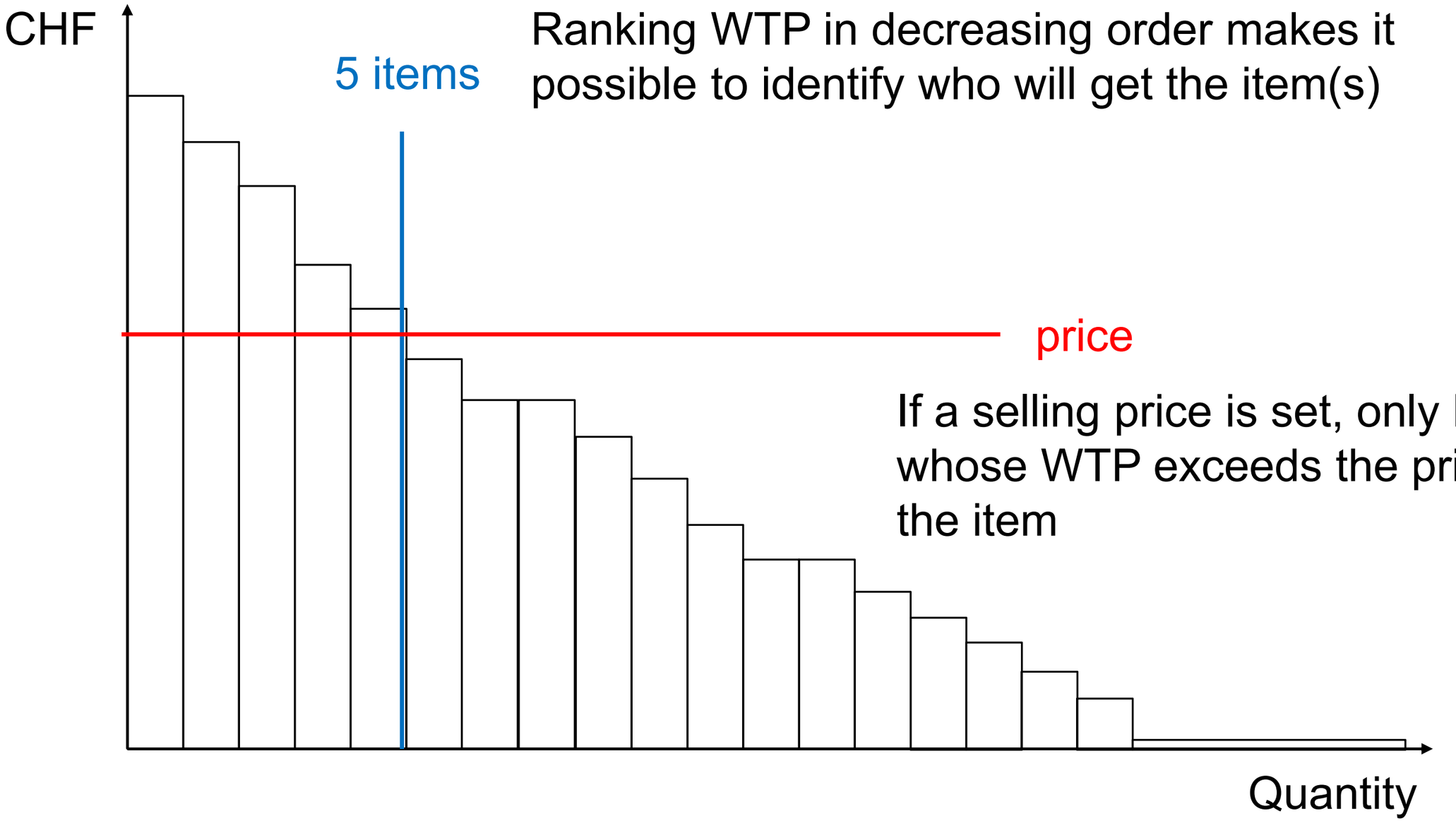
Possible allocation criteria:

- Those who need it most
- Those who deserve it most (buyers' qualities)
- Those who entered their bids first (first come first serve, queuing)
- Those with the highest bids (presumably the highest WTP)

Sellers who strive for maximum profit will sell to the highest bidders

This is assumed to be the standard market outcome

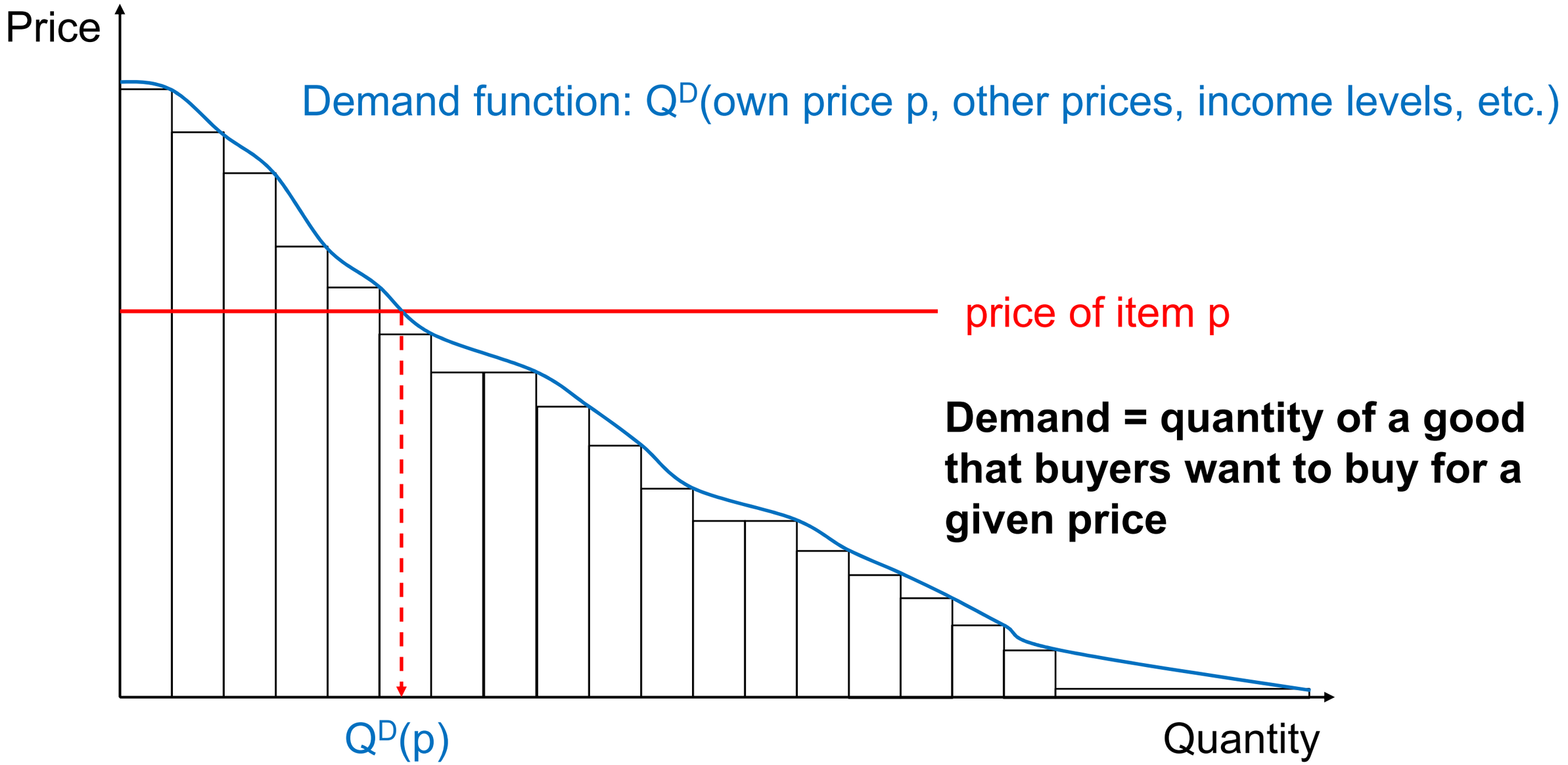
Demand curve



Ranking WTP in decreasing order makes it possible to identify who will get the item(s)

If a selling price is set, only buyers whose WTP exceeds the price will buy the item

Demand function



Basics
ELASTICITIES

Elasticity of demand

- The **elasticity** measures the responsiveness of a variable to another one

$$\mathrm{y} = \mathrm{f(X)} \rightarrow \text{elasticity} = \frac{\frac{\partial \mathrm{f}(X)}{\partial x_i}}{\frac{y}{x_i}}$$

- Demand q = Q^D(own price p, other prices, income levels, etc.)

$$\text{elasticity of demand} = \frac{\frac{\partial Q^D}{\partial p}}{\frac{q}{p}} \approx \frac{\frac{\mathrm{d}q}{q}}{\frac{\mathrm{d}p}{p}} = \frac{\%change\ q}{\%change\ p}$$

Calculating or estimating the elasticity of demand

Example 1

$$Demand: \quad q = \frac{\alpha R p'}{p^2}$$

R is income, p' is price of other goods, α is preference parameter

$$\frac{\partial Q}{\partial p} = -2\frac{\alpha R p'}{p^3}$$

$$\frac{q}{p} = \frac{\alpha R p'}{p^3}$$

$$elast = \frac{\frac{\partial Q}{\partial p}}{\frac{q}{p}} = -2$$

Example 2

$$Demand: \quad q = \alpha - \frac{\beta p}{R p'}$$

$$\frac{\partial Q}{\partial p} = -\frac{\beta}{R p'}$$

$$\frac{q}{p} = \frac{\alpha}{p} - \frac{\beta}{R p'}$$

$$elast = \frac{\frac{\partial Q}{\partial p}}{\frac{q}{p}} = -\frac{1}{\frac{\alpha R p'}{\beta \boldsymbol{p}} - 1}$$

For α=100, β=5000, R=1000, p'=5

For p = 1, elast = –0.01

For p = 10, elast = –0.11

For p = 50, elast = –1

For p = 90, elast = –9

Example 3

Data on gasoline sales in Switzerland

	prix ct/l	conso. finale kt	prix %var	quantité %var
2017	151	2373		
2018	163	2342	7.9%	-1.3%

Empirical elasticity:

$$elast = \frac{\%change\ q}{\%change\ p}$$

$$elast = \frac{-1.3\%}{7.9\%} = -0.16$$

Caution: the variation in consumption was not only caused by the change in price

More or less elastic demand curves

$$\text{elasticity of demand} = \frac{\frac{\partial Q^D}{\partial p}}{\frac{q}{p}} \approx \frac{\%change\ q}{\%change\ p}$$

High elasticity (in absolute value) when

- close substitutes are available
- the good or service represents a large share of the consumer's budget
- a longer time horizon is considered

Other elasticities

- Own-price elasticity of demand = $\frac{\%\ change\ in\ quantity\ demanded\ of\ good\ j}{\%\ change\ in\ price\ of\ good\ j}$

- Cross-price elasticity of demand = $\frac{\%\ change\ in\ quantity\ demanded\ of\ good\ j}{\%\ change\ in\ price\ of\ good\ \boldsymbol{k}}$
  - positive for **substitutes**
  - negative for **complements**

- Income elasticity of demand = $\frac{\%\ change\ in\ quantity\ demanded\ of\ good\ j}{\%\ change\ in\ income}$
  - positive for **normal goods**
  - negative for **inferior goods**

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Basics

ESTIMATING THE DEMAND FOR GASOLINE IN SWITZERLAND

Simple estimation of elasticity

In 1993, fuel duties on gasoline were raised by 20 ct/litre (approved in a vote on March 7, effective March 8). What were the consequences?

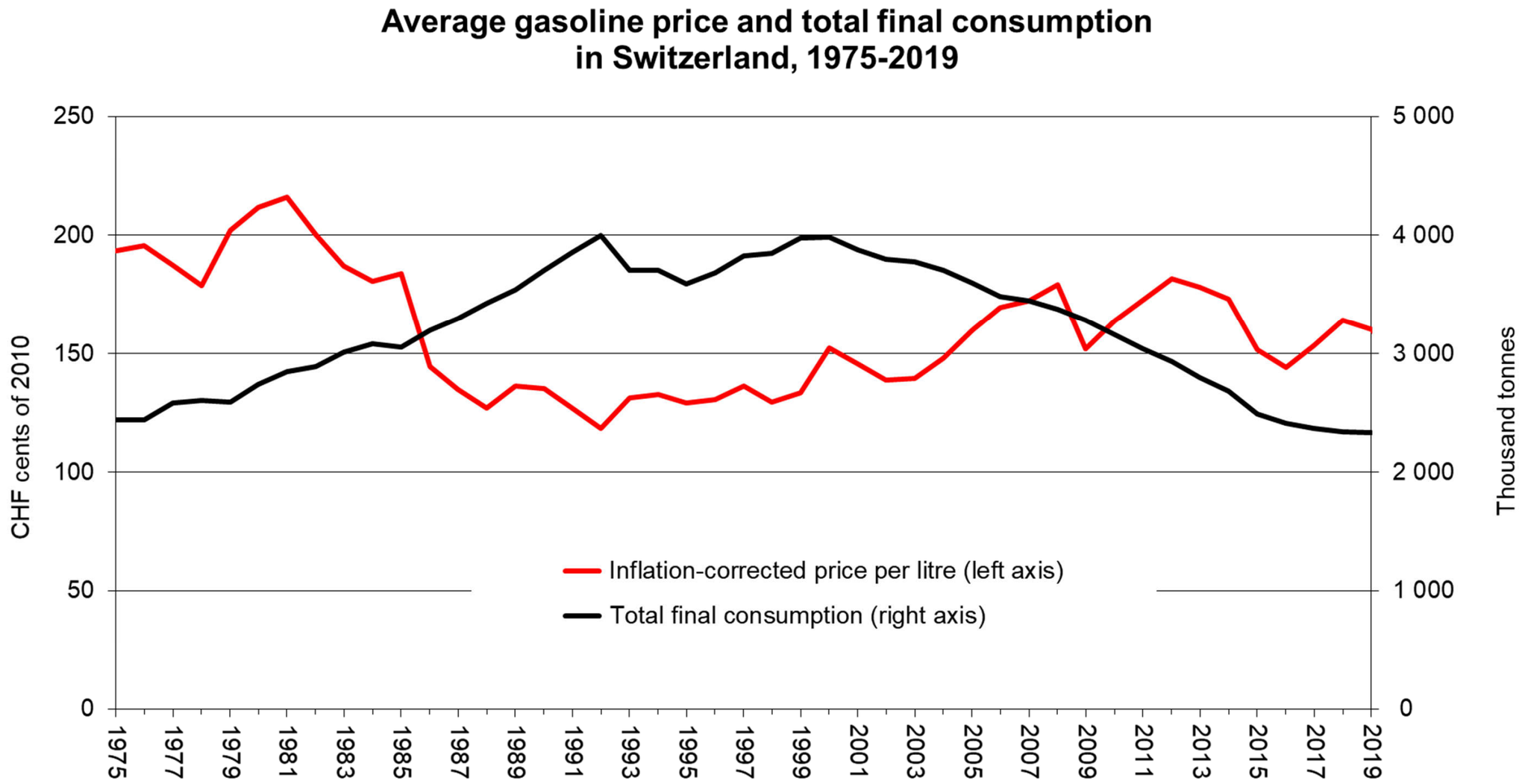
1993 is problematic because 2 months without additional tax (with accelerated imports), so 1994 must be compared with 1992:

	Consumption (kt)	Nominal price (ct)
1992	3 995	98.7
1994	3 703	115.5
	-7%	+17%

-7%/17% = -0.41 elasticity

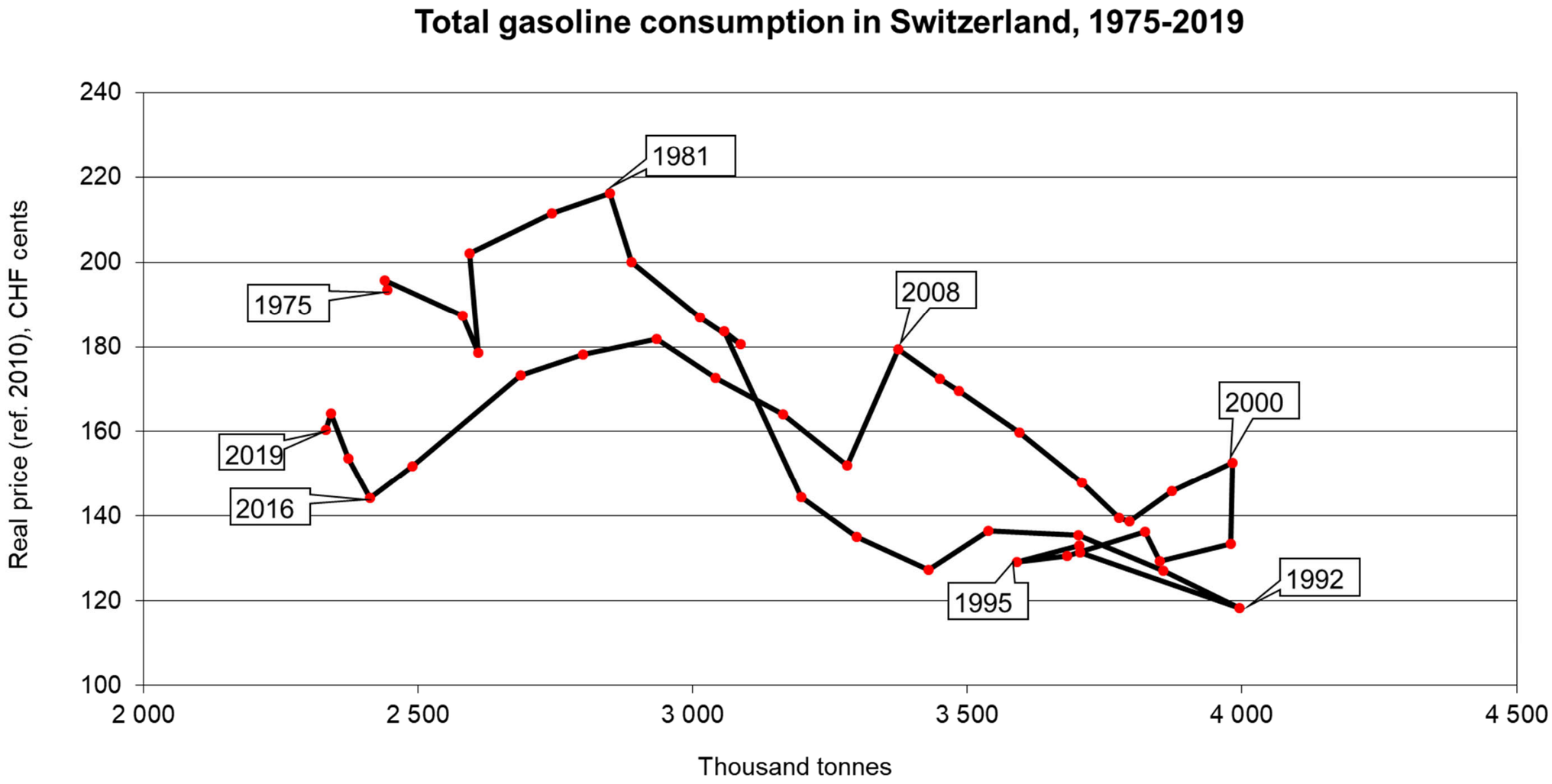
Note that the price only increased by 16.8 ct! The expected tax revenue was 20ct. × Q_{1992} = 800 MCHF. The actual revenue was 20ct. × Q_{1994} = 740 MCHF

Gasoline in Switzerland since 1975

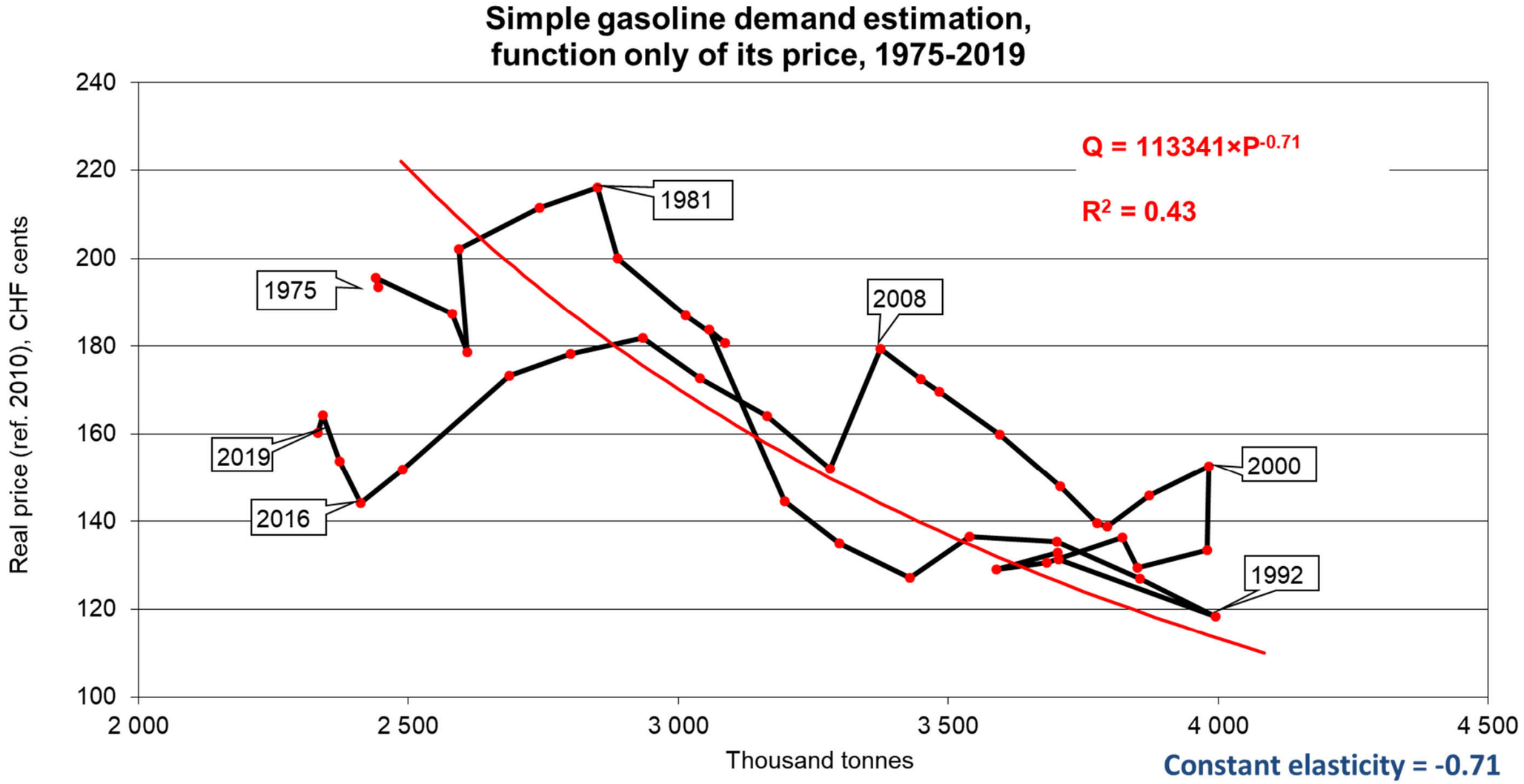


In this graph and the following ones, I use data from the Federal statistical office

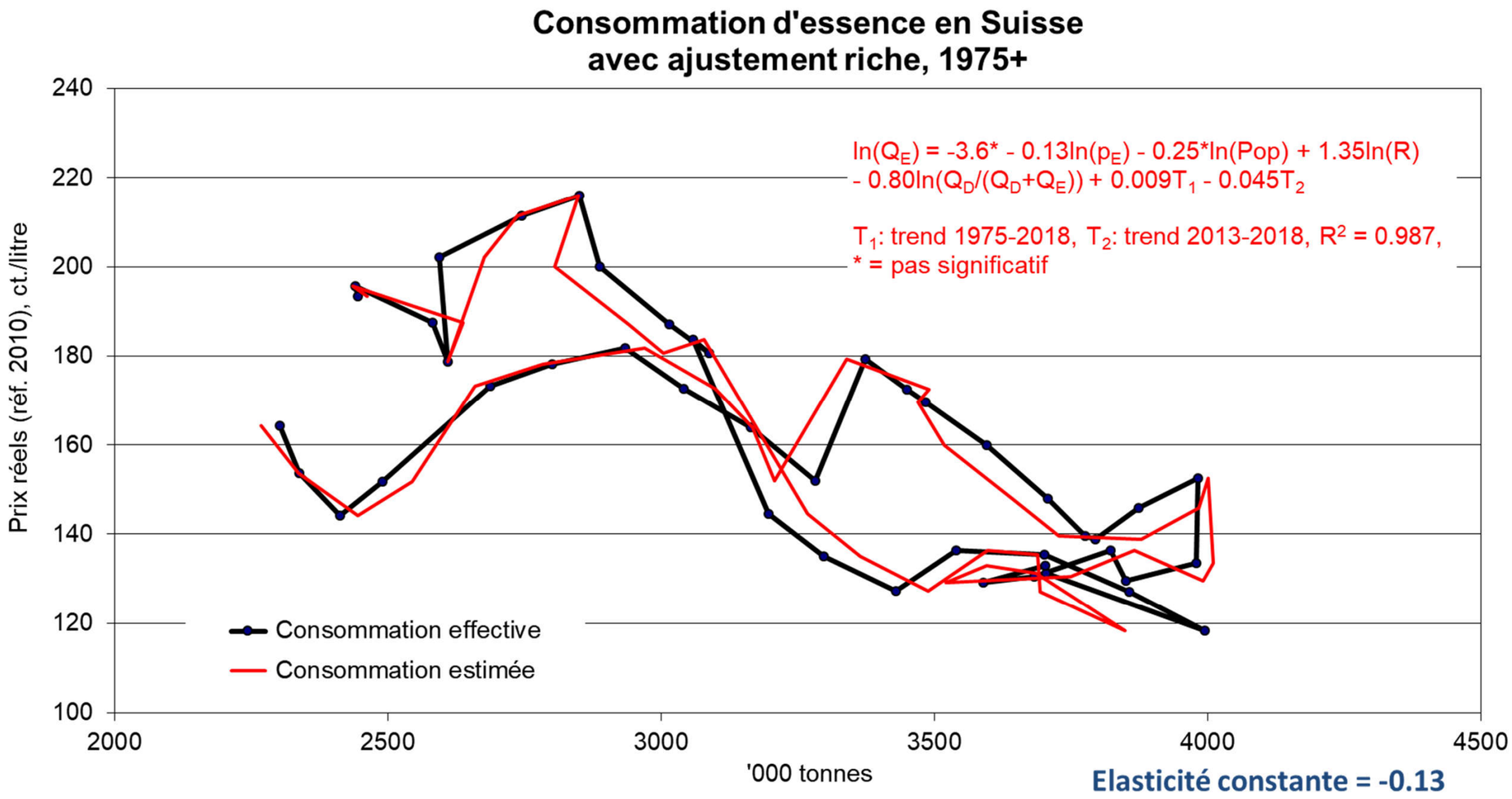
Consumption and price crossed



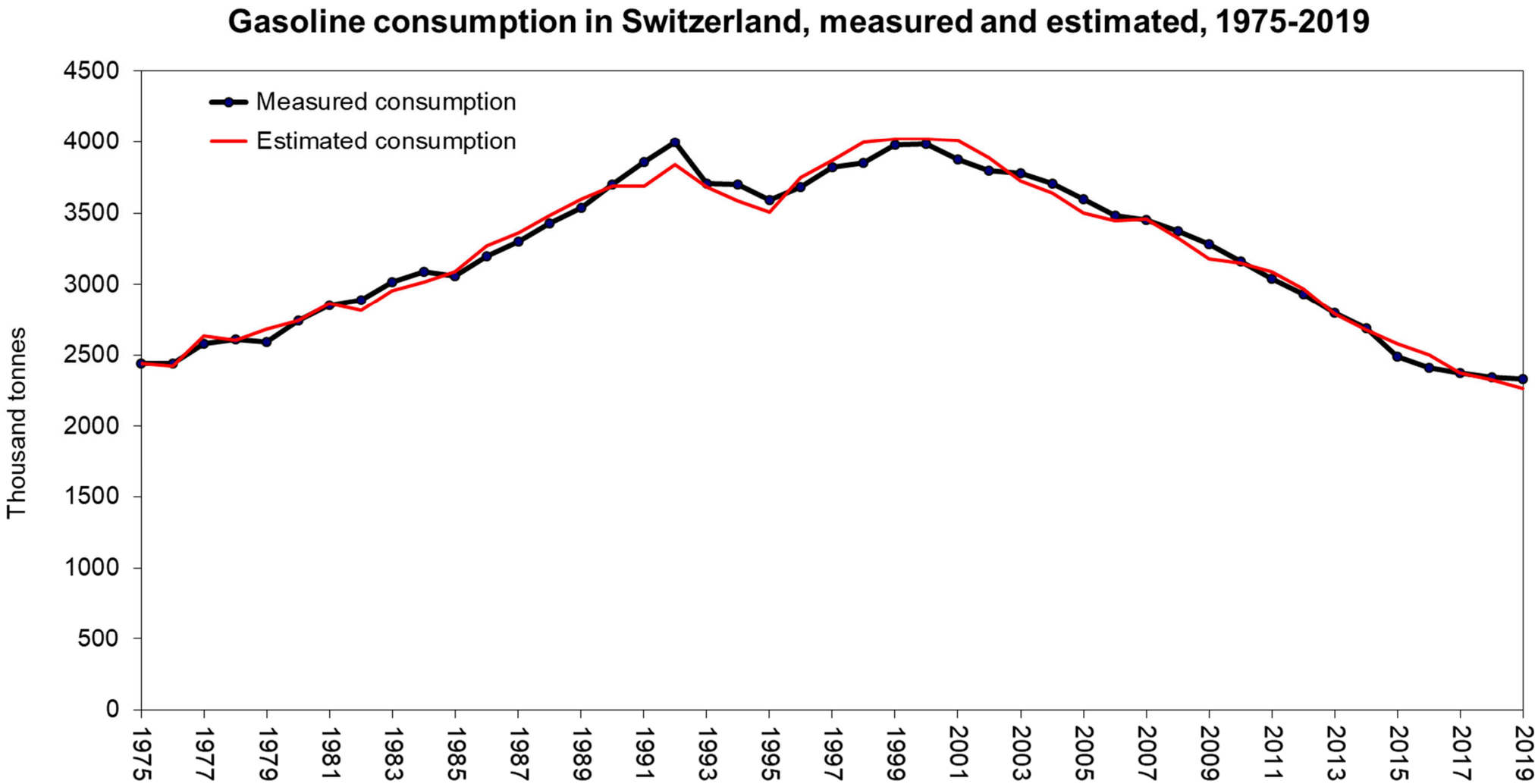
Demand – first estimation



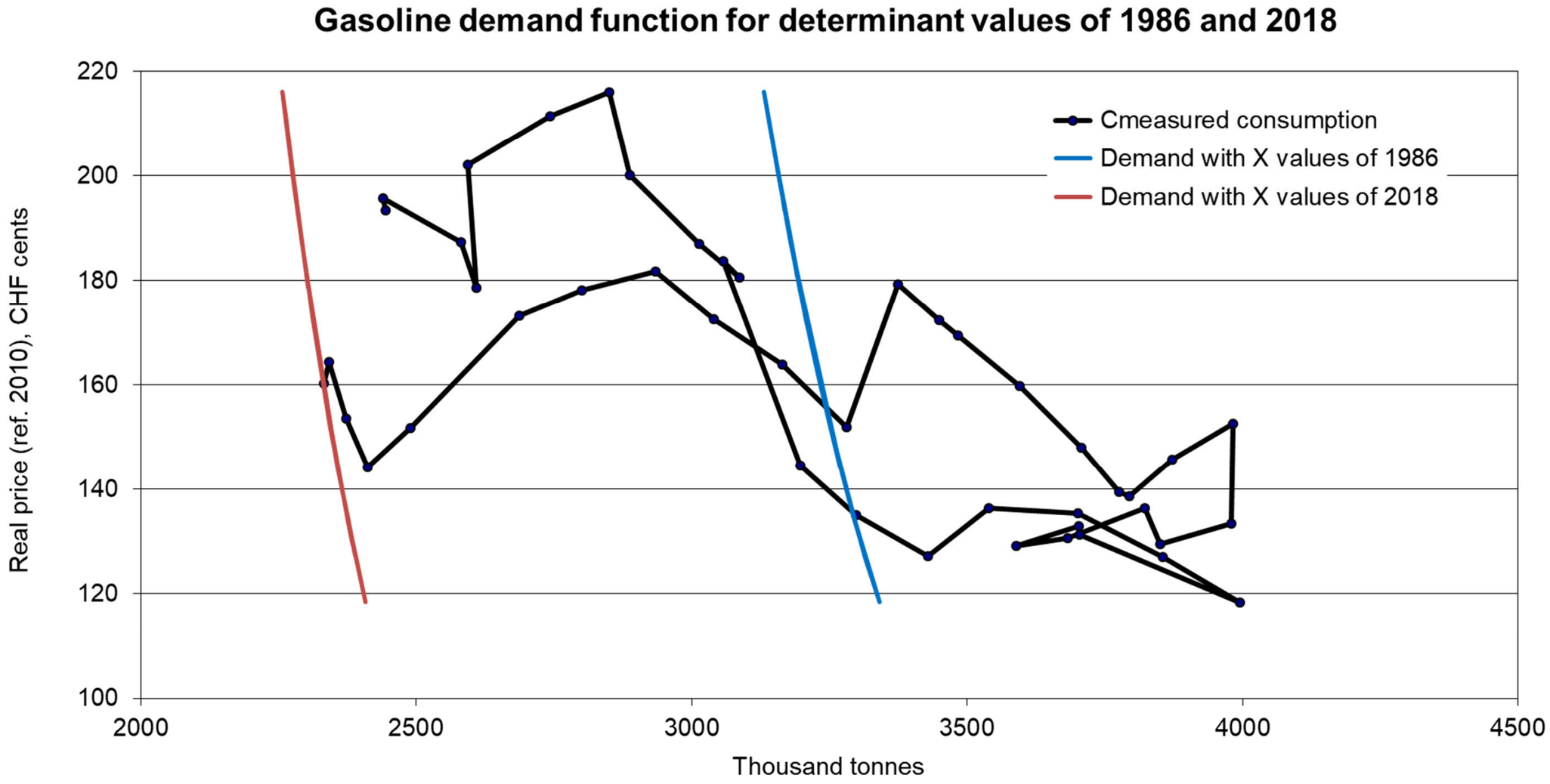
More sophisticated estimation



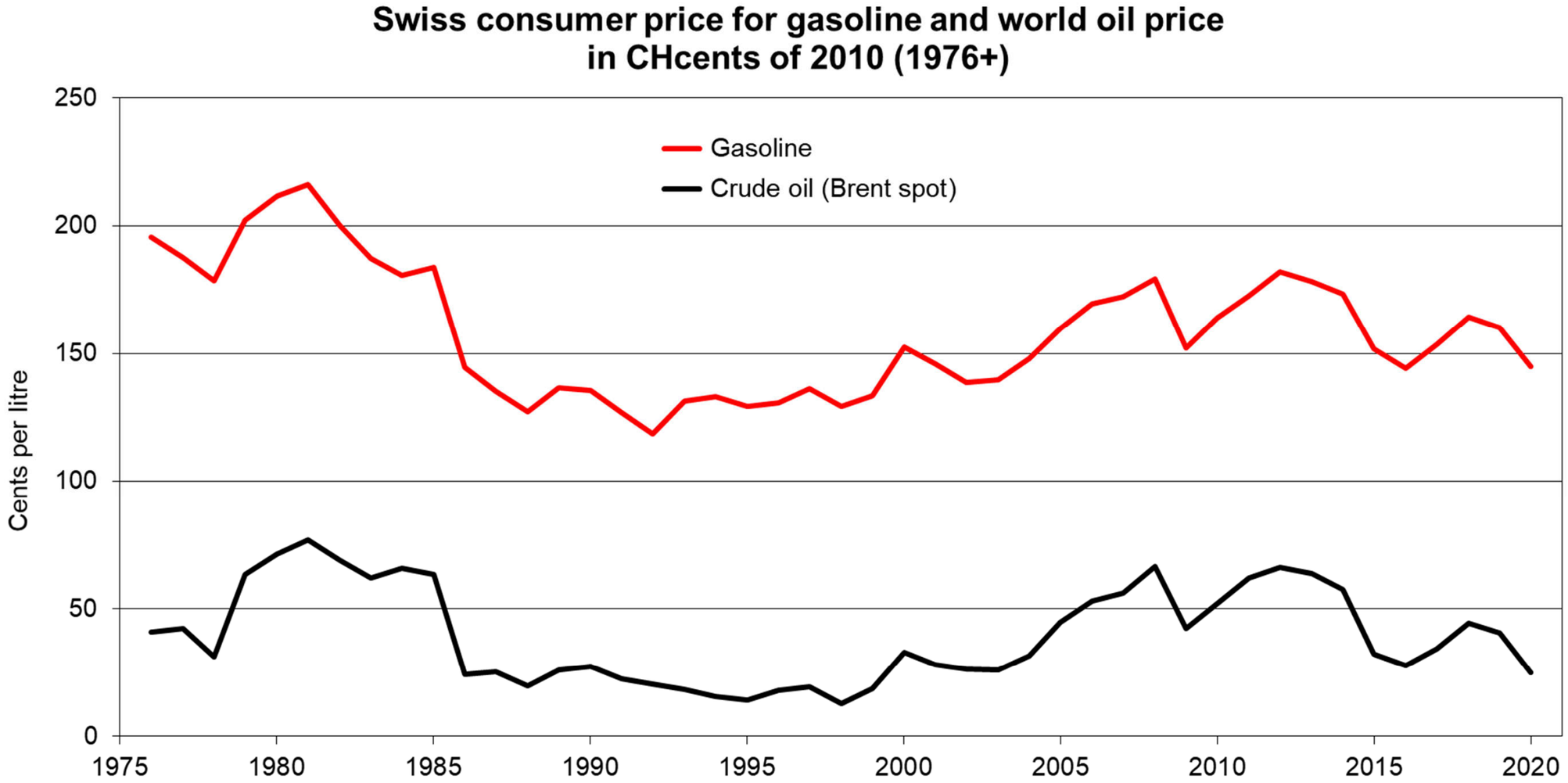
Quality of fit



Meaning of low demand elasticity



Gasoline price = oil price + margin



Sources: gasoline price: Swiss CPU, aerage price of energy and motor fuels (T.05.02.91); crude oil: computed from BP and SNB data