Firm productivity and derived factor demand:
when market power leads to a decoupling

JOB MARKET PAPER

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KU LEUVEN

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  2. Theoretically puzzling

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→ **Decoupling** of factor demand from productivity growth

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3. **Application to Chinese manufacturing:** how relevant is it?

1. Theory

Intuition

$$q = f(\underline{\boldsymbol{x}})\,\omega$$

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- Productivity shock $\Delta\omega > 0 \Rightarrow \Delta x^*$?

$$\begin{cases} \ominus \ \text{produce same } q \text{ with } \textbf{LESS} \text{ input} \\ \oplus \ \text{more efficient } (\downarrow MC)\text{, incentive to increase } q^* \text{ so need } \textbf{MORE} \text{ input} \end{cases}$$

- **Net effect** $\Delta x^* \lesseqgtr 0$ depends on the size of output expansion $\Delta q^* > 0$

Intuition

- Express in *logs*

$$q^* = x^* \omega$$

$$\log(x^*) = \log(q^*) - \log(\omega)$$

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$$\frac{d\log(x^*)}{d\log(\omega)} = \frac{d\log(q^*)}{d\log(\omega)} - \frac{d\log(\omega)}{d\log(\omega)}$$
- Elasticities
$$\eta_{x^*,\omega} = \eta_{q^*,\omega} - 1$$

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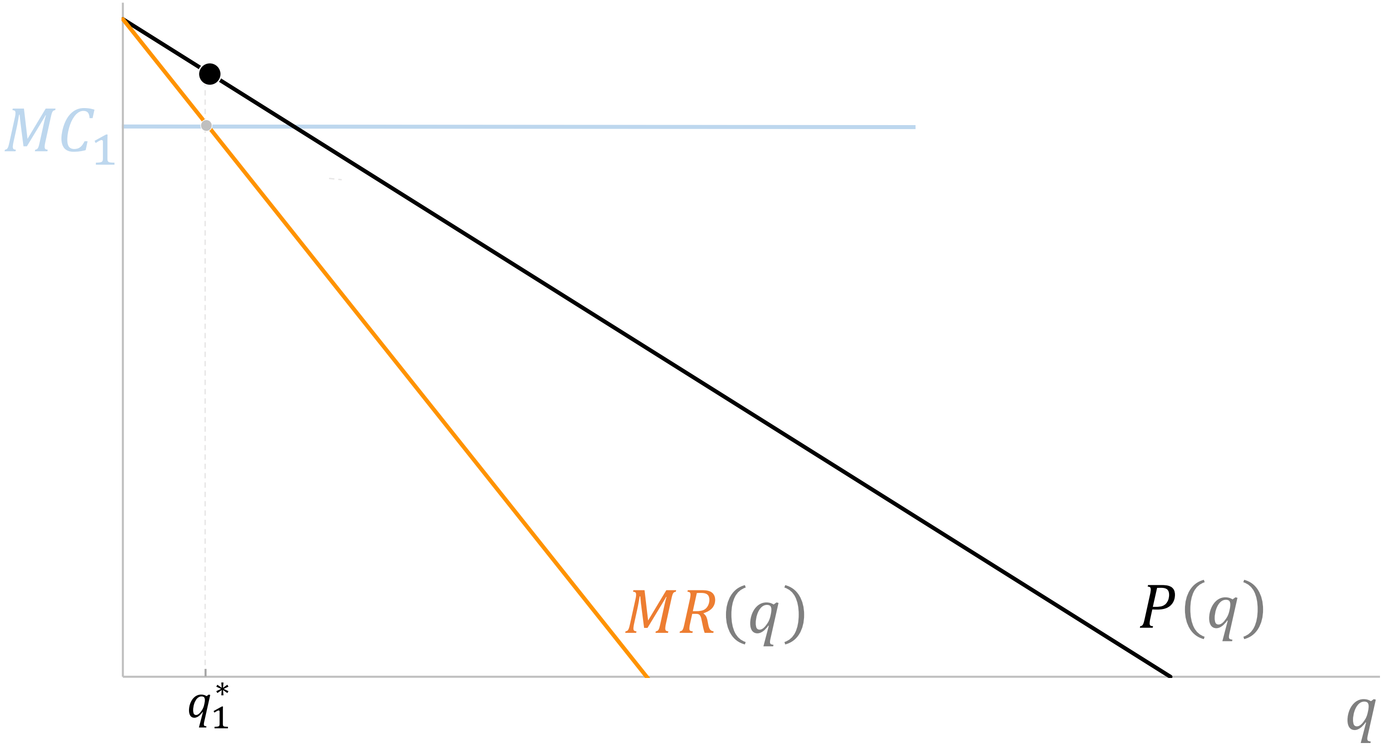
- **Equilibrium outcome**: a. output demand b. market structure

Monopoly & Linear demand

$$MC_i = \frac{w}{\omega_i}$$



Monopoly & Linear demand

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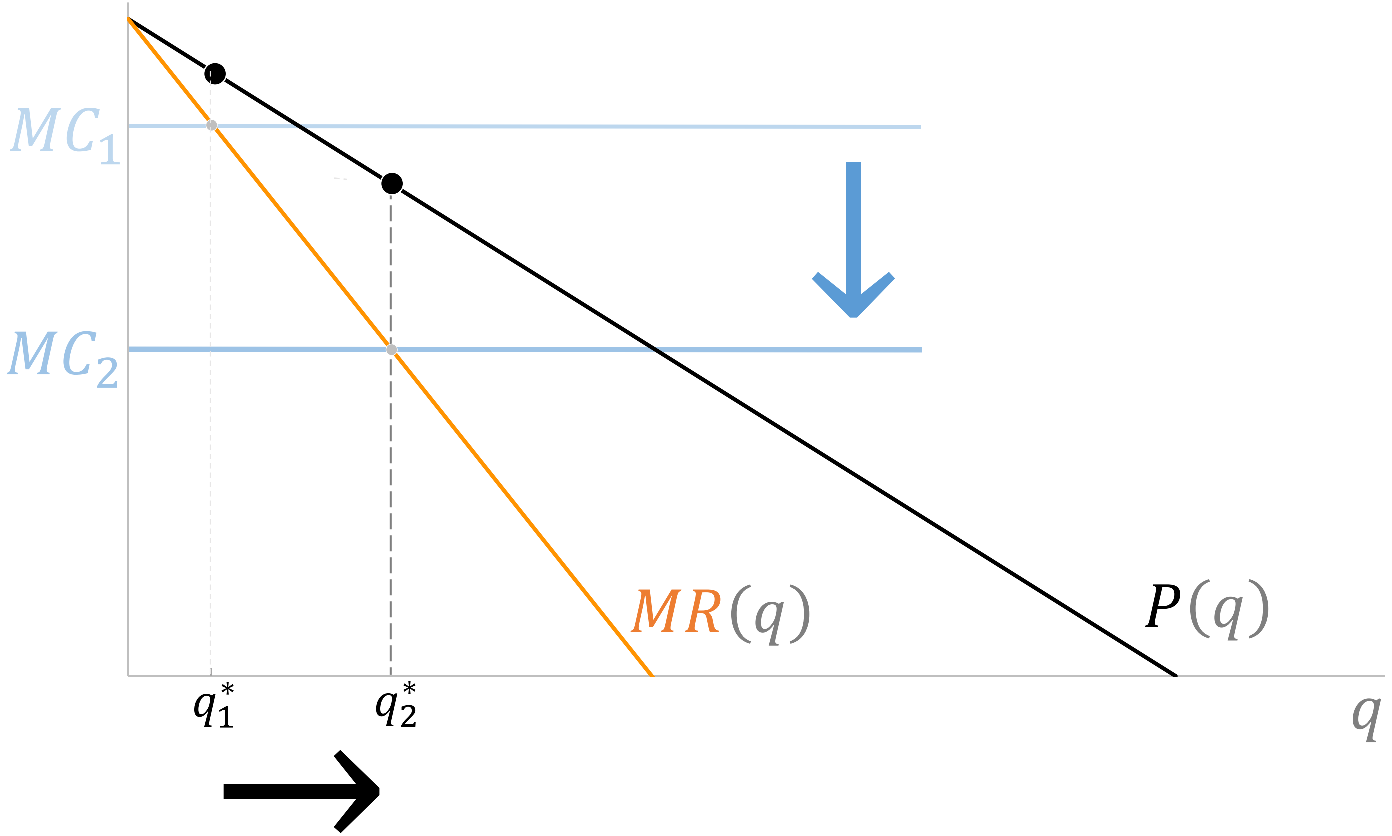

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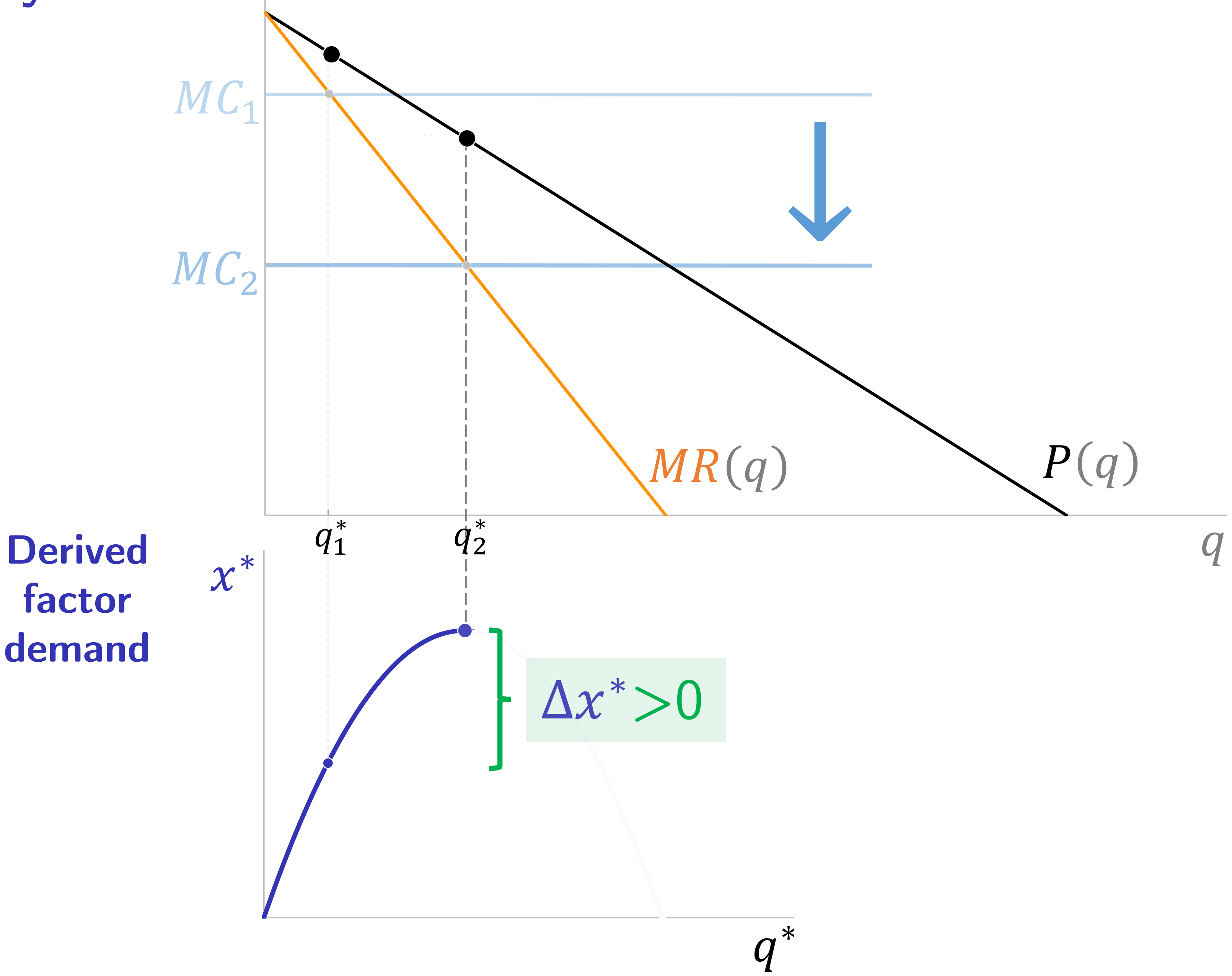

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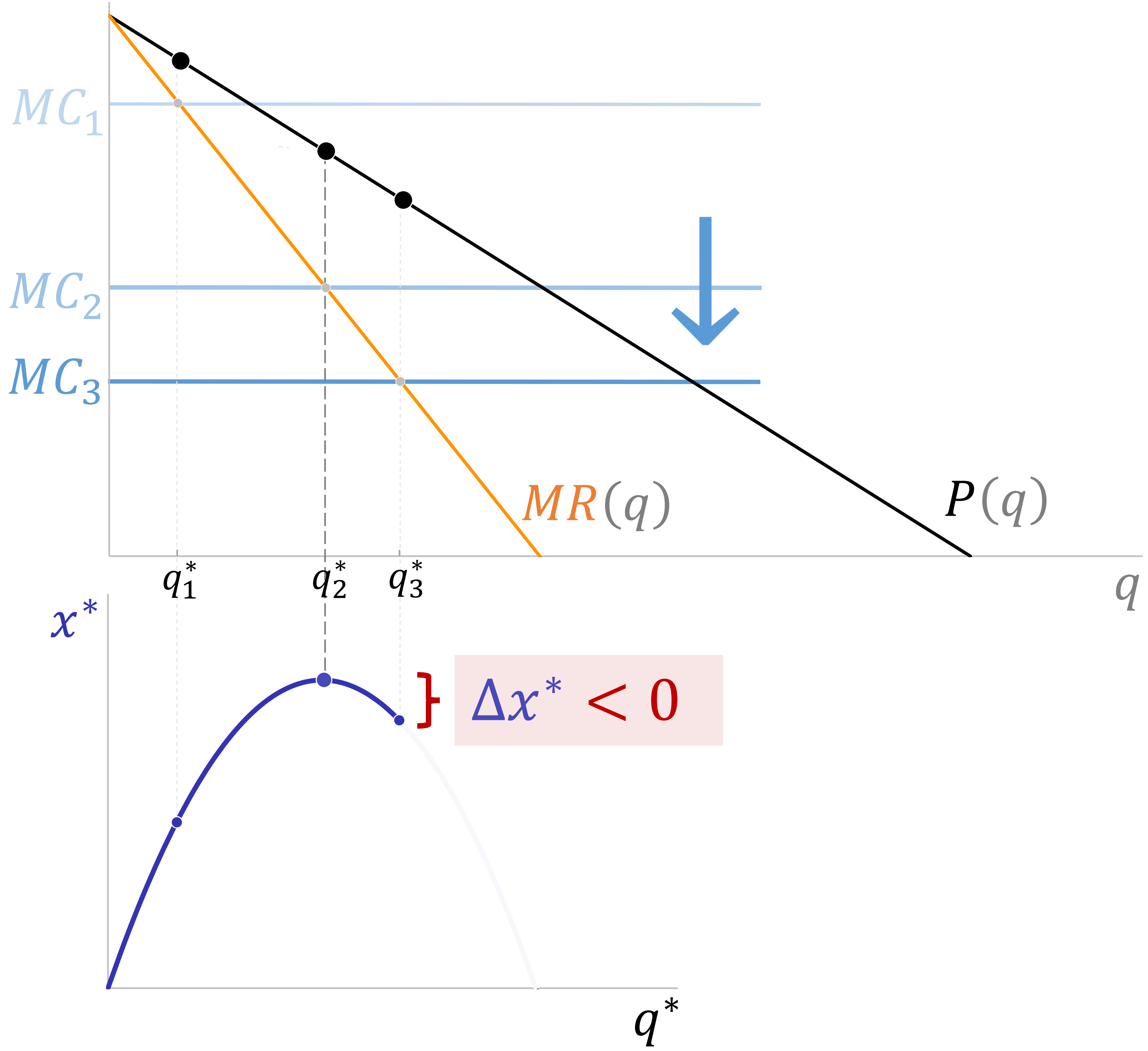
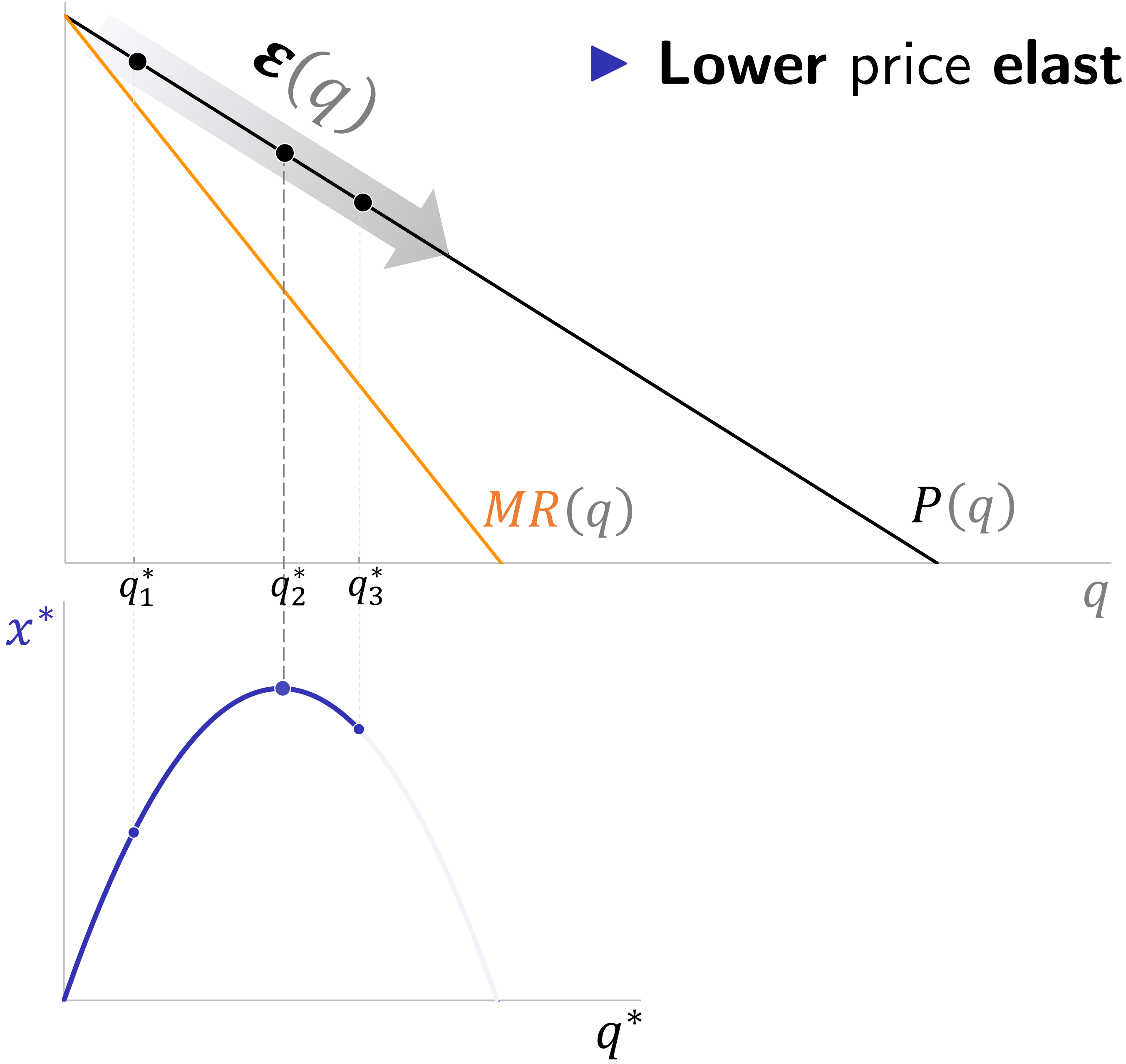


Mechanism

- **Lower** price **elasticity** of **demand**



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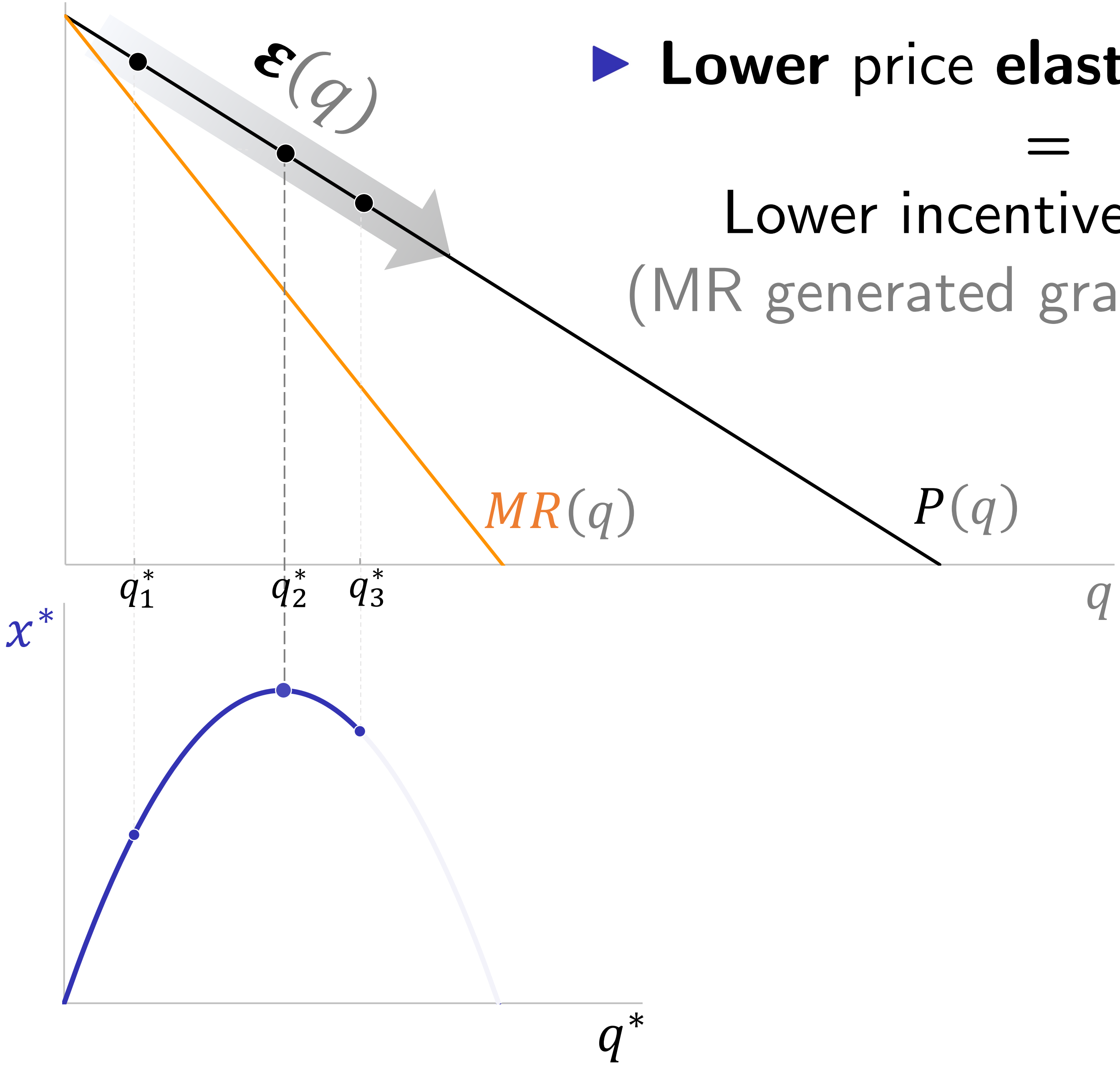


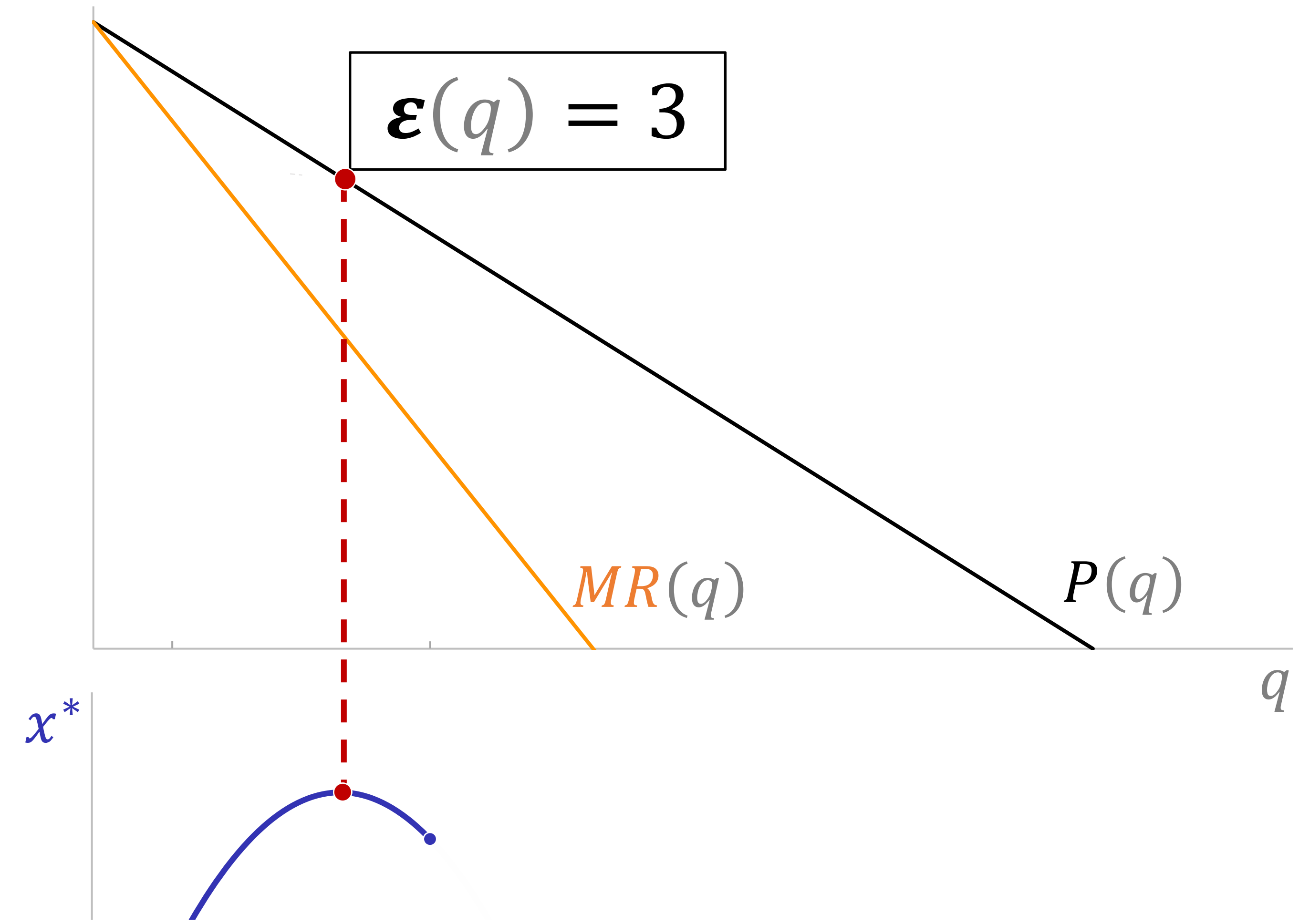
- **Lower** price **elasticity** of **demand**

  =

  Lower incentives to expand q^*

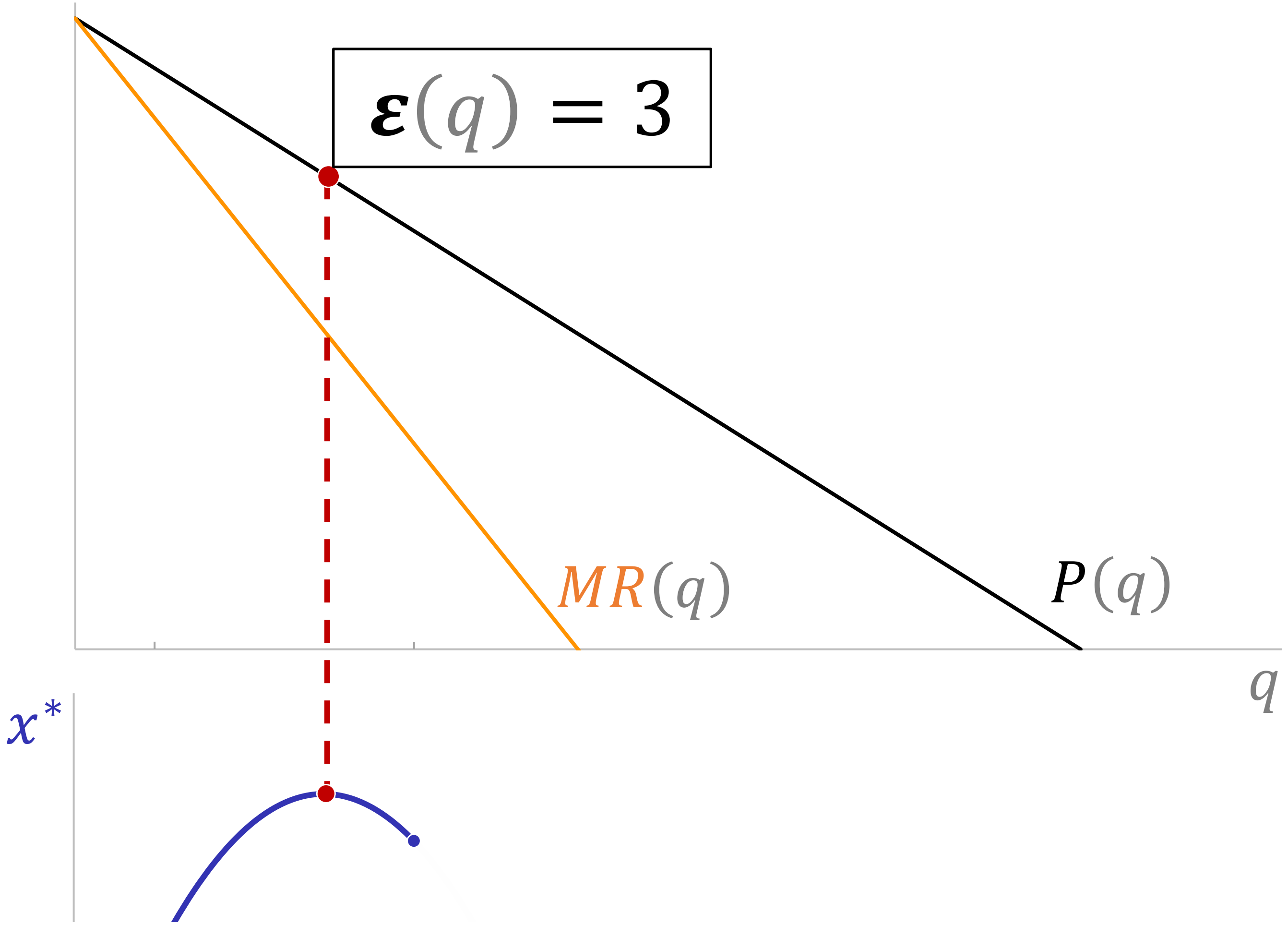
  (MR generated gradually declines)

Mechanism



- At a certain level of output, demand becomes "***nearly-satiated*** "
  i.e. to convince customers to buy 1% more output, the price must fall so much that MR starts decreasing by more.

Mechanism



- Takes its "**foot off the gas**" and decides to **expand q^*** by **less than 1%**

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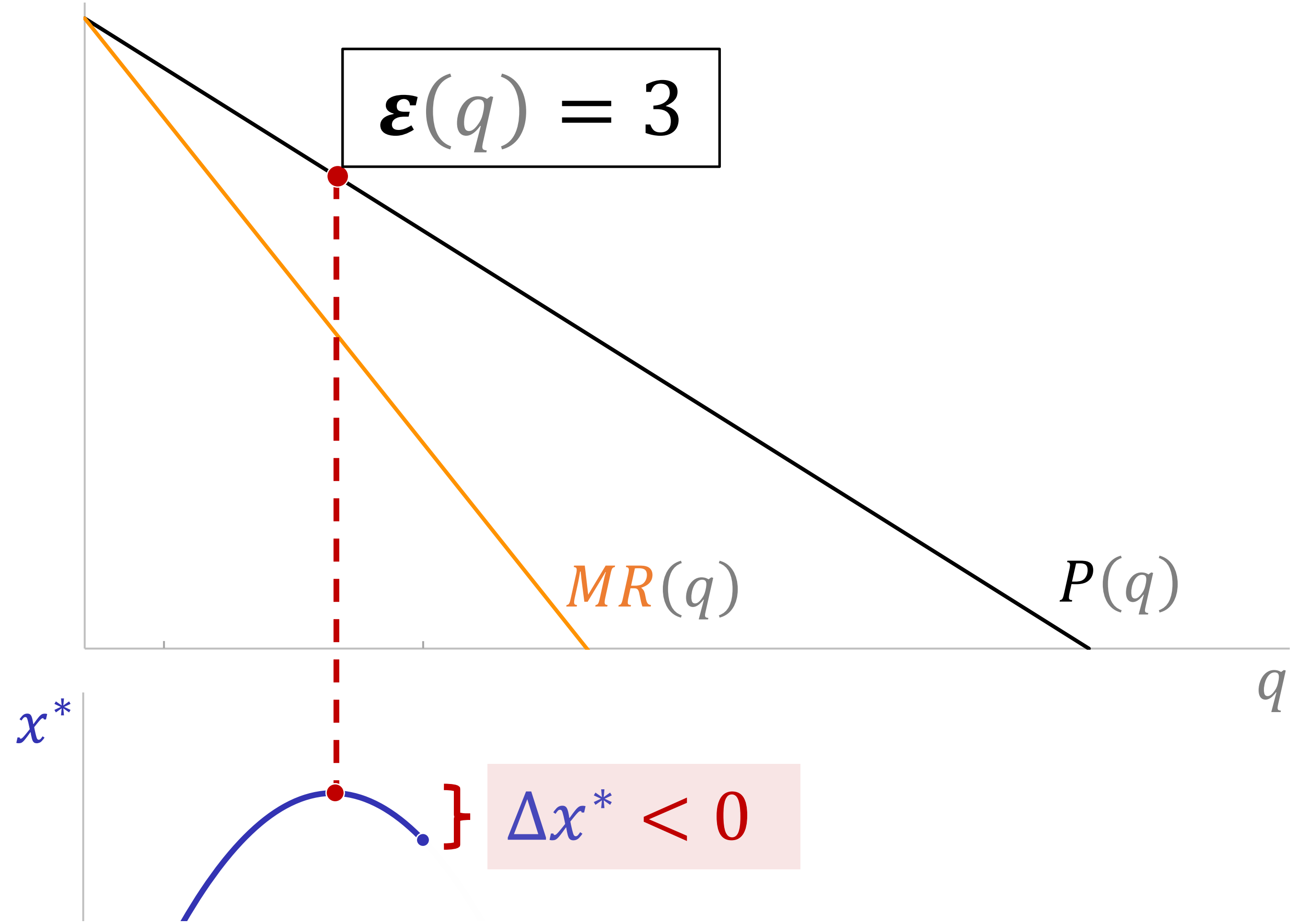

- Takes its "**foot off the gas**" and decides to **expand q^*** by **less than 1%**
- Productivity improvement is more than enough, so **less input** is needed!

a. Features of demand

- In general

[Prop. 1c] $$\boxed{\eta_{x^*,\omega} < 0 \quad \Longleftrightarrow \quad \boldsymbol{\varepsilon}(q^*) < 3 - \boldsymbol{\rho}(q^*)}$$

the threshold of $\boldsymbol{\varepsilon}(q)$ depends also on **curvature** $\boldsymbol{\rho}(q) \equiv -\frac{p''q}{p'}$
as it governs the rate at which $\boldsymbol{\varepsilon}(q)$ declines with q

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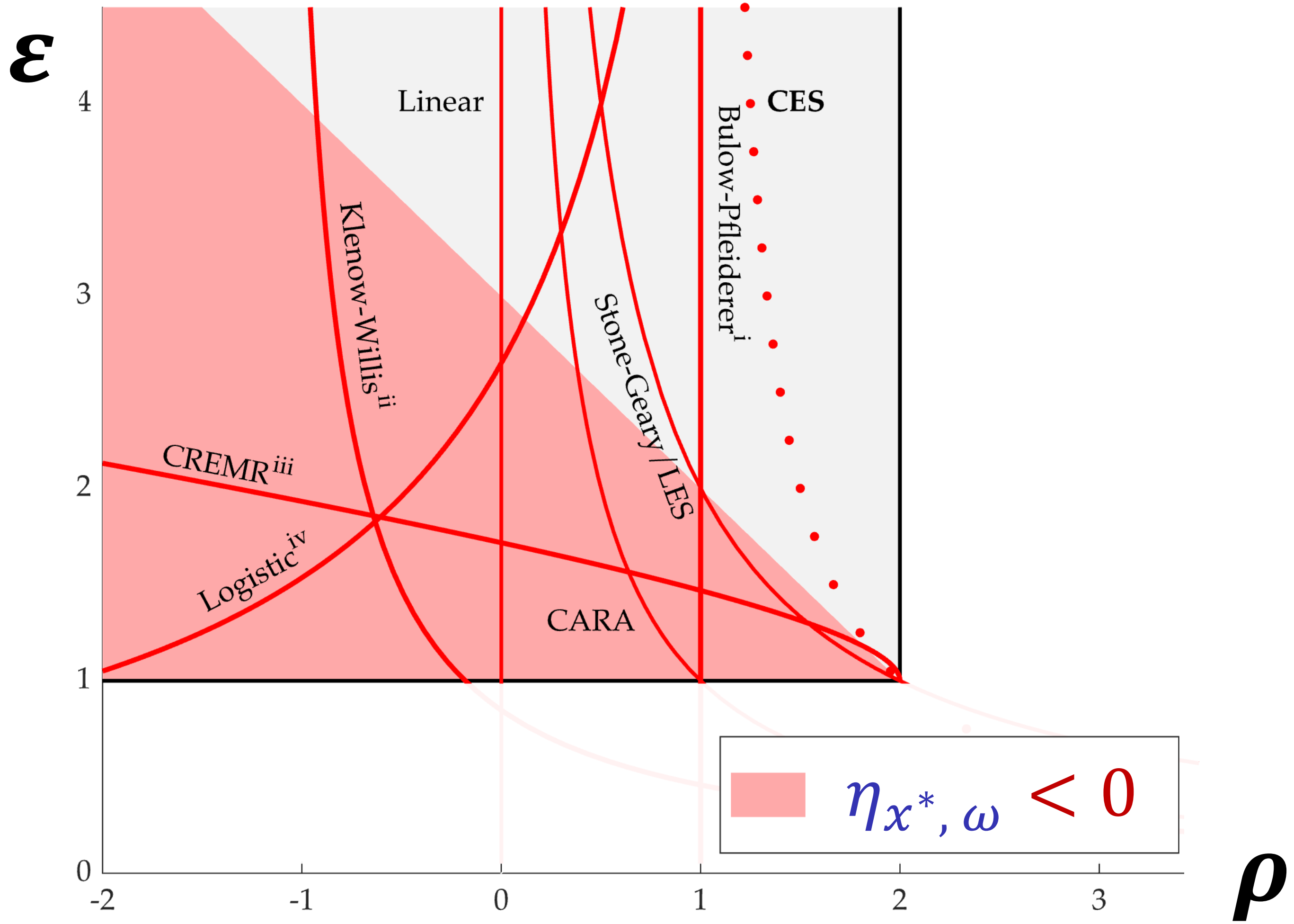
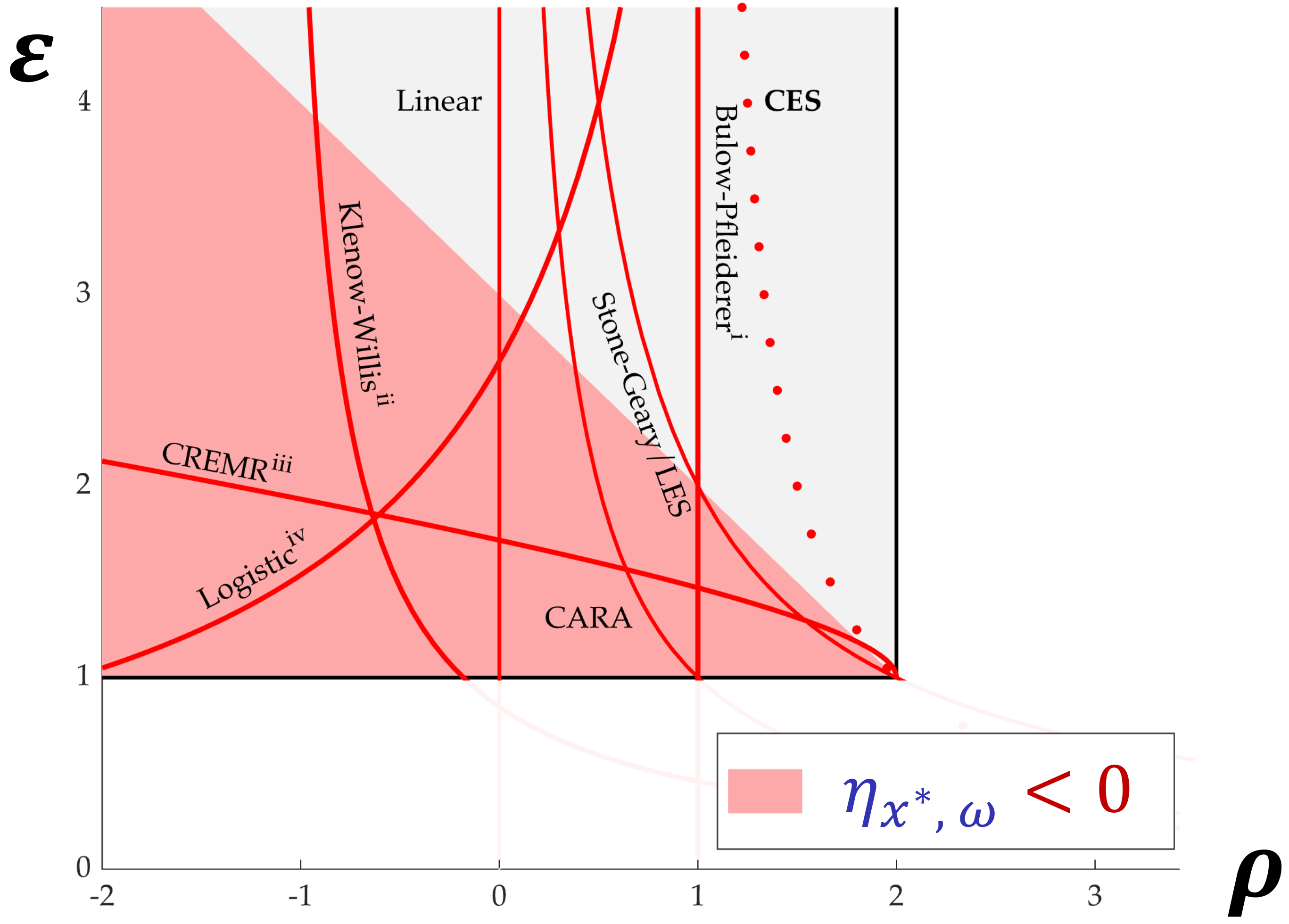
- I bring this into the ***demand manifold*** framework (Mrázová & Neary, 2017) which allows comparing demands based only on their implied relationship between $\boldsymbol{\varepsilon}(q)$ and $\boldsymbol{\rho}(q)$

a. Features of demand



- It occurs in **many** commonly-used **demand functions** (2nd Marshall law)
  e.g. Linear, LES, CARA, Bulow-Pfleiderer, Klenow-Willis, Logistic, ...

a. Features of demand



- Direct link to values of **pass-through** and **markups** e.g. linear $\mu \geq 1.5$

b. Market structure

- Beyond monopoly, this result depends on elasticity of the ***residual*** demand

  - positioning of each firm *vs.* others
  - competitive pressure in the market

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- Take-aways:

1. **Small** firms always increase x^* *vs.* **large** may not adjust and scale back

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$$\text{higher } \omega_i \not\Rightarrow \text{larger } x_i$$

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- <u>Take-aways:</u>

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3. **Oligopoly**: - any reduction in competition (i.e. merger, conduct) $\downarrow \eta_{x^*,\omega}$

   - even CES leads to $\eta_{x^*,\omega} < 0$

2. From theory to empirics

Ideal detection test for $\eta_{x^*,\omega} < 0$

- Observe $\Delta\omega_i > 0$ and check

$$\begin{cases} \Delta x_i^*(\Delta\omega_i) < 0 \\ \Delta q_i^*(\Delta\omega_i) > 0 \end{cases}$$

Challenges

1. **Other contemporaneous** (demand, cost) **shocks** may overshadow $\Delta\omega_i$

$$\begin{cases} \Delta x_i^*(\Delta\omega_i\ ,\ \Delta\xi_i\ ,\ \Delta\psi_i\ ,\ \Delta w) \gtrless 0 \\ \\ \Delta q_i^*(\Delta\omega_i\ ,\ \Delta\xi_i\ ,\ \Delta\psi_i\ ,\ \Delta w) > 0 \end{cases}$$

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1 & 2 + **imperfect competition** $\rightarrow$ ω_i and $\Delta\omega_i$ not estimable

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- *Prediction*: Ratio more likely to become negative among larger firms

3. Application

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- Restrict analysis to single-(main) product firms

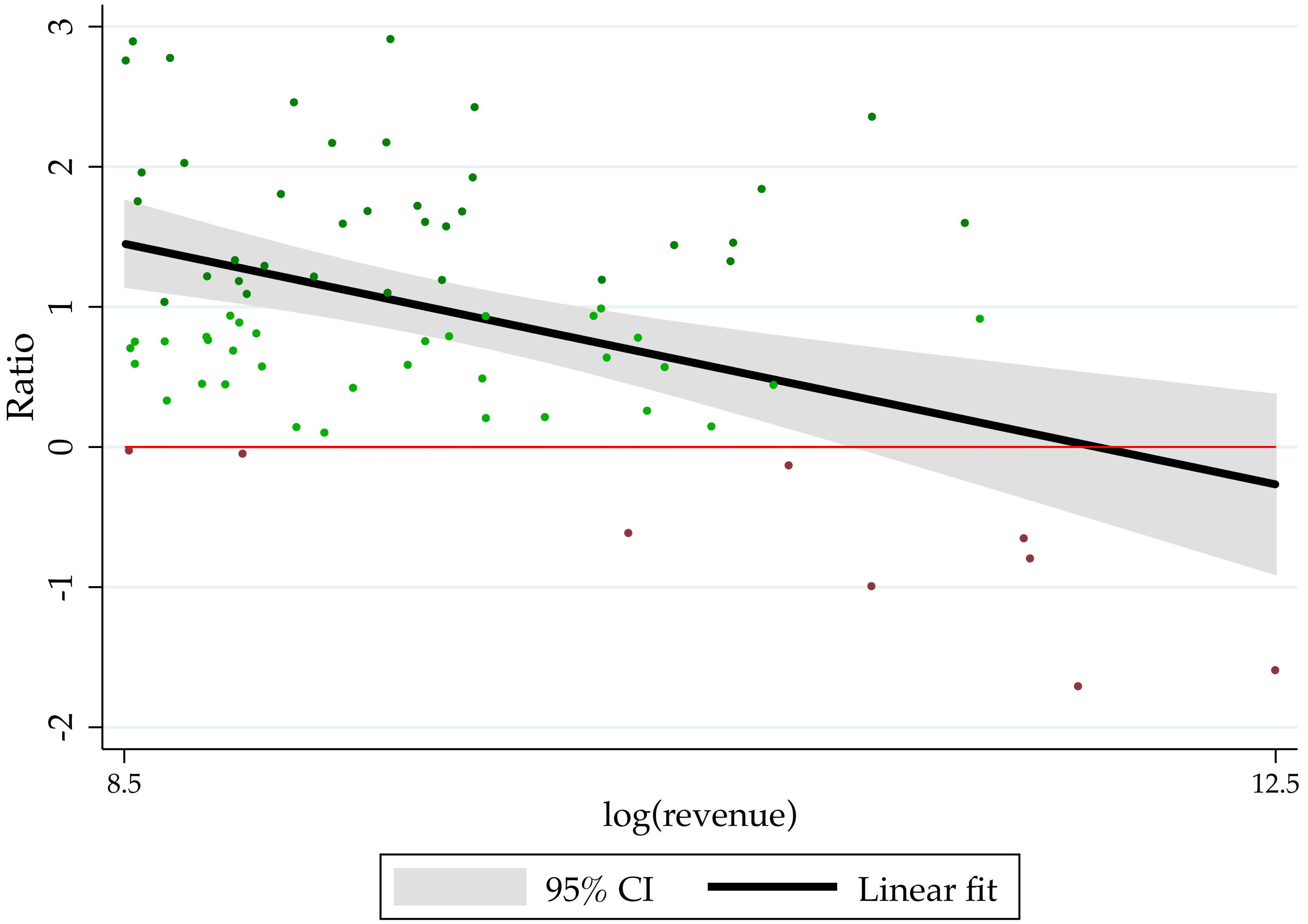
- Estimate output elasticity as **cost shares** for labor, intermediate and capital as yearly median at 4-digit industry-province level

- Aggregate **composite input** x^* with a Cobb-Douglas PF

$$f(l, m, k)\,\omega = \underbrace{l^{\beta_l}\, m^{\beta_m}\, k^{\beta_k}}_{x^*}\,\omega$$

Results (1999-1998)

Illustrative example. Manufacturing of rubber boots (CIC 2960)



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- Evidence consistent with a **decoupling** of **factor demand** to **productivity growth** in at least 20% of industries

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- Evidence consistent with a **decoupling** of **factor demand** to **productivity growth** in at least 20% of industries
- In all of them, firms with higher revenues set higher markups (as expected)

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  ... many others still to be unveiled

Thanks!