Envrionmental policy with with financial frictions

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How do financial frictions affect the socially optimal price of carbon?

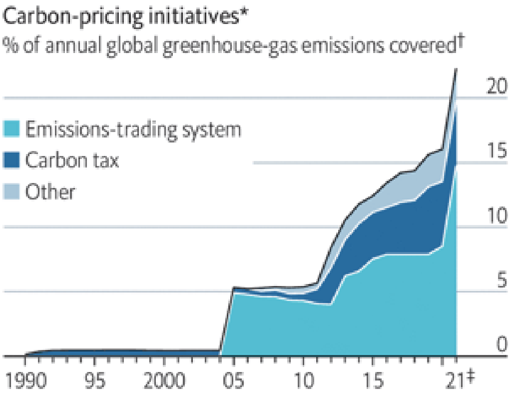
Addressing climate change imposes an enormous financial burden

Polluting firms must pay for the negative externality

But firms are financially constrained

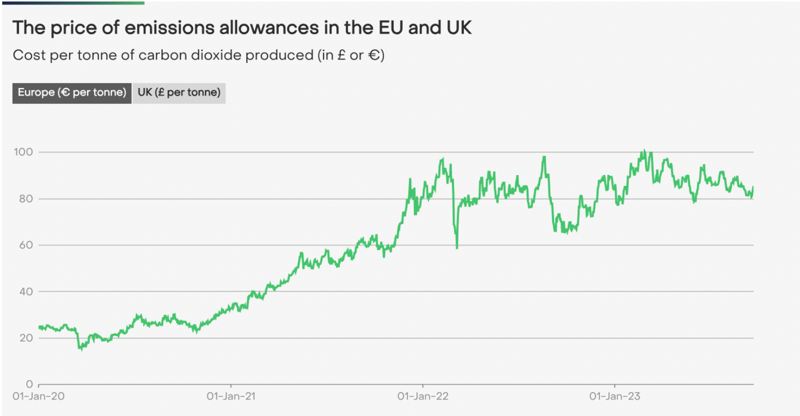
Does that mean one should go easier on firms?

Carbon pricing is a major policy tool



Source: The Economist (May 23, 2020)

The price of carbon has increased significantly



Source: Ember-climate.org

Holmström & Tirole model with industry equilibrium and market for emission rights

Holmström & Tirole (1997): financing constraints for producers

Industry equilibrium: supply = demand, consumer surplus matters

Policy instrument: cap-and-trade for emission rights

Despite financial constraints for low polluters, a higher price of carbon can be socially optimal

"Pigou" if there are no financial constraints

Increase price of carbon ("Porter hypothesis")

- If industry is financially unconstrained (zero profits at the margin)
- But low polluters are financially constrained

Possibly reduce price of carbon

- If whole industry is financially constrained

Literature

Large established literature on deviation from Pigou

- But no paper on financing constraints

New literature on "green investment" with financial frictions

- Hoffmann, Inderst & Moslener (2017), Oehmke & Opp (2020), Inderst & Opp (2022), Döttling & Rola-Janicka (2022)
- But no industry equilibrium (and cap-and-trade)

Financial frictions are acknowledged in policy literature

- But no format treatment

Production

Mass one of firms, $i \in [0, 1]$

Each firm invests I_i, output I_i

Aggregate output, $I = \int_0^1 I_i di$

Price of sold output $P(I)$ with $P' < 0$

Pollution

Emissions of a firm: $y_i I_i$

- Low polluter (y_l) and high polluter (y_h): $y_l < y_h$
- Proportion of low polluters μ_l

Social cost of aggregate emissions: $v \int_i y_i I_i di$

Policy tool: cap-and-trade

Planner sets a cap K on total emissions: $\int_i y_i I_i \leq K$

Each firm receives or buys emission allowances

Firms can trade allowances

Market clearing price τ

Social objective function

$$\Omega = \int_0^I P(\hat{I})d\hat{I} - \int_i (1 + vy_i)I_i di$$

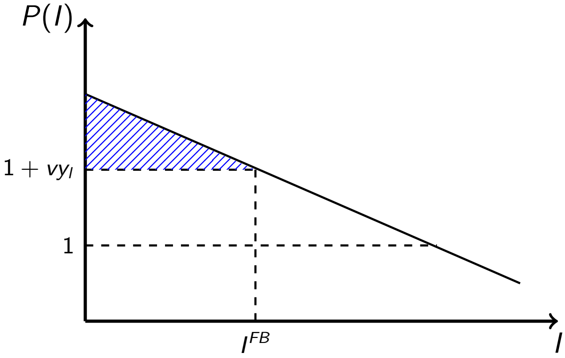
First-Best

No financial constraints

No distinction between firms and investors

Only low polluters produce, and $P(I^{FB}) = 1 + vy_l$

First-best



Agency conflict between firms and investors

Firms have own funds A; can borrow from investors

Production success depends on owner-manager's unobservable monitoring effort

If he shirks, production fails (for sure) but he obtains per-unit private benefit b

Owner-manager is protected by limited liability

Financing constraint

Financing need $I_i(1+\tau y_i) - A$

Each firm takes $P(I)$ as given

An individual firm's investment is limited by

$$I_i \leq \frac{1}{b - [P(I) - (1+\tau y_i)]} A$$

Shadow cost of capital

$$\lambda_i = \frac{P(I) - (1+\tau y_i)}{b - [P(I) - (1+\tau y_i)]}$$

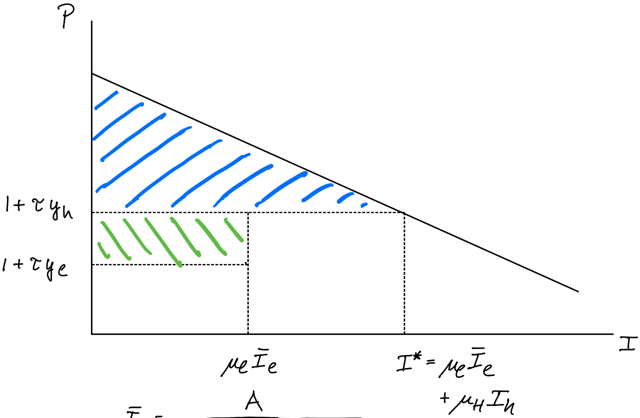
Market equilibrium

Fixed-point problem with several cases

Focus on

- High polluters are active (e.g., small μ_I), and
- Make zero profits (e.g., large A)

Market equilibrium



$$\bar{I}_e = \frac{A}{b-[P(I^*)-(1+\tau y_e)]}$$

Planner considers industry size and composition

Social objective becomes

$$\Omega = \int_0^{I^*} P(\hat{I})d\hat{I} - I^*(1 + vy_h) + I_l^* v(y_h - y_l)$$

Total investment margin

$$\frac{dI^*}{d\tau}\left[P(I^*) - (1 + vy_h)\right]$$

Composition margin

$$\frac{dI_l^*}{d\tau} v(y_h - y_l)$$

Why $\tau^* > v$

Total investment margin

$$\underbrace{\frac{dI^*}{d\tau}}_{<0}[P(I^*) - (1 + vy_h)]$$

Composition margin

$$\frac{dI_l^*}{d\tau}v(y_h - y_l)$$

Why $\tau^* > v$

Total investment margin

$$\underbrace{\frac{dI^*}{d\tau}}_{<0}\underbrace{[P(I^*) - (1 + vy_h)]}_{=0 \text{ when } \tau = v}$$

Composition margin

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Why $\tau^* > v$

Total investment margin

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Composition margin

$$\underbrace{\frac{dI_l^*}{d\tau}}_{>0} v(y_h - y_l)$$

Conclusion

Firm financial constraints $\not\Rightarrow$ cheaper price for emission rights

Industry conditions and composition matter

Holmström & Tirole (1997), industry equilibrium, pollution externality and cap-an-trade system

Novel pecuniary externality

- Reduce industry output to ease financial constraints for infra-marginal, low-polluting firms