

Carbon Policy Simulator — Model Parameters (ReadMe)

This document summarises the core parameterisations used in the paper and exposed in the interactive simulator: (i) production cost, (ii) demand and import supply, and (iii) abatement investment cost (including a comparison to techno-economic benchmarks).

1 Production cost and parameters

Static Cournot environment (per market-period)

Firms compete à la Cournot under capacity constraints. For firm i with output q_i and annual capacity s_i , production cost follows a “hockey-stick” form with constant marginal cost up to a utilisation threshold and convex escalation above it:

$$C(q_i; \delta, \eta_i, \tau) = \delta_1 q_i + \mathbf{1}[q_i > \delta_2 s_i] \delta_3 \left(\frac{q_i}{s_i} - \delta_2 \right)^2 + \phi(q_i, \eta_i, \tau), \quad (1)$$

where η_i is emission intensity and τ the carbon price (policy). Under a carbon tax:

$$\phi(q_i, \eta_i, \tau) = \tau q_i \eta_i. \quad (2)$$

Estimated production-cost parameters

| Parameter | Value | Units |
|--|-------|-------------------|
| Constant marginal production cost δ_1 | 72.35 | EUR/ton |
| Utilisation threshold δ_2 | 0.75 | Share of capacity |
| Utilisation cost curvature δ_3 | 0.67 | EUR |

These are the baseline cost parameters used to generate per-period equilibrium outcomes across states.

2 Demand and import elasticity

Aggregate demand (isoelastic)

In each market m and period t , aggregate demand is isoelastic:

$$\ln Q_{m,t}(P_{m,t}) = \alpha_{0,m,t} + \alpha_1 \ln P_{m,t}. \quad (3)$$

The elasticity is set to $\alpha_1 = -2$. Market-year intercepts $\alpha_{0,m,t}$ are fitted to match observed levels given prices and the elasticity.

Import supply (isoelastic)

Import supply into market m at time t is:

$$\ln I_{m,t}(P_{m,t}) = \rho_{0,m,t} + \rho_1 \ln P_{m,t}, \quad (4)$$

with import supply elasticity $\rho_1 = 0.5$. Market-year intercepts $\rho_{0,m,t}$ are fitted analogously. Domestic strategic firms face residual demand after subtracting imports (and the competitive fringe, if included), so changes in τ affect equilibrium both through marginal cost and the import margin.

3 Investment cost and comparison to techno-economic estimates

Continuous abatement choice and intensity mapping

Firms choose an abatement level $\theta_i \in [0, 100]$, interpreted as a percentage reduction in emission intensity relative to baseline intensity $\bar{\eta}$. Baseline intensity is set to $\bar{\eta} = 0.63$ tCO₂e per ton of cement, implying the mapping:

$$\eta_i = \left(\frac{100 - \theta_i}{100} \right) \bar{\eta}. \quad (5)$$

Investment cost function (level)

Investment costs are proportional to capacity and increasing in abatement, with an idiosyncratic cost shock affecting marginal costs:

$$\text{InvCost}_i(\theta_i \mid \lambda, \varepsilon_i) = s_i \theta_i (\lambda_1 + \lambda_2 \theta_i + \lambda_3 \varepsilon_i), \quad \varepsilon_i \sim \mathcal{N}(0, 1). \quad (6)$$

If a firm moves from θ_i to $\theta'_i > \theta_i$, it pays the incremental (step) cost:

$$\text{InvCost}_i(\theta'_i \mid \theta_i) = \text{InvCost}_i(\theta'_i \mid \lambda, \varepsilon_i) - \text{InvCost}_i(\theta_i \mid \lambda, \varepsilon_i). \quad (7)$$

This structure reflects scalable, combinable abatement options and incremental upgrading. The discount factor is set at 0.975.

Estimated abatement-cost parameters

| Parameter | Estimate |
|-------------|----------|
| λ_1 | 0.62 |
| λ_2 | 0.12 |
| λ_3 | 4.07 |

These parameters are estimated by matching (i) mean investment and (ii) within-market dispersion (standard deviation) of investment across firms over investment periods.

Comparison to techno-economic benchmarks

As a reference point reported in the paper, the estimated cost curve implies an expected cost of about EUR 6.3bn to reduce the emission intensity of the entire French cement industry by 50%, while a techno-economic assessment reports about EUR 3.3bn for the same reduction (ADEME, 2021). The interpretation is that the structural estimates embed additional opportunity costs (overhead, downtime, financing, implementation frictions) beyond engineering CAPEX.