

Catching up and falling behind: Cross-country evidence on the impact of the EU ETS on productivity growth

Nicolas Koch Michael Themann



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Motivation

Two broad views in the environmental policy-competitiveness literature ([Ambec et al. 2013](#); [Dechezlepretre/Sato 2017](#))

- ▶ Conventional wisdom: firms need to relocate resources from traditional uses, which slows down productivity
- ▶ Porter Hypothesis: induced incentives for [broadly defined] innovation can lead to higher productivity (strong version) & gains more likely under market-based policies (narrow version)

What is the impact of the EU ETS on firm productivity?

- ▶ We hypothesize that productivity dispersion matters, i.e. policy impact on productivity may depend on firm position within industry productivity distribution
- ▶ We construct a consistent and representative European dataset for firm-level total factor productivity (TFP)
- ▶ We account for neo-Schumpeterian catch-up: productivity growth depends on firm's ability to adopt own innovations *and* efficient technologies & processes available in market

Related Literature

- ▶ Climate policy evaluation literature using TFP as a summary estimate of the costs of regulation borne by firms ([Greenstone et al. 2012](#))
 - ▶ Cross-sectional analyses for EU ETS find insignificant ([Marin et al. 2017](#)) or marginally significant negative effects ([Commins et al. 2011](#)); positive or insignificant effects in single-country investigations ([Lutz 2016](#); [Loeschel et al. 2016](#); [Hintermann et al. 2020](#))
 - ▶ **This paper** focuses on heterogeneity and deviates from static framework
- ▶ Neo-Schumpeterian literature emphasizes productivity convergence to a technological frontier ([Aghion/Howitt 2006](#); [Griffith et al. 2004](#))
 - ▶ [Bourles et al. \(2012\)](#) and [Albrizio et al. \(2017\)](#) show heterogeneous policy effects depending on the distance to the frontier in more general contexts
 - ▶ **This paper** demonstrates that not accounting for the dynamic forces of productivity growth can lead to omitted variable bias

Key findings

1. EU ETS effect on TFP is nonlinear in the distance to the technological frontier
2. Productivity effects are positive for firms that are close to the frontier, but they turn negative for least advanced laggards
3. No statistically significant effect for majority of firms in the middle of the productivity distribution
4. Positive effects pronounced in Northern Europe, negative effects more present in Southern Europe

Data

- ▶ Construct nationally representative firm-level TFP database for eight European countries using ORBIS & EUTL
 - ▶ Focus on manufacturing & energy sector, 2002-2012
 - ▶ Criteria on national representativeness ([Kalemli-Ozcan et al. 2015](#)): high coverage of economic activity, low degree of data fluctuations, representative firm size distribution
- ▶ Novel estimator for production function that jointly deals with measurement error in capital and the standard simultaneity bias ([Collard-Wexler/de Loecker 2020](#))
 - ▶ Overcomes challenges with very low capital coefficients obtained from standard estimators using ORBIS data

Capital & labor elasticities by sector

Empirical specification

- ▶ Error correction model in which each firm i converges toward its own steady-state level of TFP relative to the industry frontier F_s Definition

$$\begin{aligned}\Delta \ln TFP_{icst} &= \alpha_1 \Delta \ln TFP_{Fst} + (1 - \alpha_0) \ln \left(\frac{TFP_{F_s}}{TFP_{ics}} \right)_{t-1} \\ &\quad + \beta_1 ETS_{it} + \beta_2 ETS_{it} \ln \left(\frac{A_{F_s}}{A_{ics}} \right)_{t-1} \\ &\quad + \delta x_{icst-1} + \gamma d + \varepsilon_{icst}\end{aligned}$$

- ▶ If coefficients for **frontier TFP growth** and **distance to frontier** $0 < \alpha_0 < 1$ and $\alpha_1 > 0$, then we see productivity catch-up
- ▶ We allow **EU ETS** to have a **nonlinear effect** by crossing the *ETS* dummy with distance to frontier
- ▶ Total effect of EU ETS $\beta_1 + \beta_2 \times \ln \left(\frac{TFP_{F_s}}{TFP_{ics}} \right)_{t-1}$

Identification

- ▶ Treatment effect captures variation in TFP growth specific to ETS firms relative to non-ETS firms, in years after policy introduction relative to before
 - ▶ while controlling for time-varying firm characteristics
 - ▶ and fixed, unobservable characteristics at different levels
- ▶ Control group is constructed by means of entropy balancing ([Hainmueller 2012](#))
 - ▶ Assigns weight to each non-ETS firm such that moments of covariates are balanced
 - ▶ Reweighting makes parametric inferences considerably less model-dependent

Covariate balance/parallel trends

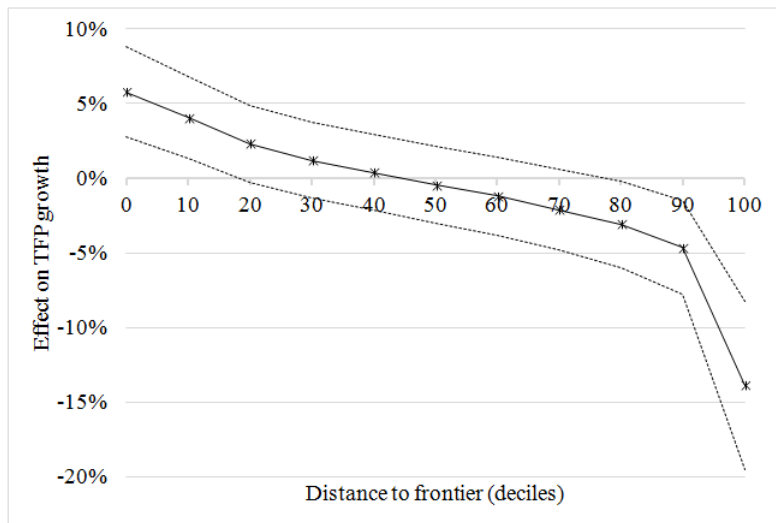
Main result

	Within-group			AB-GMM
	(1)	(2)	(3)	(4)
ETS	-0.02 (0.013)	-0.03* (0.014)	0.06*** (0.015)	0.04*** (0.015)
ETS x distance to frontier			-0.09*** (0.016)	-0.09*** (0.023)
Distance to frontier		0.44*** (0.040)	0.50*** (0.040)	0.25*** (0.068)
Frontier growth		0.32*** (0.051)	0.33*** (0.049)	0.29*** (0.075)
Size, sales, age, MNE controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Country x industry FE	Yes	Yes	Yes	-
Country x year FE	Yes	Yes	Yes	-
Firm FE	Yes	Yes	Yes	Yes
Observations	453.779	453.779	453.779	396.955
AB-AR(1)				0.000
AB-AR(2)				0.203
Hansen J (p-value)				0.132

Notes: Standard errors are clustered at the 4-digit industry level. *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

GMM estimator of Arellano/Bond 1991 to address Nickell bias.

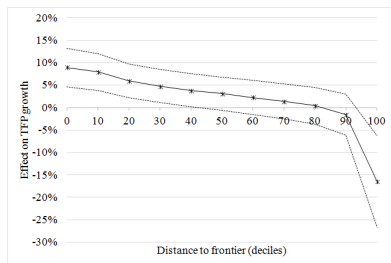
Non-linear impact of EU ETS



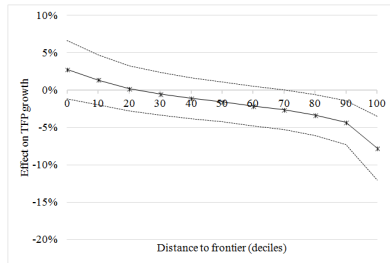
Heterogeneity across country groups

North = BE, FR, DE, GB, NO & SE; South = IT & ES

(a) *Firms in Northern Europe*



(b) *Firms in Southern Europe*



Robustness

1. Unobservable selection ([Oster 2019](#))
2. Sample of only survival firms: no indication for attrition bias
3. Announcement or anticipation effects
4. Late joiner test: no indication for SUTVA violations
5. Alternative estimators: simple DiD, propensity score matching DiD, and propensity score weighted DiD

Conclusions

Evidence brings together two central paradigms

- ▶ Technological leaders in EU ETS benefit from policy (Porter view) while least efficient firms face a productivity slow down in adapting to the policy (conventional view)

Policy implications

- ▶ EU ETS may exacerbate pre-existing structural differences in productivity dynamics among European economies
- ▶ Widening productivity gap across firms matters for distributional implications of EU ETS
- ▶ Case for companion policies? Sharing benefits of new technologies and/or improving country-specific conditions

Thank You

Nicolas Koch

koch@mcc-berlin.net



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