CLIMATE CHANGE POLICY AND THE GREEN TRANSITION

LESSONS FROM FIRM-LEVEL DATA

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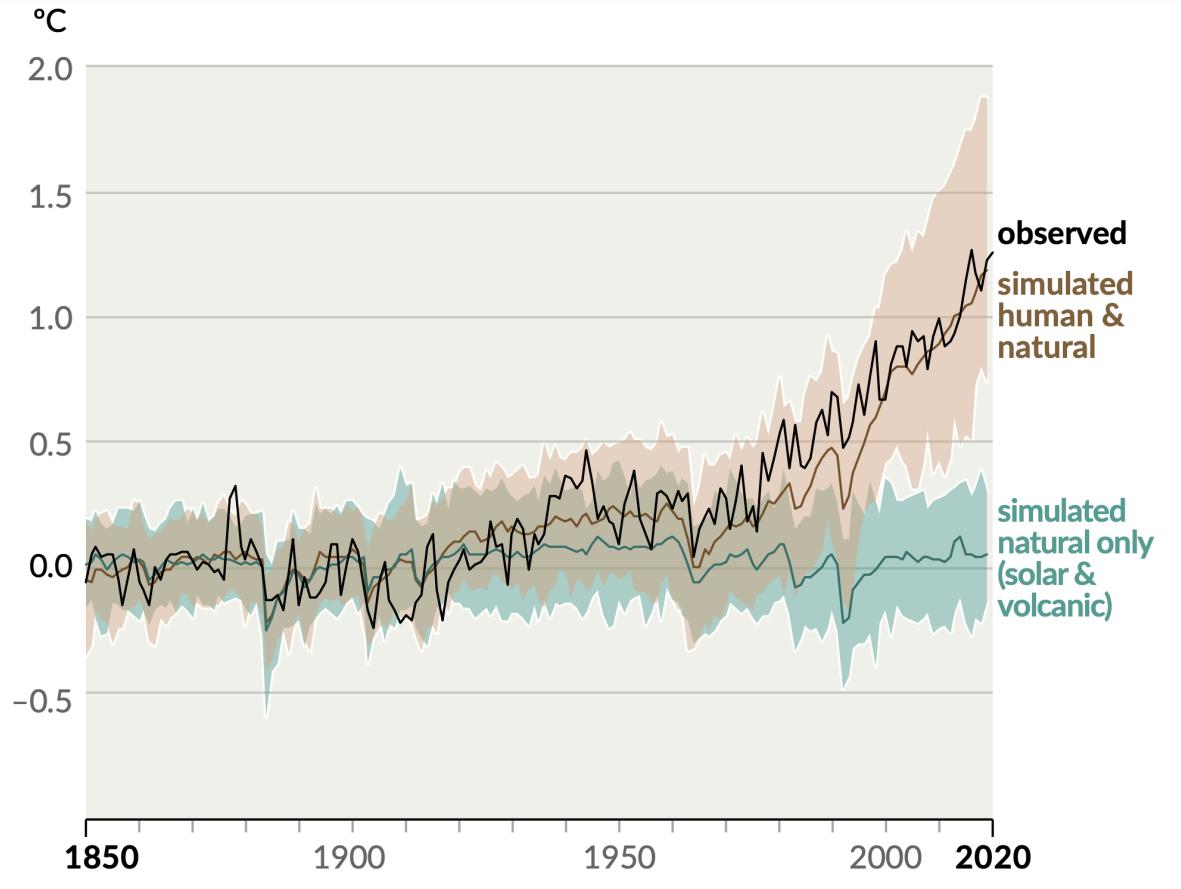
July 7, 2022

Annual Conference of the Global Forum on Productivity, Brussels

A CHANGING CLIMATE: ANTHROPOGENIC CLIMATE CHANGE

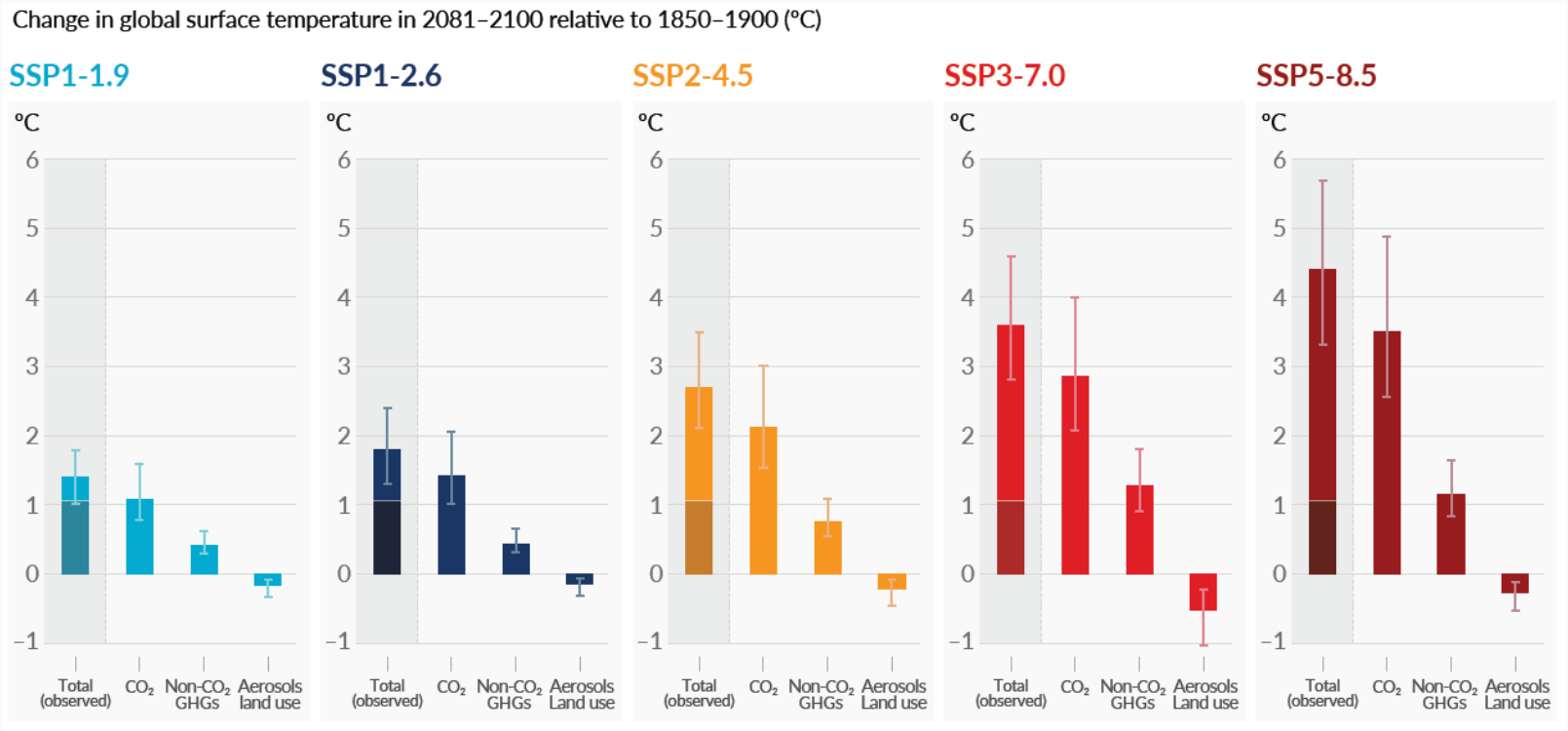
A.1 It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred.
{2.2, 2.3, Cross-Chapter Box 2.3, 3.3, 3.4, 3.5, 3.6, 3.8, 5.2, 5.3, 6.4, 7.3, 8.3, 9.2, 9.3, 9.5, 9.6, Cross-Chapter Box 9.1} (Figure SPM.1, Figure SPM.2)



Source: IPCC (2021) *Climate Change 2021 – The Physical Science Basis (SPM)*

A CHANGING CLIMATE: ON THE BRINK?

B.1 Global surface temperature will continue to increase until at least mid-century under all emissions scenarios considered. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in CO_2 and other greenhouse gas emissions occur in the coming decades.
{2.3, Cross-Chapter Box 2.3, Cross-Chapter Box 2.4, 4.3, 4.4, 4.5} (Figure SPM.1, Figure SPM.4, Figure SPM.8, Table SPM.1, Box SPM.1)



Source: IPCC (2021).

A CHANGING CLIMATE AND A CLIMATE OF CHANGE

Implications for policy-making:

- Business as usual is no longer a viable alternative.
- Emissions must be curbed, climate policy is inevitable!

Theory says that 'pricing in the externalities':

- Leads to fewer/more costly inputs and output falls in short run.
- Investment is lower, productivity growth slows down.

However...

- Productivity and development are closely linked.
- Climate policy must be compatible with (green) growth.

If 'output' is given by

$$Y = \Omega F(K, hL, E, N, \ldots)$$

need to complement carbon 'pricing' with measures to support:

- Technological change – invention, innovation and diffusion
- Structural change – infrastructure, supply chains
- Skills for green transition – health and (life-long) education
- Investment in nature – conservation, nature-based solutions

LESSONS FROM EXISTING POLICY: THE EU ETS

The EU ETS was the first major cap-and-trade system in the world

- 11,000+ installations across 31 (EU27+4) countries, ∼45% of EU GHG emissions.
- Four 'phases': 2005-2007, 2008-2012, 2013-2020, 2021-2030.
- Several changes in structure and coverage over the years, overall prices remained low until recently.
- Concerns on costs, profitability, and productivity.
- Allocation: push back from business focussed on 'exposure to competition' argument.

FIFTEEN YEARS IN FIVE MINUTES...

- Did the EU ETS make a difference to emissions?
  Lithuania (2005-2007)
- Is participation in the EU ETS really so costly?
  Ireland (2005-2007)
- Are profits lower for ETS firms?
  Lithuania (2005-2010), Germany (2005-2014)
- How high are abatement costs?
  Germany (2005-2014)
- Do ETS firms need protection vis-à-vis 'unfair' competition?
  Germany (2005-2014)
- Did the ETS lead to technical change? Innovation, efficiency and productivity
  EU (2005-2007), Germany (2005-2014) TFP and Efficiency

LESSONS LEARNED

- The transition to (net) zero is both urgent and complex, the macro aspects are understood, devil in the details.
- Understanding how policy instruments work in practice is key to informed and transparent policy debate.
- Firm-level data allowed us to show that:
  - Significant heterogeneity exists across and within industries
  - Initially, the EU ETS was not stringent enough to reduce emissions.
  - Participation in the EU ETS seems to be linked to increases in efficiency, productivity.
  - Profits did not fall, they may have increased.
  - Energy costs pass-through incomplete, but firms received 80% of allowances for free and passed on 40% to consumers $\Rightarrow$ Windfall profits!

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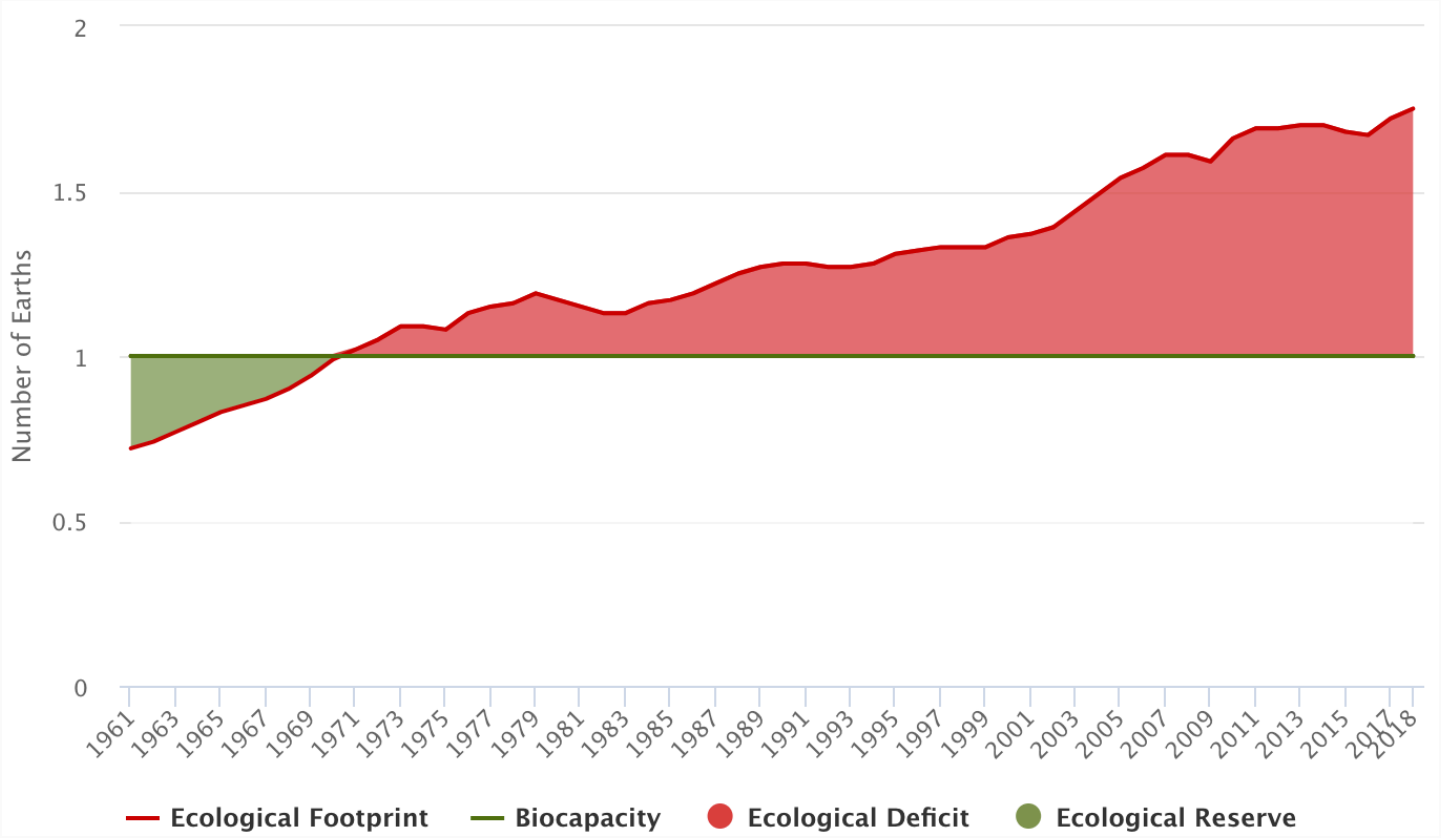
GLOBAL ECOLOGICAL FOOTPRINT



Source: data.footprintnetwork.org

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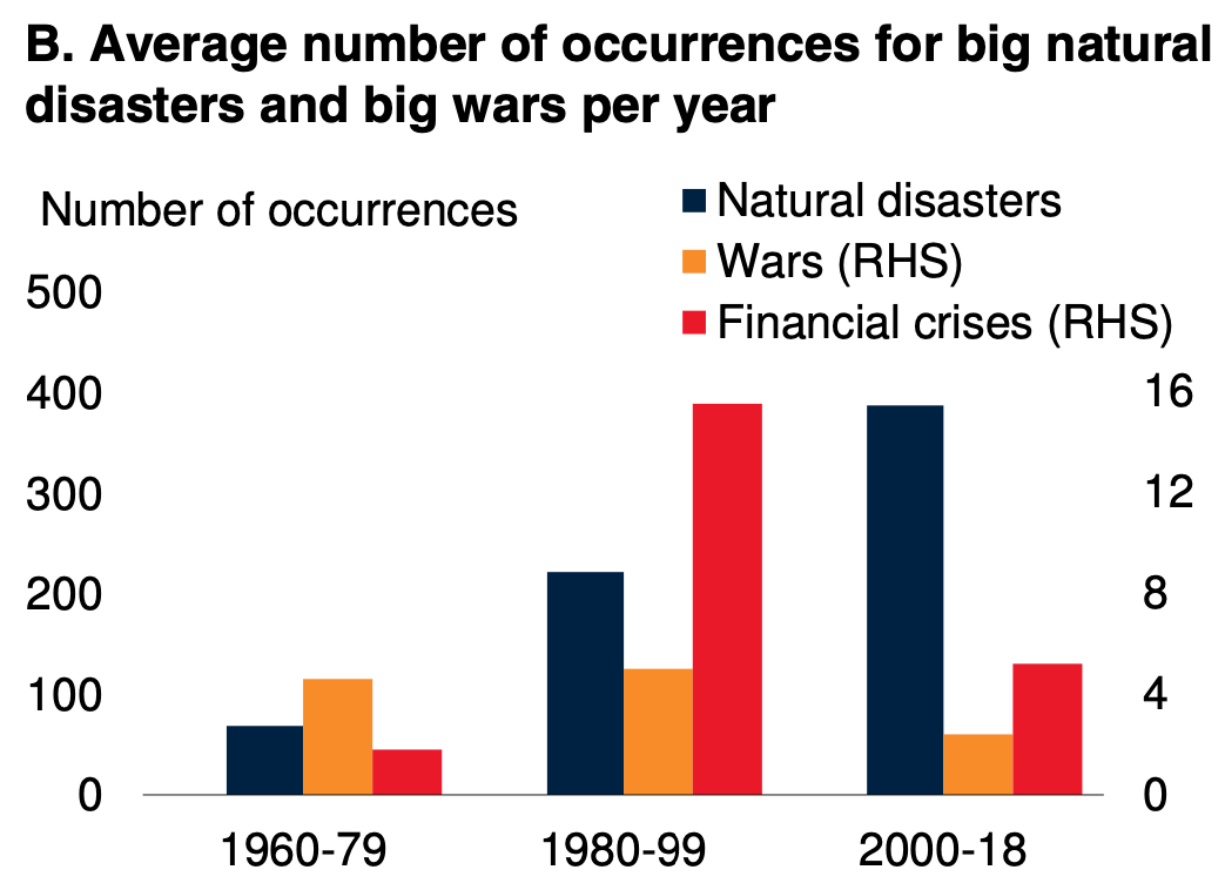

Source: A. Dieppe (ed.) (2021) 'Global Productivity: Trends, Drivers, and Policies'

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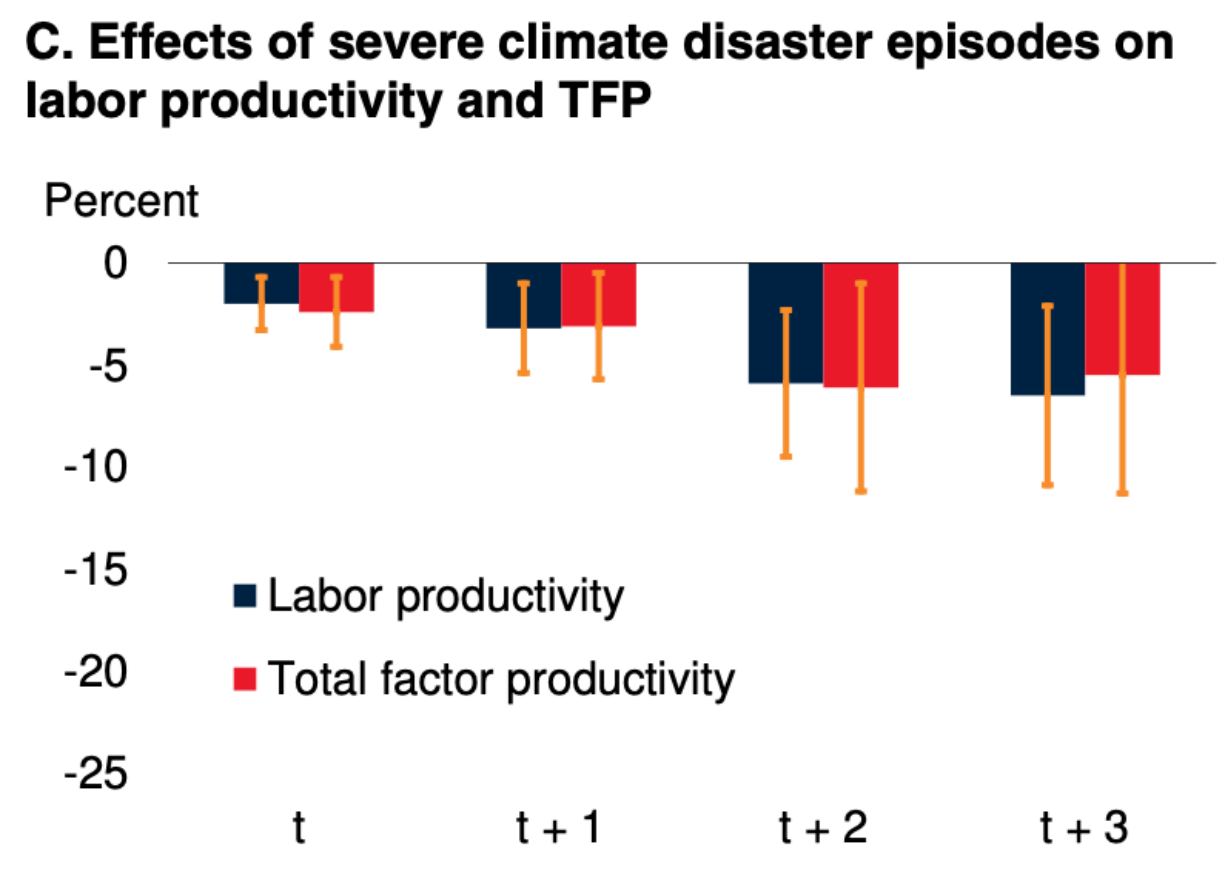
NATURAL DISASTERS AND PRODUCTIVITY



Source: A. Dieppe (ed.) (2021) 'Global Productivity: Trends, Drivers, and Policies'

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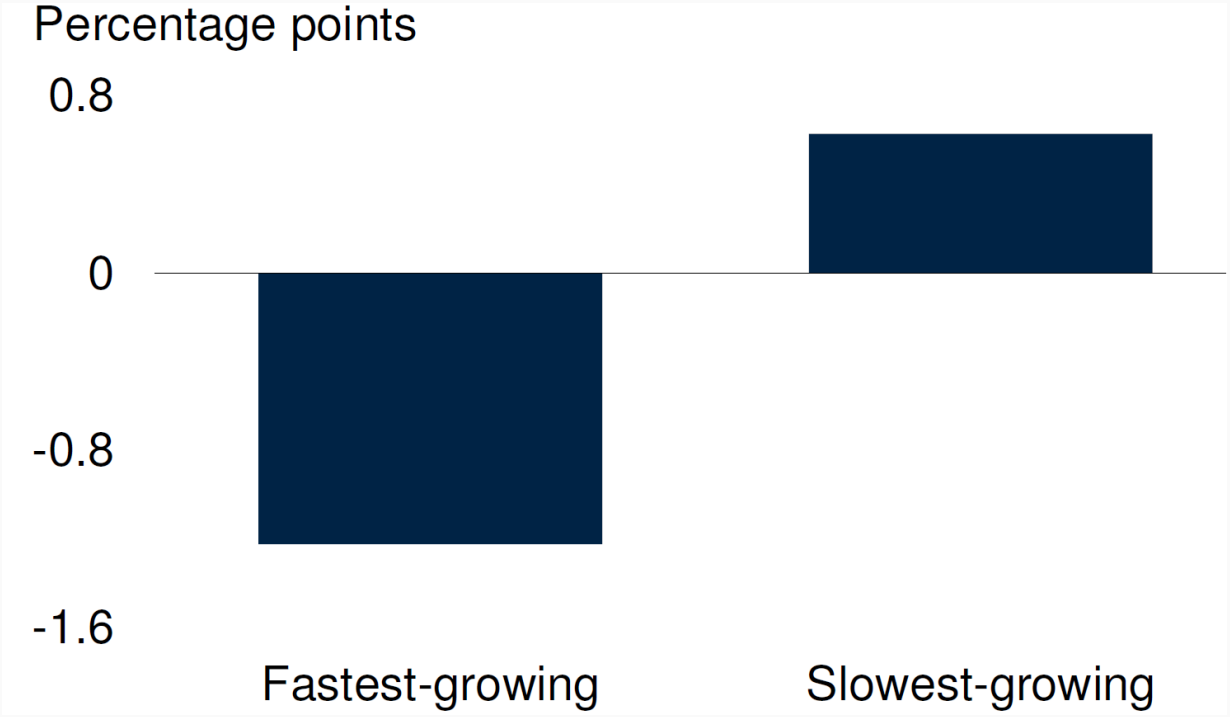
ANNUAL CHANGE IN THE POVERTY RATE – EMDES BY PRODUCTIVITY GROWTH



Source: A. Dieppe (ed.) (2021) 'Global Productivity: Trends, Drivers, and Policies'

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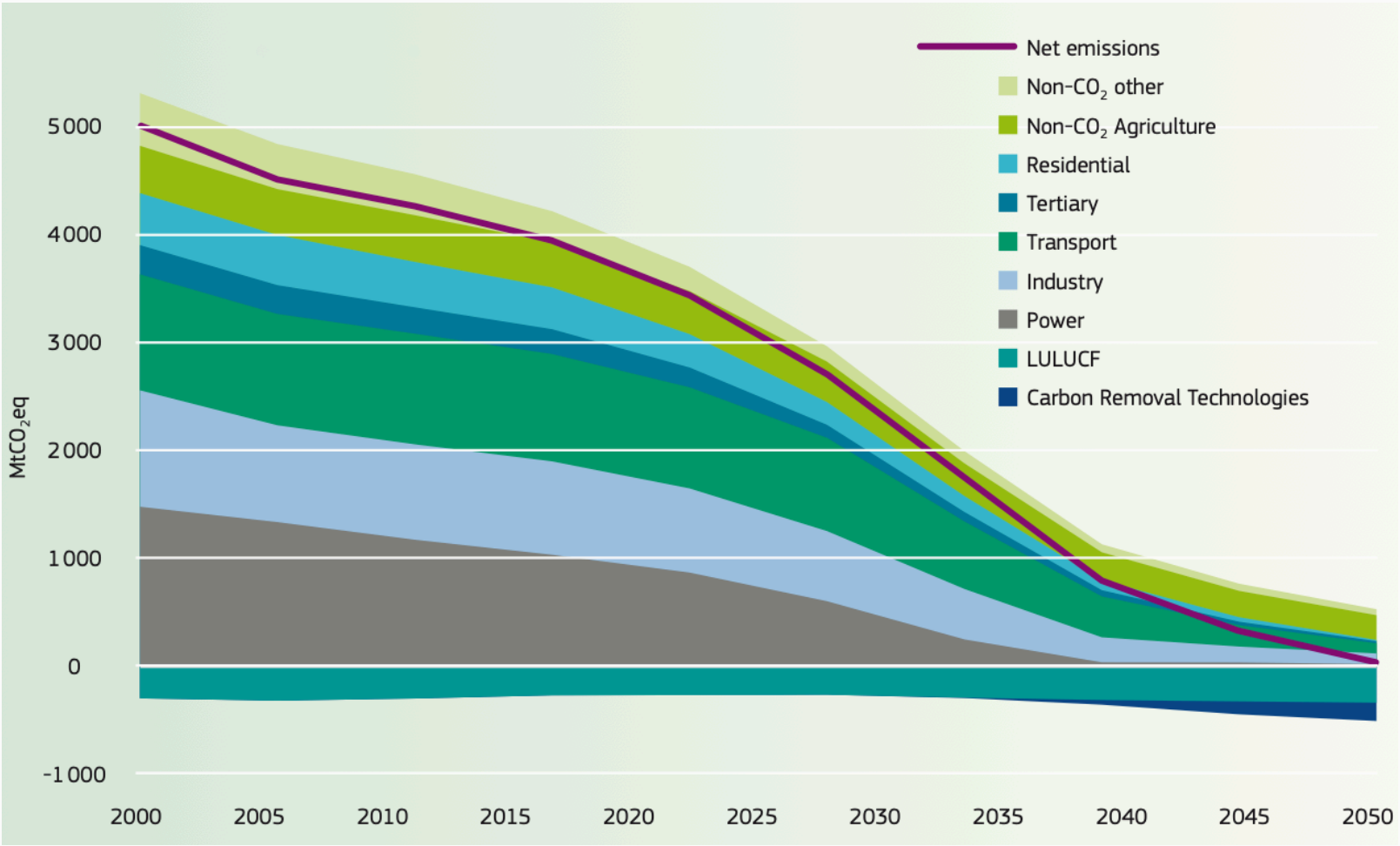
EU: PATH TO (NET-)ZERO BY 2050



Source: European Commission (2019) *Going Climate-Neutral by 2050*

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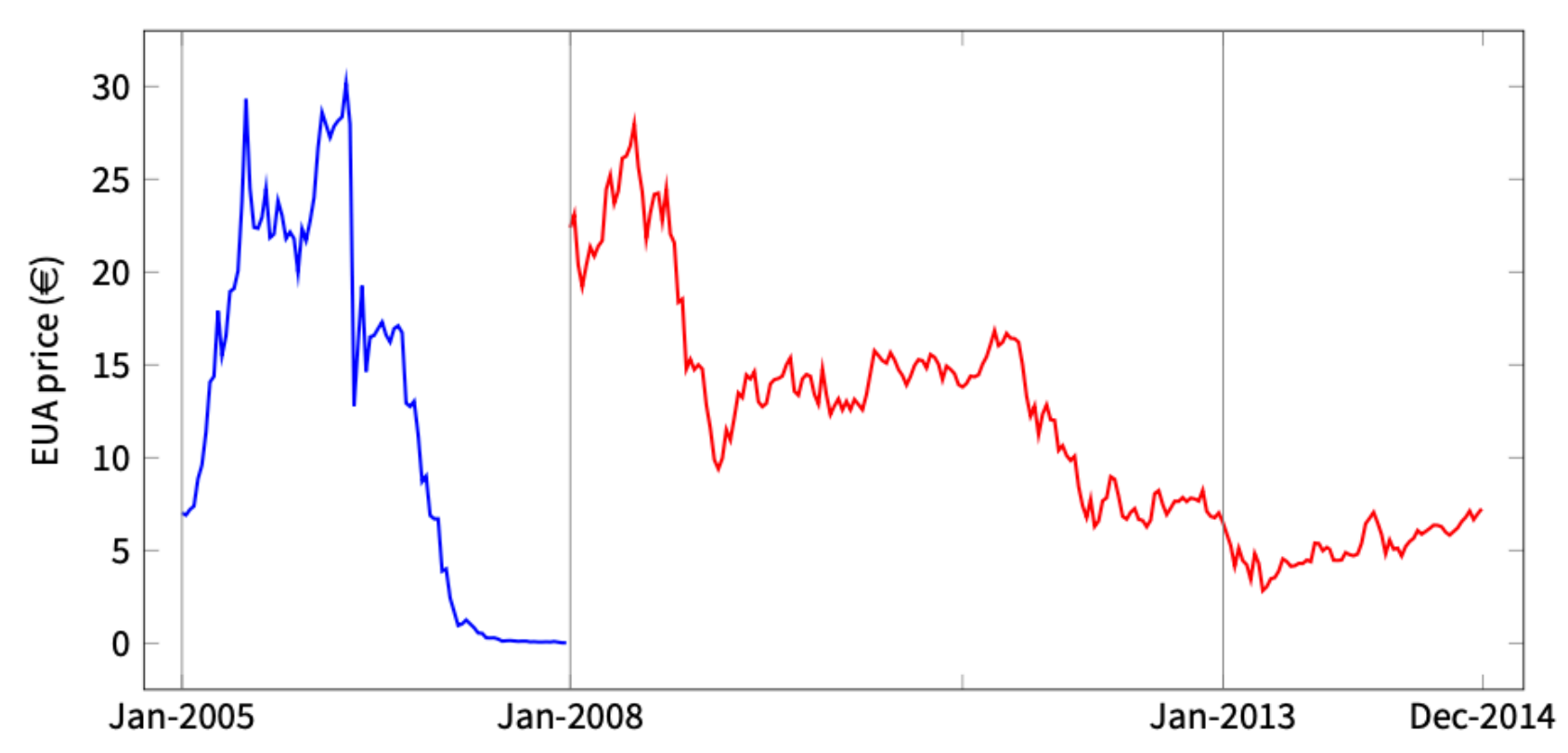
ALLOWANCE PRICES 2005-2013



Source: Di Maria, Zarkovic and Hintermann (2020)

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EFFECTS OF THE EU ETS ON LITHUANIAN FIRMS (2005-2010)

Table 9: Effects of the EU ETS Participation—Environmental and Economic Outcome Variables

Year	2005		2006		2007		2008		2009		2010	
Method	NN	Kernel	NN	Kernel	NN	Kernel	NN	Kernel	NN	Kernel	NN	Kernel
Outcome: Changes compared to 2004												
CO_2 emissions (kt)	15.6	17.2	−4.0	−2.6	29.4	30.4	—	—	—	—	—	—
	(16.0)	(14.6)	(21.4)	(24.6)	(40.0)	(46.8)						
CO_2 emission intensity	0.017	0.108	−0.004	0.057	−0.212	−0.174	—	—	—	—	—	—
(t/000' LTL)	(0.149)	(0.144)	(0.182)	(0.120)	(0.234)	(0.218)						
Tangible capital assets	−268,294*	−279,182**	−231,511*	−241,331**	−205,228*	−212,534**	−236,077**	−243,133**	−238,193*	−245,108*	138,267*	147,359**
(000' LTL)	(167,868)	(152,869)	(158,402)	(142,307)	(124,378)	(123,191	(136,610)	(129,401)	(162,769)	(153,047)	(89,324)	(86,612)
Profitability	0.046	0.071	0.045	0.056	−0.022	−0.002)	−0.119	−0.112	−0.116*	−0.092	−0.178*	−0.177*
(000'LTL/000' LTL)	(0.089)	(0.075)	(0.053)	(0.048)	(0.063)	(0.049)	(0.102)	(0.101)	(0.084)	(0.085)	(0.123)	(0.130)
Outcome: year-on-year changes												
CO_2 emissions (kt)	15.6	17.2	−19.6	−19.8	33.4	33.0	—	—	—	—	—	—
	(13.6)	(14.3)	(18.6)	(14.4)	(32.9)	(33.0)						
CO_2 emission intensity	0.017	0.108	−0.021	−0.051	−0.208*	−0.232*	—	—	—	—	—	—
(t/000'LTL)	(0.168)	(0.142)	(0.129)	(0.117)	(0.145)	(0.144)						
Tangible capital assets	−268,294*	−279,182**	36,783*	37,851**	26,284*	28,797**	−30,849**	−30,599**	−2,116	−1,975	376,460*	392,466**
(000'LTL)	(193,011)	(160,858)	(23,768)	(21,504)	(17,504)	(16,861)	(15,774)	(14,696)	(23,362)	(22,164)	(267,101)	(185,823)
Profitability	0.046	0.071	−0.001	−0.016	−0.067**	−0.057**	−0.097*	−0.110**	0.003	0.021	−0.062	−0.085*
(000'LTL/000'LTL)	(0.077)	(0.067)	(0.065)	(0.058)	(0.037)	(0.028)	(0.075)	(0.058)	(0.144)	(0.141)	(0.058)	(0.059)

Notes:
1. ***p < =0.01, **p < = 0.05, *p < = 0.1, the p-values are calculated using one-tailed t-tests.
2. The bootstrapped standard errors are in the parentheses.
3. All monetary variables are in real terms.
4. There are 41 ETS firms in the treated group.
5. Kernel matching is based on 312 firms in the control group.
6. NN matching with replacement is based on 22 firms in the control group.

Source: Jaraite and Di Maria (2016)

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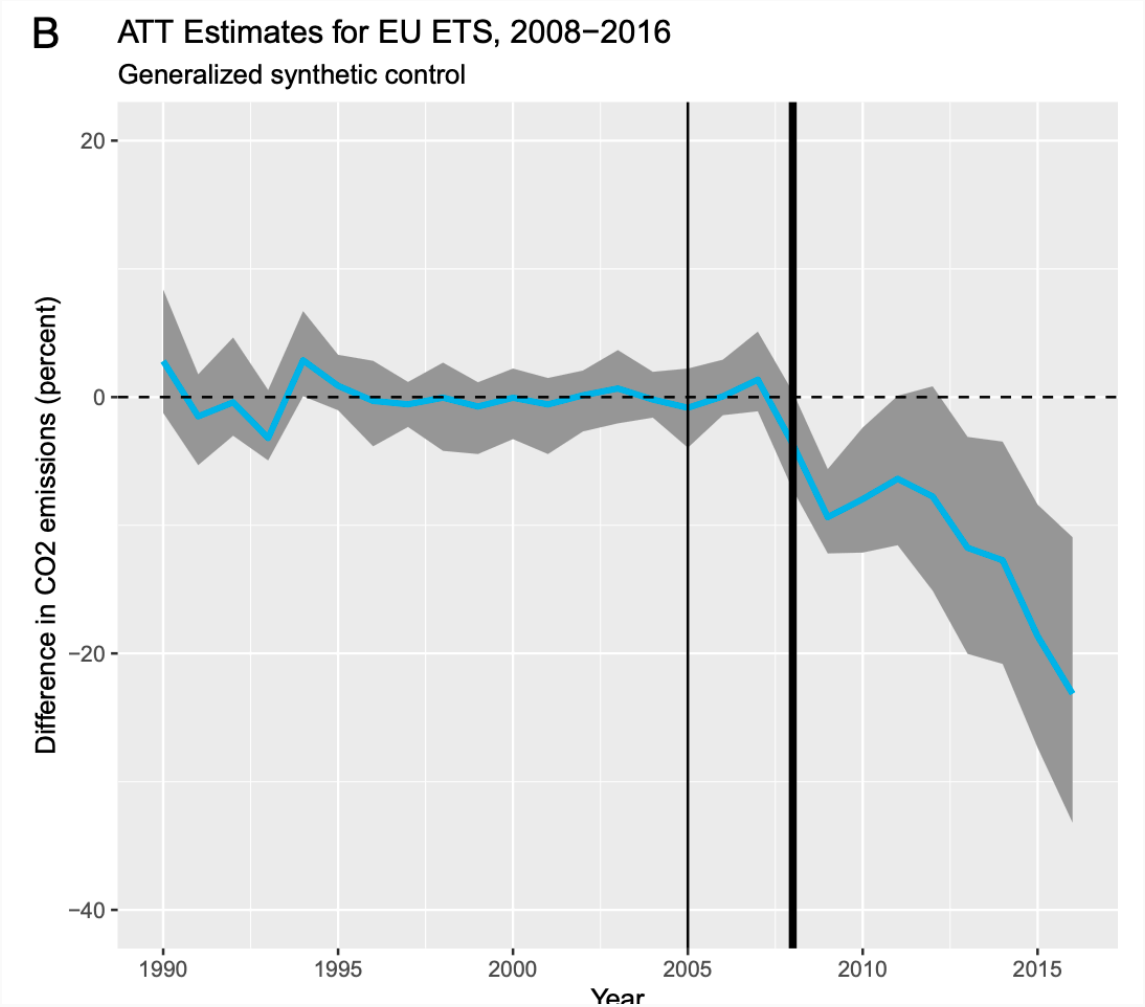
EFFECTS OF THE EU ETS ON CO_2 EMSSIONS (2005-2017)



Source: Bayer and Aklin (2020)

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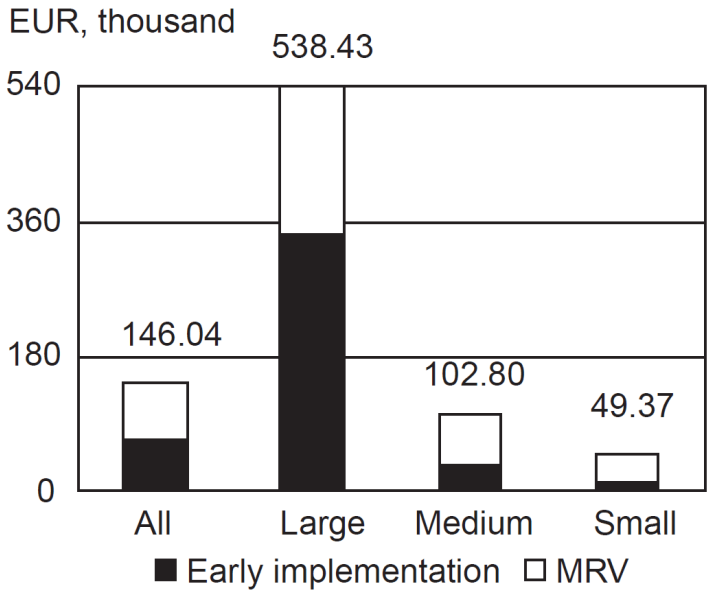
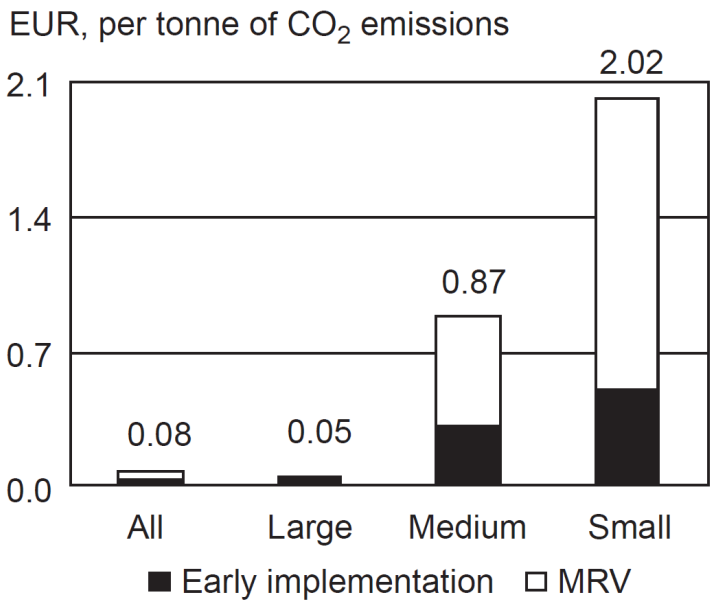
TRANSACTION COSTS IN THE EU ETS





Source: Jaraite, Convery and Di Maria (2010)

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EFFECTS OF THE EU ETS ON GERMAN FIRMS' PROFITS (2005-2014)

Table 3: The effect of the EU ETS on Profits

	Two-digit Industry					
	All	10	17	20	23	24
ETS	0.054	0.246	0.022	0.057	-0.019	0.187***
	(0.037)	(0.162)	(0.074)	(0.117)	(0.078)	(0.060)
Matching	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓	✓
N	6874	504	980	1380	1238	1114

Note: This table displays the results of the fixed-effect difference-in-difference analysis regressions of the EU ETS' impact on profits. Standard errors (in parentheses) are clustered on the matched pair. Industry codes: 10 – Food products, 17 – Paper and paper products, 20 – Chemicals and chemical products, 23 – Other nonmetallic mineral products, 24 – Basic metals. Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder (survey years 2001-2014). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Hintermann, Zarkovic, Di Maria, Wagner (2020)

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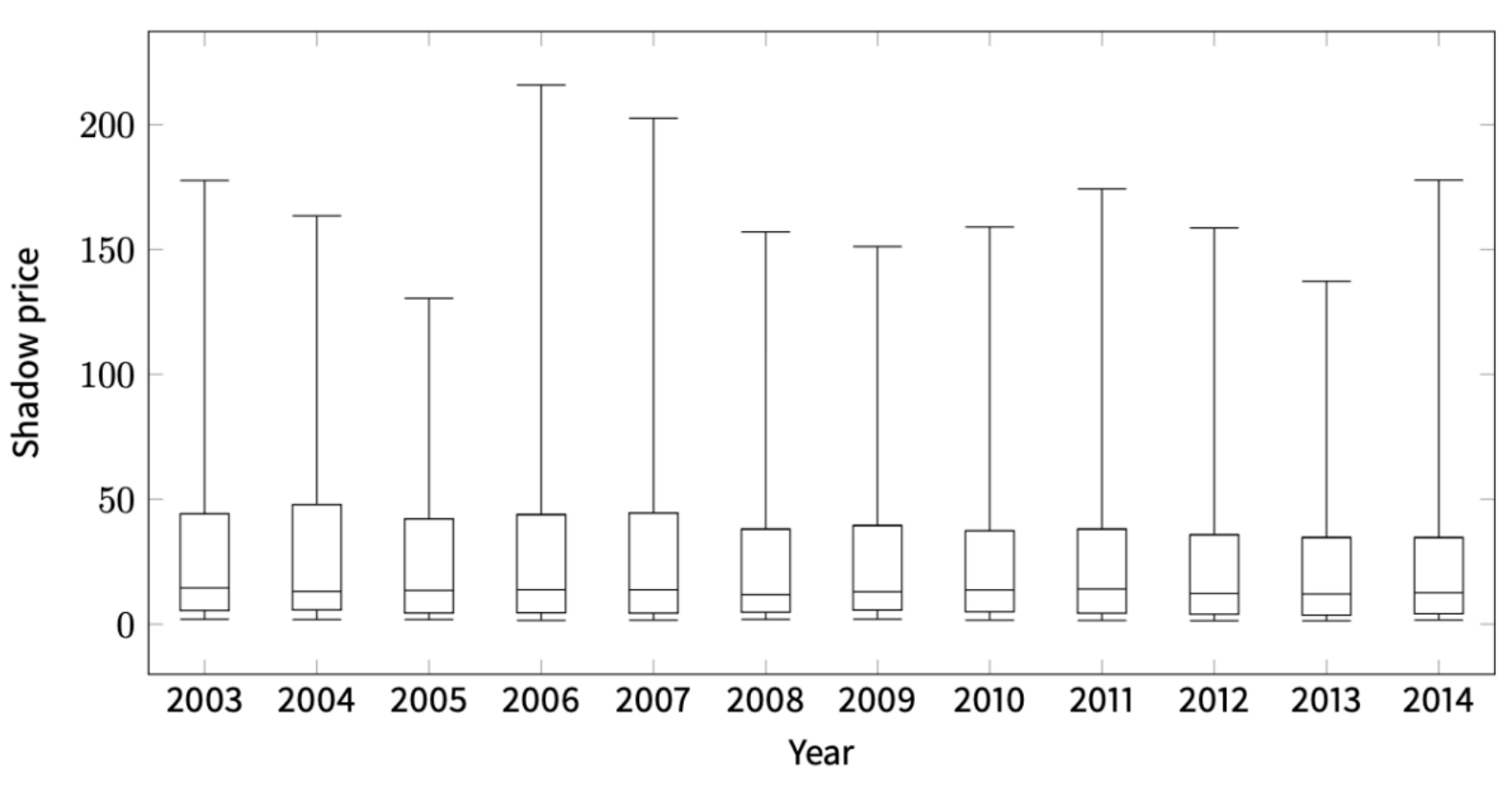
CARBON ABATEMENT COSTS IN GERMAN MANUFACTURING (2005-2014)



Source: Di Maria, Zarkovic and Hintermann (2020)

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EFFECTS OF THE EU ETS ON GERMAN FIRMS' TFP (2005-2014)

Table 4: The effect of the EU ETS on TFP

	Two-digit Industry					
	All	10	17	20	23	24
ETS	-0.087	-0.138	-0.137	-0.037	-0.230	0.266**
	(0.0966)	(0.419)	(0.124)	(0.101)	(0.356)	(0.107)
Year FE	✓	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓	✓
N	466,073	97,480	13,885	73,049	19,660	23,208

Note: This table displays the results of the fixed-effect difference-in-difference analysis regressions of the EU ETS' impact on TFP for the full sample. Standard errors in parentheses. Industry codes: 10 – Food products, 17 – Paper and paper products, 20 – Chemicals and chemical products, 23 – Other nonmetallic mineral products, 24 – Basic metals. Source: RDC of the Federal Statistical Office and Statistical Offices of the Länder (survey years 2001-2014). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Hintermann, Zarkovic, Di Maria, Wagner (2020)

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COST PASS-THROUGH AMONG GERMAN FIRMS' (2005-2014)

	(1)	(2)	(3)	(4)	(5)	(6)
λfjt	0.450***	0.338***	0.422***	0.332***	0.533***	0.400***
	(0.048)	(0.071)	(0.043)	(0.070)	(0.037)	(0.057)
$\lambda fjt \times ETS_{ft}$			-0.005	0.000		
			(0.003)	(0.002)		
$\lambda fjt \times EXP_{ft}$					0.003	0.003
					(0.001)	(0.001)
N	400,835	278,857	400,835	278,857	342,953	227,453

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Instruments are energy prices by themselves (odd columns) or multiplied by shares (even columns). Standard errors (in parentheses) are clustered on the firm level.

Source: Hintermann, Zarkovic, Di Maria, Wagner (2020)

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EFFICIENCY IN POWER GENERATION

Dep. variable: environmental efficiency (inverse)	I	II	III
CO_2 price	−0.039***[a]	−0.025***	−0.034***
Allocation to verification ratio	0.003**	0.003***	0.002**
Coal price (log difference)*Solid fuel share	–	0.185***	−0.215***
Coal price (log difference)*Oil fuel share	–	0.255***	−0.229***
Coal price (log difference)*Gas fuel share	–	0.196***	−0.301***
Crude oil price (log difference)*Oil fuel share	–	0.288***	0.160***
Crude oil price (log difference)*Solid fuel share	–	0.202***	0.107***
Crude oil price (log difference)*Gas fuel share	–	0.217***	0.128***
Natural gas price (log difference)*Gas fuel share	–	0.066**	0.016
Natural gas price (log difference)*Solid fuel share	–	0.071**	0.027
Natural gas price (log difference)*Oil fuel share	–	0.074*	0.023
Coal price (log difference)	−0.396**	−19.000***	23.953***
Crude oil price (log difference)	0.578**	−20.790***	−10.285***
Natural gas price (log difference)	0.737***	−6.231**	−1.327
Specialisation	−0.023**	−0.015**	−0.020**
CHP dummy	−0.868***	−0.789***	−0.669***
Solid fuel share	−0.015	−0.097***	−0.027
Oil fuel share	−0.011	−0.086***	−0.018
Gas fuel share	−0.087***	−0.179***	−0.102***
Industrial production index (log difference)	3.912***	4.166***	3.868***
Industrial production	–	–	–
FDI inflow share	−0.027***	−0.018**	−0.022**
Export-TPES ratio	−0.044***	−0.026***	−0.042***
Constant	0.179***	7.902***	2.322***
No. of obs.[b]	160	160	160
R-squared[c]	0.730	0.717	0.750

Source: Jaraite and Di Maria (2012)

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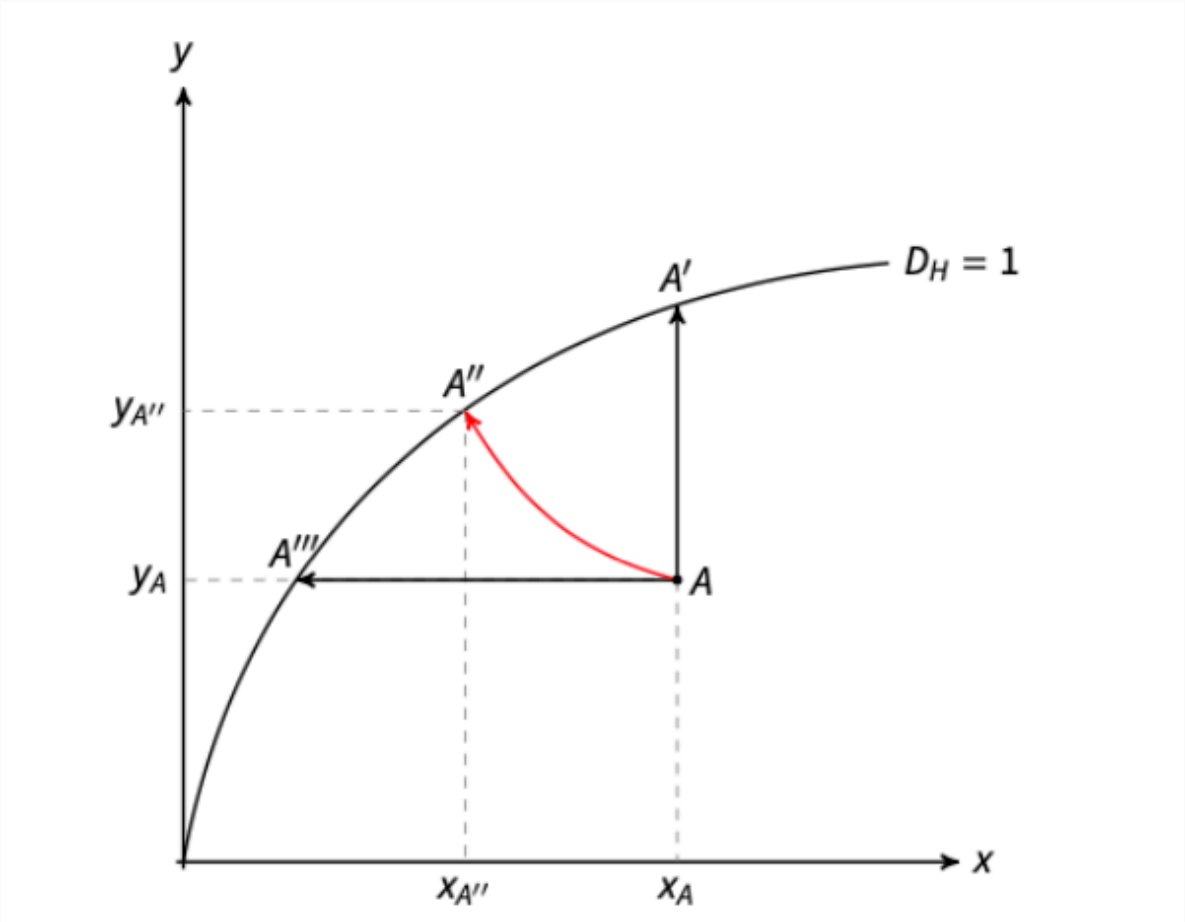
ENHANCED HYPERBOLIC DISTANCE FUNCTION



Source: Di Maria, Zarkovic and Hintermann (2021)

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EFFECTS OF THE EU ETS ON GERMAN FIRMS' EFFICIENCY (2005-2014)

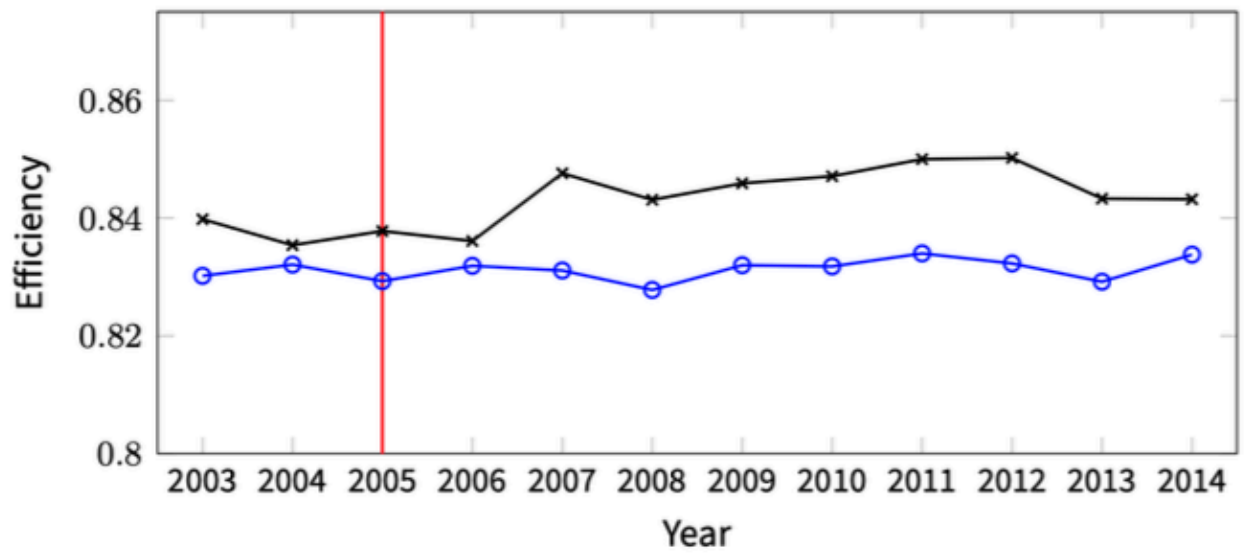

Figure 5: Mean environmental efficiency among ETS (x) and non-ETS firms (o) over time (Non-metallic minerals, 2003–2014)

Source: Di Maria, Zarkovic and Hintermann (2021)

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