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Marginal abatement costs for fulfilling the NDC pledges – A meta-analysis

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Background

- Significant question for bottom-up international climate agreements like Paris agreement: abatement costs of different countries
- These are generated e.g. by CGE models but model outcomes differ significantly - What is driving this?
- Meta-regression analysis (MRA)
  - Combines results of independent studies; more insightful and has greater explanatory power than individual results
  - Dependent variable -> summary statistic drawn from each study,
  - Independent variables -> method characteristics, design & data used in studies
  - E.g., Repetto & Austin (1997), Fischer & Morgenstern (2006), Kuik et al. (2009)
  - Studies often rely on limited and only partly comparable data from divers studies

Our approach

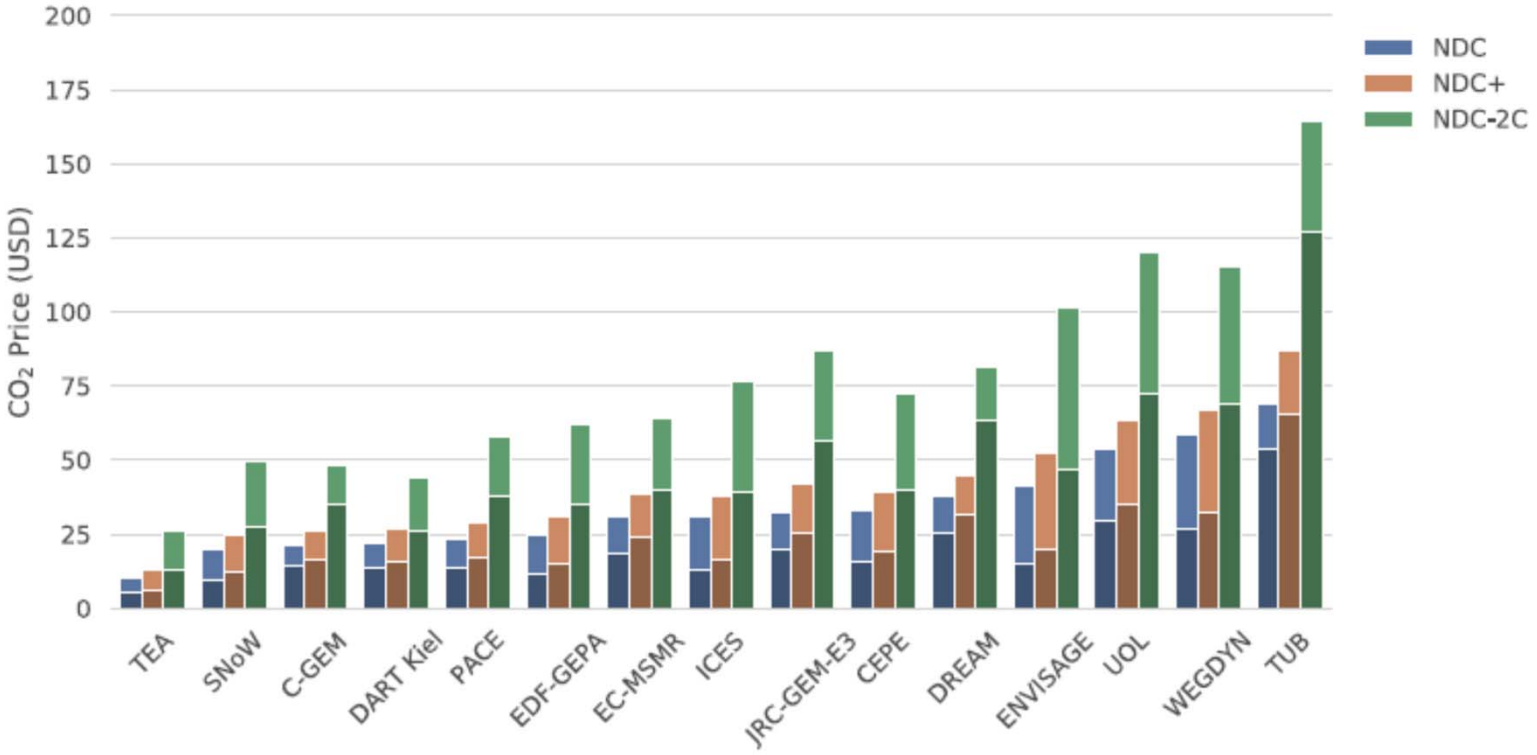
- Use data from the EMF36 cross-model comparison study jointly organized by Kiel Institute for World Economy and University of Oldenburg
- 15 global CGE models (6 static, 9 recursive dynamic) all based on GTAP9
- All teams model a common set of scenarios
- Results highlight areas of robust agreement and disagreement: Böhringer, Chr., S. Peterson, T. Rutherford., J. Schneider & M. Winkler (2021). Climate Policies after Paris: Pledge, Trade and Recycle. Insights from the 36th Energy Modeling Forum Study (EMF36). Energy Economics 104. https://doi.org/10.1016/j.eneco.2021.105471
- But difficult to separate the key factors that lead to the range of results across models
- We use data from EMF36 to undertake additional meta-regression-analysis that strengthens findings on impacts of scenarios and adds impacts of model choices

Database

15 models	x	2 baselines	x	3 climate targets	x	6 policy scenarios
CEPE CGEM DART DREAM EC-MSMR EDF-GEPA ENVISAGE ICES(CMCC) JRC SNOW_GL TEA TUB UOL WEGDYN ZEW		IEO WEO		NDC NDC+ NDC-2degree		No climate policy REF ASIA EURCHN PARTIAL GLOBAL

Horizon: 2030

Global av. CO_2-prices across scenarios & models; lighter bars = unilateral CO_2-pricing, darker bars = global ETS



Description of variables

- Dependent variable: **CO_2 price in 2030, OLS regression**

Structural independent Variables	
EU	Log of total number of regions replaced by differentiated EU 1 if yes, 0 if no
Unemp	1 if unemployment is characteriszed, 0 otherwise (now skipped)
Dyn	1 if model is dynamic, 0 otherwise
Backstop	1 if model has backstop technology, 0 otherwise (replaces endotech)
Elediff	1 if ele sector is differentiated, 0 otherwise
Armel	1 if model strictly uses GTAP Armington elasticities, 0 otherwise; now: < = > GTAP armel
kle	Elasticity (KL) E ><= 0.5

Independent Variables: Policy	
climatarg	Categorial variable for emission reduction targets; =0 if NDC, =1 if NDC+ = 2 if NDC-2C
coop	Categorial variable for cooperation within countries and sectors; =0 if ref, =1 f asia, =2 if eurchn, =3 if partial, = 4 if global

Results : Global

Model specification

eu	-9.59
	(7.25)
elediff	**17.88*** **
	(5.33)
dyn	-0.61
	(7.12)
Armel_low	-4.87
	(6.92)
Armel_high	**-22.28** **
	(8.56)
Kle_low	11.45
	(7.89)
Kle_high	13.39
	(10.03)
backstop	**-31.20*** **
	(7.77)

Policy specification

Climtarg_NDC+	6.07***
	(0.59)
Climtarg_2C	54.35***
	(8.41)
reg_ASIA	-1.79***
	(0.43)
reg_EURCHN	-3.29**
	(1.45)
reg_Partial	-6.99**
	(2.70)
reg_global	-22.13***
	(2.57)
Constant	28.92**
	(10.08)
R-squared	0.67

Results: Regional

	AFR	CHN	EUR	IND	JPN	MEA	OAM	RUS	USA
elediff	19.37***	1.27	71.22***	2.99	6.39	14.12***	18.91***	3.46	18.60***
	(5.19)	(3.55)	(15.14)	(2.72)	(4.56)	(4.67)	(5.57)	(3.65)	(5.71)
Armel_high	-27.33**	-3.41	-53.72**	-5.95*	-25.59***	-20.80**	-23.16***	-15.03***	-31.55**
	(9.94)	(4.42)	(22.95)	(3.10)	(5.14)	(8.04)	(5.34)	(4.64)	(11.98)
Kle_low	9.44	4.28	17.87	5.65*	6.35	8.76	14.78**	5.01	10.90
	(7.85)	(4.04)	(22.74)	(2.89)	(6.52)	(6.85)	(5.20)	(4.27)	(9.57)
Kle_high	17.91	-3.80	65.25**	0.33	2.66	3.63	13.77	-3.96	6.95
	(10.94)	(5.25)	(26.25)	(3.94)	(9.68)	(8.34)	(9.37)	(6.39)	(11.97)
backstop	-20.33	-14.19***	-101.85***	-15.65***	-47.34***	-13.53	-32.93***	-17.09**	-31.39***
	(12.18)	(4.75)	(21.88)	(3.56)	(8.39)	(9.77)	(6.83)	(6.94)	(10.02)
reg_EURCHN	-1.10***	4.00***	-57.97***	-0.15	-1.07**	-3.18**	-1.18***	-1.56***	-0.17
	(1.33)	(1.15)	(12.98)	(1.29)	(3.33)	(1.66)	(1.50)	(1.46)	(3.36)
reg_global	-3.14	18.23***	-146.08***	17.62***	-26.54***	-9.86***	-16.46***	12.63***	-29.66***
	(3.63)	(2.32)	(17.62)	(2.29)	(4.92)	(2.56)	(2.92)	(2.36)	(3.35)

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Takeaways

- Meta-regression
  - directly addresses the robustness of results
  - gives insights into the role of structural assumptions of a model (not standard within a sensitivity analysis)
- Cost estimates are sensitive to policy variables AND model characteristics
- Global abatement costs are (statistically) significantly
  - Higher -> *regions, elediff, dynamic, armel_high*
  - Lower -> coefficients for *backstop*
- Largely, the direction of effect of structural variables holds at the regional level
- Policy variables show same strength as in direct model excercises

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