Climate-Change Pledges, Actions and Outcomes

Tiloka de Silva[1] Silvana Tenreyro[2]

[1]University of Moratuwa [2]London School of Economics and Bank of England

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The views expressed here are those of the authors, and not necessarily those of the Bank of England or MPC

Motivation

- Emissions are one of the biggest threats to lives and livelihoods
- Three international treaties signed in response to climate change problem:
  - Kyoto Protocol (adopted in 1997, in force from 2005-2012)
  - Copenhagen Accord (2009-2020)
  - Paris Agreement (2016-2030)
- Pledges differ in coverage, timelines, targets, compliance and measures adopted to implement them

The questions

1. What were the targets set in each agreement and did countries achieve them?
2. What was the impact of signing international agreements on countries' emissions?
3. Did it help to have quantifiable targets?
4. Which individual policies were most effective?
5. How did various measures impact GDP growth or inflation?

The Plan

- Review trends in total and per capita emissions by region and country
- Show results from three sets of exercises:
  1. Compute comparable targets across signatories and contrast with actual reductions
  2. Study the impact on emissions from
     - signing climate-change agreements
     - stating quantifiable targets
     - implementing mitigating laws, policies and specific measures, inc. carbon taxes & ETS
  3. Study the impact on GDP growth and inflation

Main Findings

- There is huge heterogeneity in targets and compliance
- Signing and having quantifiable targets set in Kyoto or Copenhagen led to material reductions in emissions
- Effects from the Paris Agreement are not yet visible
- Reductions in emissions increase with the number of climate laws or policies
  - Carbon taxes and ETS lead to material reductions in emissions
  - Other climate laws or policies have no material effects on emissions
- Climate agreements and actions had no significant impact on GDP growth or inflation.
- Much more ambitious targets would be needed to offset effects on emissions stemming from GDP and population growth

Data

Panel dataset of 190 countries from 1971-2018

- GHG and fossil CO2 emissions data: CAIT (2017) and EDGAR (2019)
- Information on climate-change pledges and targets: compiled from various sources including official documentation of UNFCCC, CAIT (2017), Fenhann (2019), etc.
- Climate-related laws and policies: Climate Change Laws of the World Database (2020) and World Bank's Carbon Pricing Dashboard (2020)
- Background data: World Development Indicators Database (2020)

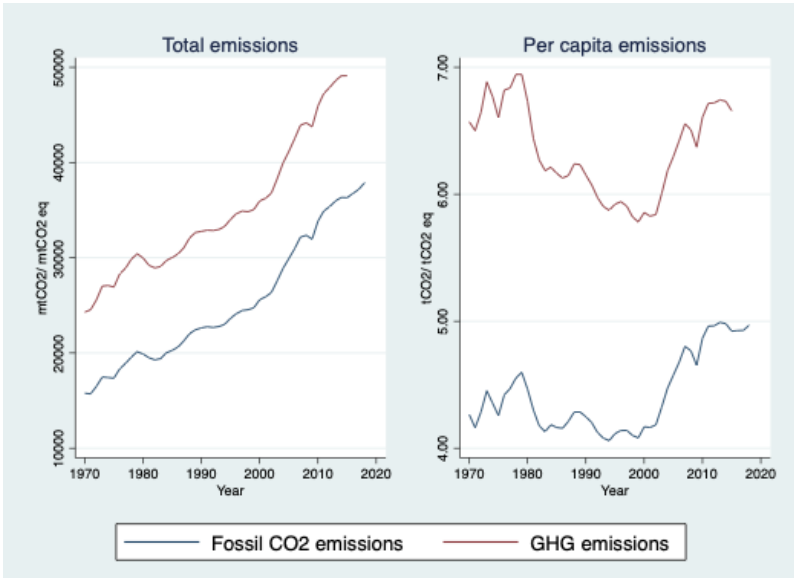
Computing targets

- Pledges varied in terms of baseline year, targeted sector, and unit of measurement
- Comparable targets constructed as targeted reduction in GHG emissions from starting year of the pledge
- Some pledges were easy to quantify with available data, others not so much

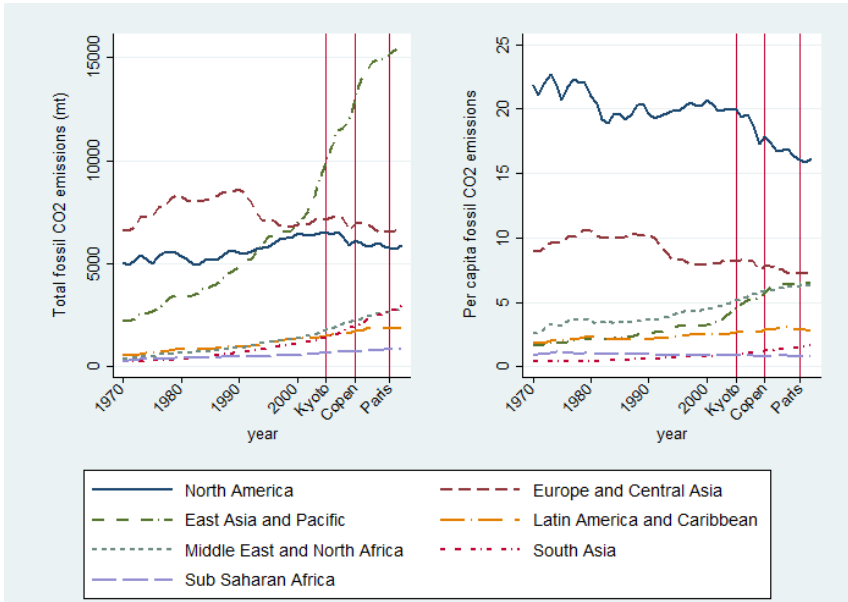
Ease of computing	Country	Pledge for 2030	Data needed
Easy	Canada	30% reduction below 2005 levels	GHG emissions in 2005 and starting year
Moderate	Algeria	7% reduction below BAU levels	Projected BAU emissions in 2030 and actual emissions in starting year
Moderate	Individual EU countries (e.g. France)	37% reduction below 1990 (blanket EU pledge is 40% reduction)	Member state emission reductions and emissions in 1990 and start year
Moderate	China	60-65% of CO2 emissions per unit of GDP below 2005 level	Projected GDP for 2030, and GDP and emissions in starting year
Difficult	Trinidad and Tobago	30% reduction in public transportation below BAU	Projected BAU emissions in transport sector in 2030 and actual emissions in transport sector in start year

Trends in emissions

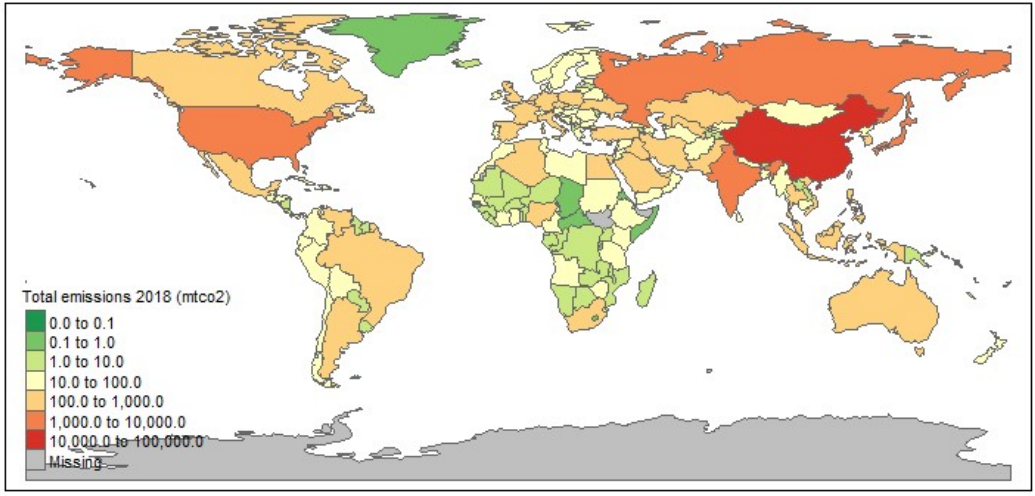
Global emissions



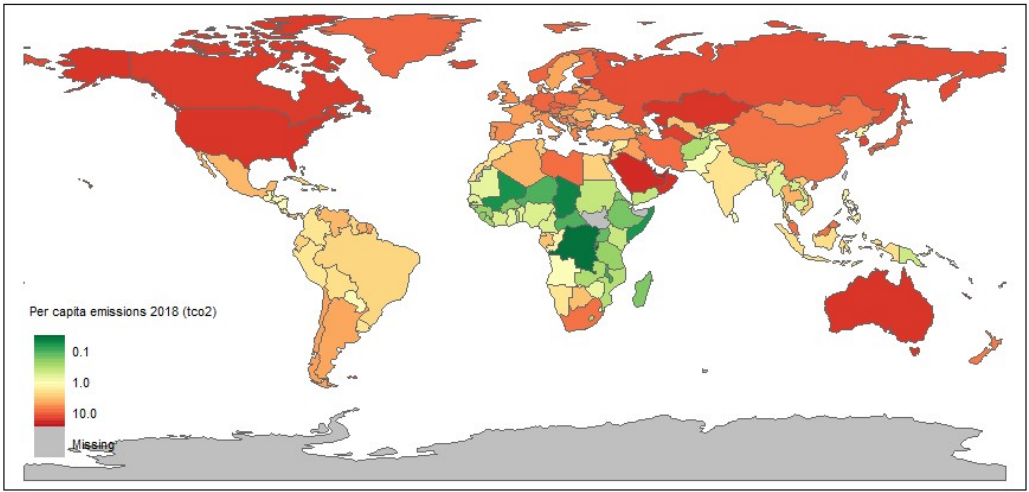
Trends in emissions by region



Total emissions by country in 2018



Per capita emissions by country in 2018



Covariates of emissions

	Total Fossil CO2 emissions (in logs)			
	(1)	(2)	(3)	(4)
GDP per capita (in logs)	0.843***	0.707***	0.848***	0.696***
	[0.010]	[0.061]	[0.010]	[0.060]
Population (in logs)	1.106***	1.250***	1.109***	1.219***
	[0.006]	[0.176]	[0.006]	[0.158]
Urban population (% of total)	0.011***	0.008*	0.009***	0.008*
	[0.001]	[0.004]	[0.001]	[0.005]
Oil rents (% of GDP)			0.020***	0.002
			[0.001]	[0.004]
Country and Year FE	No	Yes	No	Yes
N	7991	7991	7189	7189
R-sq	0.903	0.884	0.907	0.885

Notes: Robust standard errors in brackets. * p<0.1, ** p<0.05, *** p<0.01.

Agreements and targets

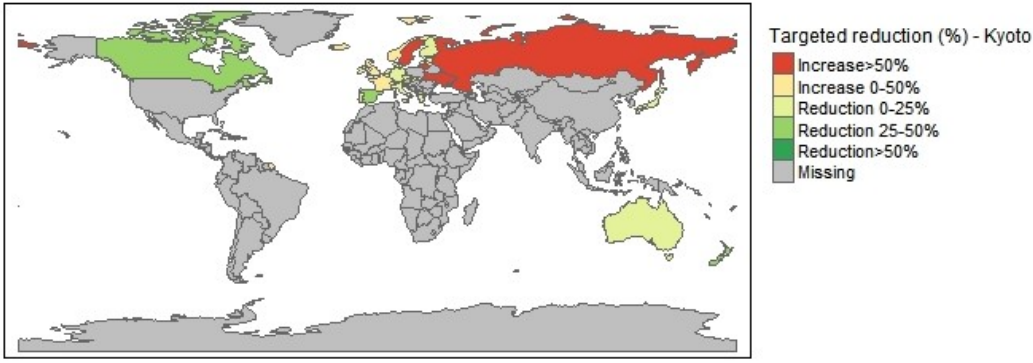
Climate agreements and targeted emission reductions

	Kyoto	Kyoto (without Russia)	Copenhagen	Paris
No. of signatories proposing targets or NAMAs (excluding EU28 in total)	37	36	100	188
Start year considered	2005	2005	2010	2014[a]
Countries with quantified emission reduction targets	37	36	59	149
Countries with quantifiable objectives	30	29	54	117
Contribution to world GHG emissions by signatories with quantifiable objectives in starting year[a] (%)	22.95	17.73	75.48	83.39
Contribution to world GHG emissions by all signatories	24.44	19.22	81.93	98.85
Targeted reduction from starting year (unconditional)[b]	-679.83	400.4885	1427.219	2839.568
Targeted % reduction from starting year (unconditional)	-7.2	5.49	4.27	7.19

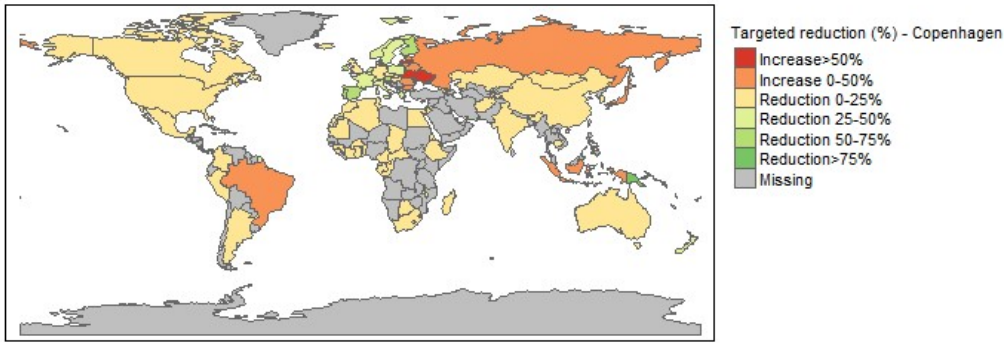
Notes:[a] Start years considered for each pledge: Kyoto: 2005, Copenhagen: 2010, Paris: 2014

Targets

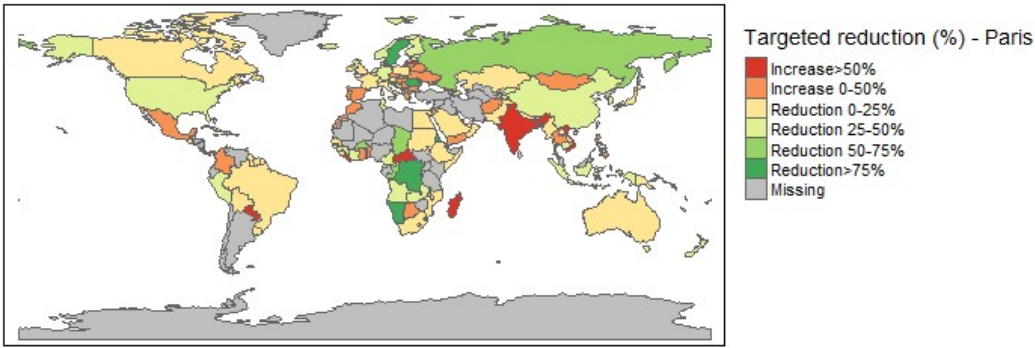
Targets under Kyoto Protocol



Targets under Copenhagen Accord

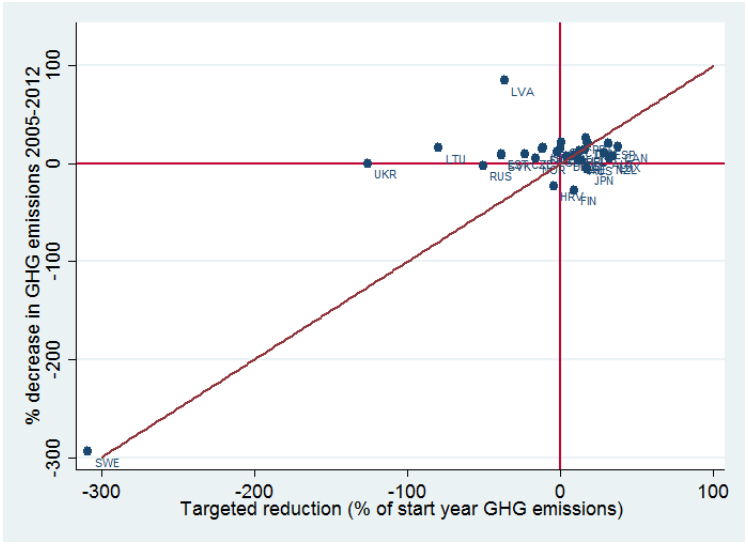


Targets under Paris Agreement

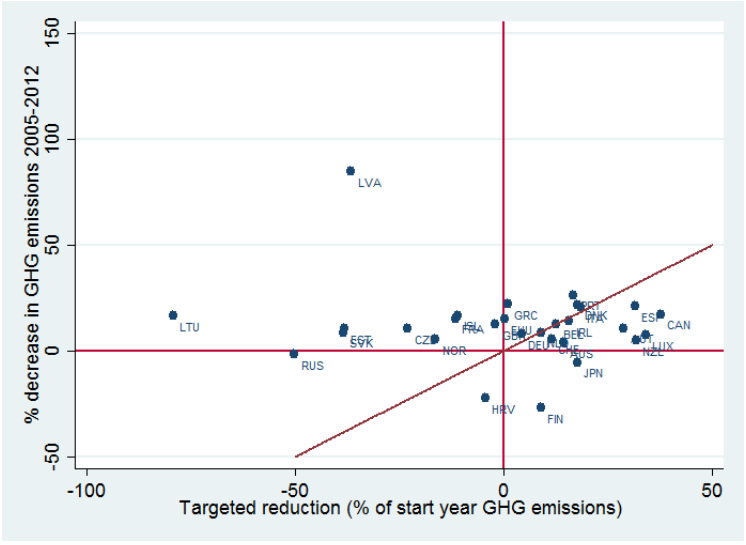


Targets and actual reductions

Achievement of targets under Kyoto Protocol



Achievement of targets under Kyoto Protocol - excluding Sweden and Ukraine



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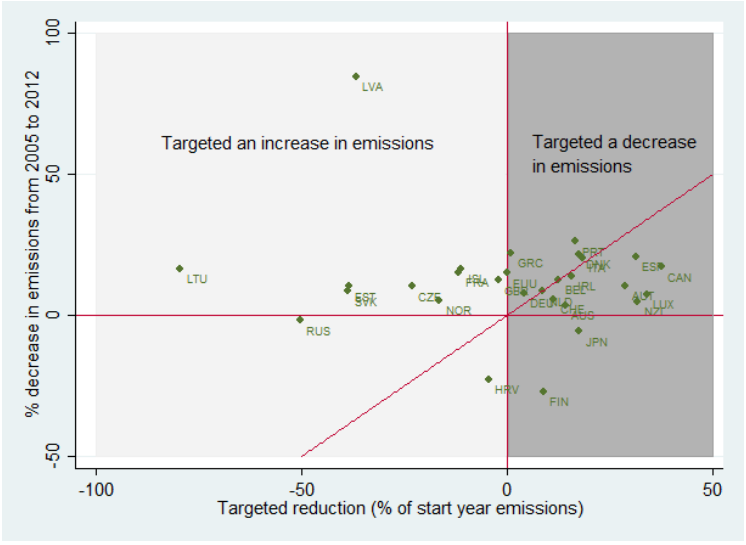

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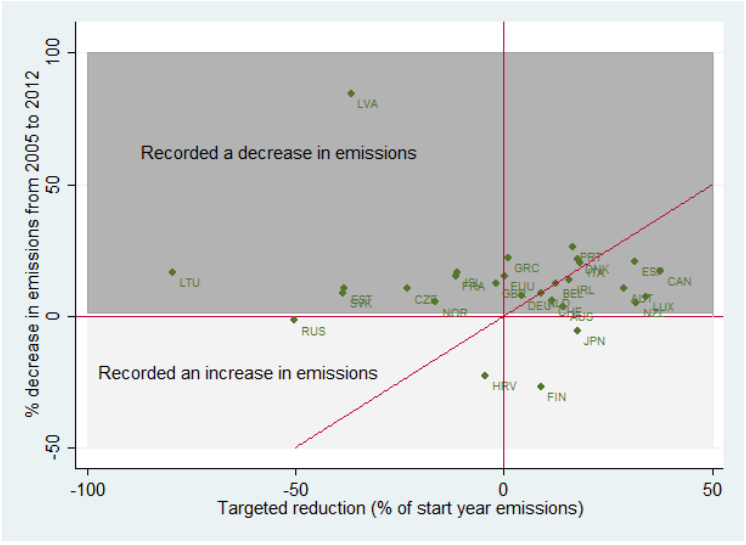

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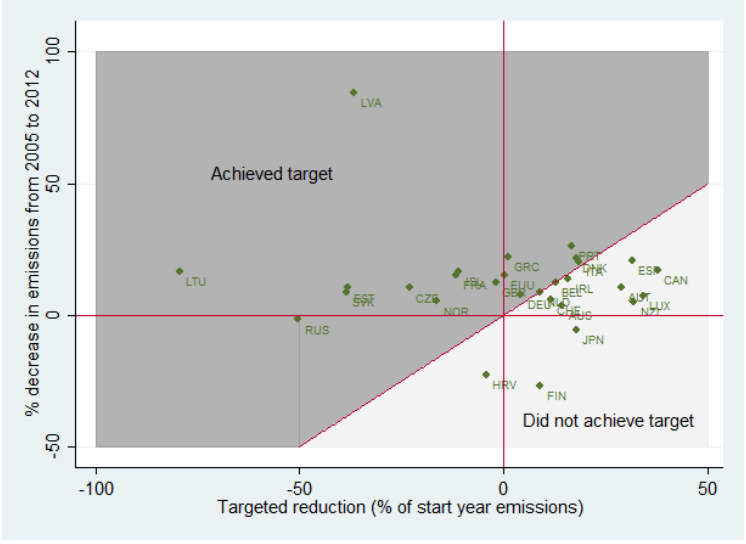

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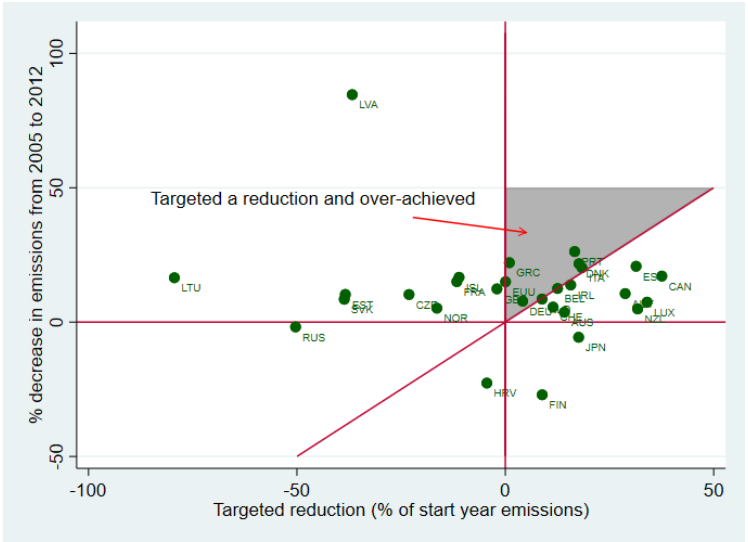
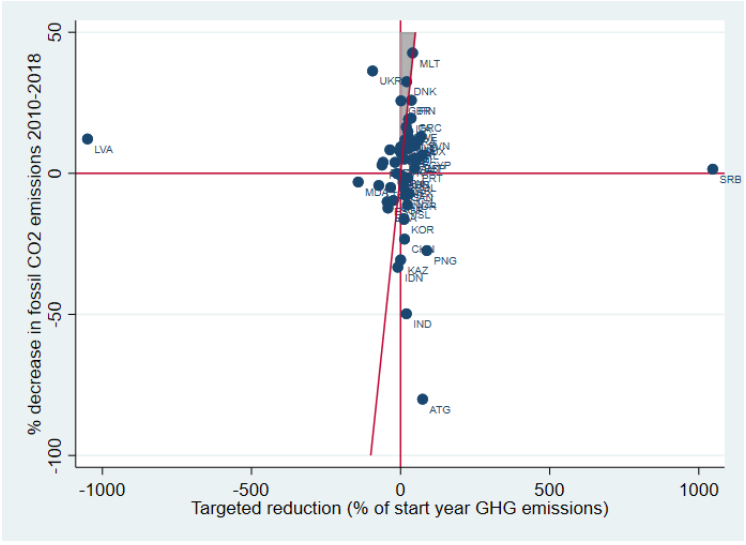
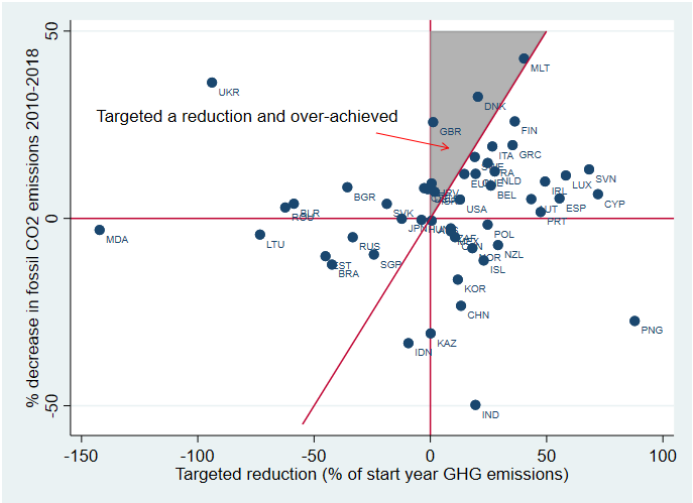


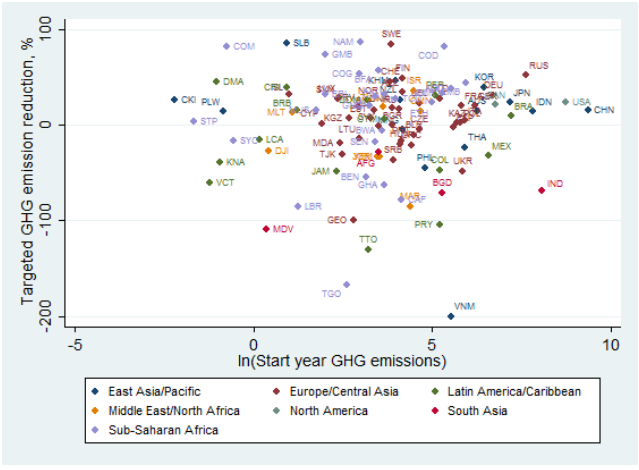
Progress made under Copenhagen Accord (unconditional targets)



Progress made under Copenhagen Accord (unconditional targets) - exc. Latvia, Serbia, Antigua & Barbuda



Target reductions (unconditional targets) under Paris Agreement



Note: The graph excludes outliers: Kiribati, Latvia and Madagascar

Impact of climate agreements and actions

Covariates of emissions

	Total Fossil CO2 emissions (in logs)			
	(1)	(2)	(3)	(4)
GDP per capita (in logs)	0.843***	0.707***	0.848***	0.696***
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Oil rents (% of GDP)			0.020***	0.002
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Country and Year FE	No	Yes	No	Yes
N	7991	7991	7189	7189
R-sq	0.903	0.884	0.907	0.885

Notes: Robust standard errors in brackets. * p<0.1, ** p<0.05, *** p<0.01

Impact of climate agreements and actions

- Introduce indicator for when/whether a country signed an agreement (or implemented policy)
- To address endogeneity, we use inverse probability weighting (IPW) estimation
  - First stage: estimate probability of signing each pledge as a function of economic variables and past emissions
  - Second stage: use inverse of estimated probabilities to weight subsequent regressions
  - Distribution of propensity scores for treated and untreated group show large overlap, but some observations have very high/low weights, hence use truncated weights
- To explore dynamic effects and two-way feedback, we use Jorda's (2005) local projection methods with IPW (as in Jorda and Taylor [2016])

Agreements and emissions

	Total Fossil CO2 emissions (in logs)			
	(1)	(2)	(3)	(4)
Signed Kyoto	-0.438***	-0.423***	-0.349***	-0.344***
	[0.023]	[0.023]	[0.029]	[0.029]
Signed Copenhagen	-0.166***	-0.156***	-0.137***	-0.129***
	[0.025]	[0.028]	[0.026]	[0.028]
Signed Paris	0.049	0.078	0.111	0.13
	[0.291]	[0.120]	[0.291]	[0.120]
Have quantified objectives			-0.118***	-0.103***
			[0.027]	[0.027]
Using IPW	No	Yes	No	Yes
N	7870	7870	7870	7870

Notes: Indicators for signing and having quantified targets are added with a one-year lag.
All regressions include country and year FE and full set of controls.
Robust standard errors in brackets. * p<0.1, ** p<0.05, *** p<0.01

Climate laws and policies

	Number of laws passed	Number of policies passed	Countries with at least one law	Countries with at least one policy
Pre 1970	8	1	6	1
1970-79	6	0	10	1
1980-89	17	2	18	3
1990-99	78	31	62	23
2000-09	272	276	119	135
2010-19	394	724	156	176
Total to date	**775**	**1034**	**156**	**176**

Notes: Computed using data from the Climate Laws of the World Database.

Impact of Climate-change actions on emissions

	ln(Total fossil CO2 emissions)			
	(1)	(2)	(3)	(4)
Number of climate related laws	-0.036***	-0.036***		
	[0.003]	[0.003]		
Number of climate related policies	-0.001	0.000		
	[0.003]	[0.004]		
Have national level carbon tax	-0.215***	-0.208***	-0.222***	-0.211***
	[0.021]	[0.022]	[0.022]	[0.022]
Have national level ETS	-0.325***	-0.309***	-0.342***	-0.332***
	[0.020]	[0.020]	[0.021]	[0.021]
Number of policies by sector				
Adaptation			0.016***	0.018***
			[0.006]	[0.006]
Demand management			-0.020***	-0.019***
			[0.005]	[0.005]
Supply management			-0.026***	-0.026***
			[0.004]	[0.005]
Transport			-0.012*	-0.003
			[0.007]	[0.007]
LULUCF			0.014**	0.006
			[0.006]	[0.007]
R&D			-0.008	-0.011*
			[0.005]	[0.006]
Using IPW	No	Yes	No	Yes
N	7870	7870	7870	7870

Notes: LULUCF - Land Use, Land Use Change and Forestry. Law and policy variables are added with a one-year lag.
All regressions include country and year FE and full set of controls. Robust standard errors in brackets. * $p<0.1$, ** $p<0.05$, *** $p<0.01$

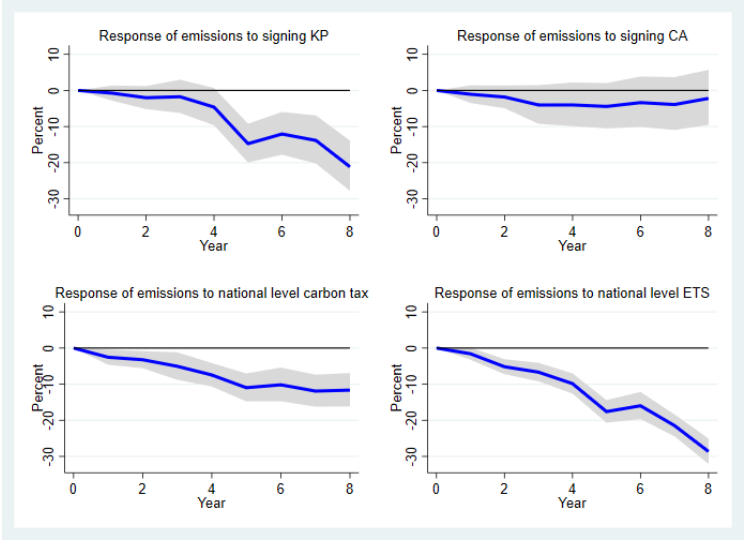
Dynamic effects on emissions

- Problem of potential feedback from emissions levels to climate-change actions
- We estimate the dynamic effect of climate-change actions on emissions using the Jorda (2005) local projection method with IPW
- We estimate

$$ln(emissions_{i,t+h}) = \gamma(L)ln(emissions_{i,t-1}) + \rho(L)X_{i,t-1} + \theta\tau_{i,t} + \delta(L)\tau_{i,t-1} + \alpha_i + W_t + \epsilon_{i,t}, \qquad h = 0, 1, ..., 7$$

  $X_{i,t-1}$: set of controls; τ: policy variable; α_i and W_t: country and time FE.
- Identifying assumption: once historical emissions and current and past factors are controlled for, we are left with the exogenous component of climate actions
- Estimated separately for each value of h and each climate change action using action-specific inverse probability weights

Local projection results - emissions



Impact on other economic variables

Dynamic effects on other economic variables

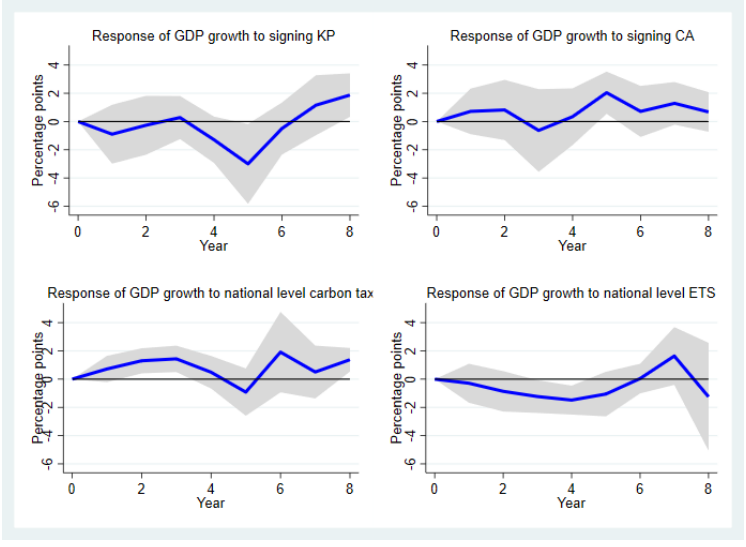
- Extend IPW linear projections framework to GDP growth and inflation
  - Use differenced specification of all controls
  - Add region-specific trends (to allow differential effects of crises)
  - Exclude top 6% of the inflation distribution from sample (maximum inflation: 30%)
- Estimate

$$\Delta Y_{i,t+h} = \gamma_{11}(L)\Delta Y_{i,t-1} + \gamma_{21}(L)\Delta P_{i,t-1} + \rho_1(L)\Delta X_{i,t-1} + \theta_{h1}\tau_{i,t} + \delta_1(L)\tau_{i,t-1} + \alpha_i + \rho_g + W_t + \rho_g * W_t + \epsilon_{i,t}, \qquad h = 0, 1, 2, ..., 7$$

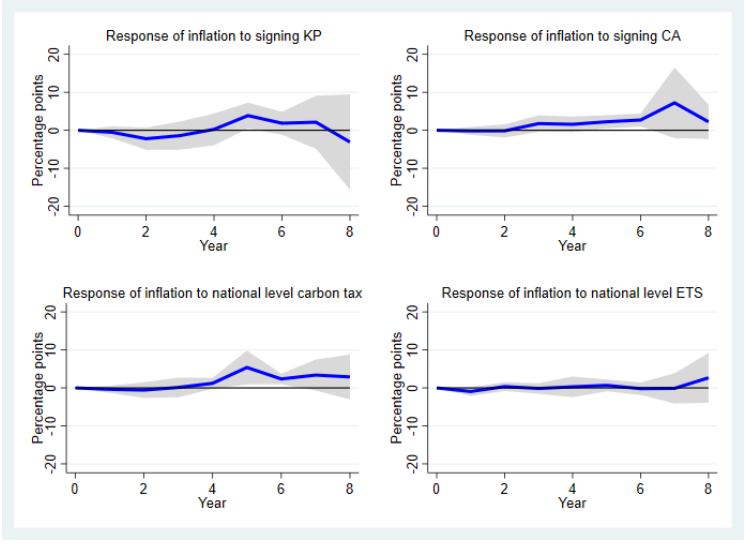
$$\Delta P_{i,t+h} = \gamma_{12}(L)\Delta Y_{i,t-1} + \gamma_{22}(L)\Delta P_{i,t-1} + \rho_2(L)\Delta X_{i,t-1} + \theta_{h2}\tau_{i,t} + \delta_2(L)\tau_{i,t-1} + \alpha_i + \rho_g + W_t + \rho_g * W_t + \epsilon_{i,t}, \qquad h = 0, 1, 2, ..., 7$$

where ΔY is GDP growth, ΔP is inflation, ΔX includes controls, τ is the policy variable, and α_i, ρ_g and W_t are country, region and time fixed effects.

Local projection results - GDP growth



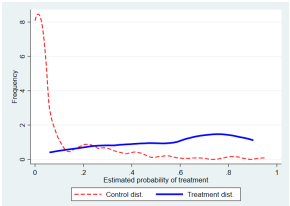
Local projection results - inflation



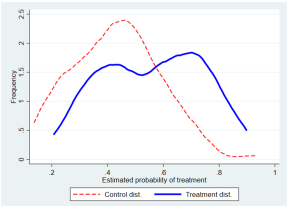
Summary

- Huge heterogeneity in targets and compliance
- Signing KP and CA led to significant emission reductions. PA not yet visible
- Having quantifiable targets helped
- Reductions in emissions increase with the number of climate laws or policies
- Carbon taxes and ETS associated with material reductions in emissions
  - Other climate laws or policies do not appear to have a significant impact
- No significant impact on GDP growth or inflation
- Much more ambitious targets would be needed to offset effects on emissions stemming from GDP and population growth

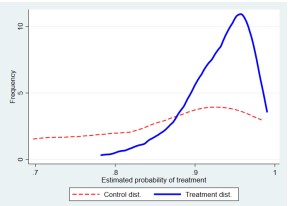
Overlap check



Copenhagen Accord



Kyoto Protocol



Paris Agreement

Note: The figure plots the smooth kernel density estimates of the distribution of the propensity scores for signing for treatment and control countries. Back