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Reduction in greenhouse gas emissions from national climate legislation

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Supplementary information

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The supplementary information contains an overview and summary statistics of all variables used in the analysis. It also describes the results of robustness checks, which were carried out to ascertain the strength of our econometric results. We split the sample, introduce different specifications of the dependent variable and experiment with different ways to measure legislative activity. The sensitivity checks confirm that our main results are robust, but they add additional insights on the relative performance of industrialised and emerging countries.

Variables Description and Summary Statistics

Information on the datasets that were used and how to access them is contained in the Online Methods. To complement this information, Table S1 contains summary descriptions of all variables.

Table S1 - Variables Description and Summary Statistics

VARIABLES	Description	Mean	Standard Deviation	Minimum	Maximum
GHG emissions	Other GHG emissions (mtCO2) per 2011 PPP \$1 GDP in year t in country i	0.347	0.653	0.00670	12.00
CO2 emissions	CO2 emissions (mtCO2) per 2011 PPP \$1 GDP in year t in country i	0.262	0.181	0.0332	1.803
Laws	Number of climate change laws passed in year t in country i	0.575	1.031	0	12
Mitigation Laws	Number of mitigation climate change laws passed in year t in country i	0.539	0.985	0	12
Legislative Acts	Number of legislative climate change laws passed in year t in country i	0.293	0.716	0	12
Stock of Laws	Number of climate change laws passed in country i until year t	4.336	5.303	0	45
Stock of Mitigation Laws	Number of climate change mitigation laws passed in country i until year t	4.142	5.139	0	43
Rule of law	Index of rule of law	0.507	0.200	0.0965	0.920
GDP per-capita	GDP per capita, PPP (constant 2011 international \$)	16,937	18,076	545.7	102,635
GDP HP filter	GDP HP filter	-0.000264	0.0206	-0.181	0.188
Import share	Imports of goods and services (% of GDP)	45.69	24.46	8.397	210.4
Services share	Services, value added (% of GDP)	52.99	11.48	12.44	93.72
Temperature Variation	Difference between the yearly average temperature and the long-term (1980-2015) average temperature	0.306	0.453	-1.726	2.763
Federal System	1 if states/provinces have legislative powers	0.187	0.390	0	1

Notes. Summary statistics are restricted to the estimating sample of 133 countries over 18 years (1999-2016).

Industrialised countries vs the rest of the world

In a first round of sensitivity tests we split the sample into an industrialised country panel and a developing country panel. The former group comprises all countries that are members of the Organization for Economic Cooperation and Development (OECD) and the European Union (EU).

The hypothesis is that advanced countries, responding to their obligations under the UN Framework Convention on Climate Change (UNFCCC), have put in place more stringent legislation. We also note that interventions in developing countries are often in the form of policy documents, rather than acts of parliament, which have less legal force (see results in Table 2 of the main manuscript).

The results confirm that climate laws in industrialised countries have had a stronger impact on emissions, particularly in the short-term and with respect to non-CO2 gases. The long-term impact on CO2 is broadly the same (Table S2).

Table S2 –Industrialised countries vs rest of the world

VARIABLES	(1) EU/OECD Countries Other GHG	(2) CO2	(3) Non-EU/OECD Countries Other GHG	(4) CO2
(L1) Stock of Recent Mitigation Laws	-0.0042*** (0.0016)	-0.0046** (0.0019)	-0.0019 (0.0033)	0.0013 (0.0037)
(L1) Stock of Older Mitigation Laws	-0.0127*** (0.0012)	-0.0083*** (0.0012)	-0.0069*** (0.0024)	-0.0097*** (0.0032)
(L1) Rule of Law	-0.9832*** (0.1703)	-0.2051 (0.2685)	-0.2479* (0.1379)	-0.4998*** (0.1336)
(L1) HP Filter	0.5337** (0.2311)	-0.0110 (0.2305)	0.2054 (0.2789)	0.4448* (0.2542)
(L1) ln(GDP per-capita PPP)	2.8691*** (0.7800)	-0.2547 (1.0765)	-0.2482 (0.2873)	0.5396* (0.3108)
(L1) ln(GDP per-capita PPP) Square	-0.1755*** (0.0408)	-0.0065 (0.0578)	-0.0110 (0.0157)	-0.0535*** (0.0168)
(L1) Import share (% of GDP)	-0.0002 (0.0007)	-0.0013* (0.0007)	0.0002 (0.0005)	0.0034*** (0.0007)
(L1) Services share (% of GDP)	0.0041* (0.0024)	-0.0073** (0.0031)	0.0021* (0.0011)	-0.0015 (0.0012)
(L1) Temperature (Deviation)	0.0005 (0.0062)	-0.0101* (0.0060)	0.0042 (0.0102)	-0.0072 (0.0118)
Federal Systems	-0.0103 (0.0181)	0.0196 (0.0325)		
Constant	-13.0959*** (3.6938)	2.6982 (4.9767)	1.7172 (1.2791)	-2.1101 (1.4224)
Observations	738	738	1,656	1,656
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
R2 (within)	0.391	0.234	0.165	0.190

Notes: Robust standard errors are shown in parentheses. ***, ** and * represent statistical significance at 1, 5 and 10 percent levels, respectively. Dependent variables are defined as Ln(kg per-\$ other GHG Emissions) and Ln(kg per-\$ CO2 Emissions), respectively.

Further robustness checks

The remaining robustness checks concern changes to the definition or in measurement of some key variables (Table S3). The adjustments are made to the regressions for CO2 only.

The first definitional change concerns the dependent variable. Instead of using emissions intensity as the dependent variable, we regress emissions per capita against the effect of climate legislation. The results are similar for the variables of interest, confirming the robustness of our main results.

Table S3 – Further robustness checks

VARIABLES	(1) Per-capita CO2	(2) Excluding EU laws	(3) Clean Tech
(L1) Stock of Recent Mitigation Laws	-0.0070*** (0.002)	-0.0049* (0.0027)	-0.0057*** (0.002)
(L1) Stock of Older Mitigation Laws	-0.0182*** (0.0014)	-0.0161*** (0.0021)	-0.0138*** (0.0014)
(L1) Rule of Law	-0.5821*** (0.1155)	-0.6321*** (0.119)	-0.4050*** (0.1101)
(L1) HP Filter	-0.4924** (0.1998)	0.3459 (0.2161)	0.3862* (0.2002)
(L1) ln(GDP per-capita PPP)	2.3226*** (0.2529)	1.3908*** (0.2577)	0.409 (0.2635)
(L1) ln(GDP per-capita PPP) Square	-0.0941*** (0.0136)	-0.0954*** (0.0139)	-0.0471*** (0.0139)
(L1) Import share (% of GDP)	0.0022*** (0.0006)	0.0015** (0.0006)	0.0017*** (0.0006)
(L1) Services share (% of GDP)	-0.0037*** (0.0012)	-0.0034*** (0.0012)	-0.0030*** (0.0011)
(L1) Temperature (Deviation)	-0.0150** (0.0067)	-0.0148** (0.007)	-0.0047 (0.0062)
Federal Systems	-0.0289 (0.0404)	-0.0142 (0.0437)	0.0218 (0.0353)
(L1) Renewable energy % of total			-0.0112*** (0.001)
Constant	-5.1556*** (1.1875)	-5.6668*** (1.2054)	-0.5557 (1.2578)
Observations	2,394	2,394	2,394
Country FE	YES	YES	YES
Year FE	YES	YES	YES
R2 (within)	0.309	0.184	0.277

Notes: Robust standard errors are shown in parentheses. ***,** and * represent statistical significance at 1, 5 and 10 percent levels, respectively. Dependent variables are defined as Ln(kg per-\$ other GHG Emissions) and Ln(kg per-\$ CO2 Emissions), respectively.

The second definitional change concerns the way climate legislation in EU member states is counted. In the main results, climate laws passed at the EU level are added to the tally of EU member states at the time of their accession to the EU. The argument is that those laws are binding

on member states. However, as a robustness check we explore what would happen if no such adjustment was made. The results are robust to this change.

The third change introduces an additional control variable to measure clean technical progress. The rapid fall in the costs of renewable energy technologies like solar PV could be an important driver of energy-related CO₂ emissions. In the main regressions we rely on country and time fixed effects to capture these trends. The former controls for differences in countries' renewable energy potential (e.g. solar irradiance or wind speeds), while the latter picks up global changes in renewable energy costs.

As a robustness check we introduce an additional variable, the share of renewable energy in total energy generation, which serves as a proxy for technical progress. There are alternative proxies of technical progress, such as patent data, but they are not sufficiently granular to cover all 2,394 country-years. There is a possibility that this variable is endogenous (i.e., determined, among other factors, by the provisions in climate laws), but the variable is significant, and our main results remain intact.