The Global Cost of Internationally Uncoordinated Environmental Policies*

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January 16, 2021

Abstract

High-income and high-productivity countries have pushed their agenda towards environmental policies. The carbon-leakage hypothesis predicts that these policies will increase emissions in unregulated countries, which typically have low-income and low-productivity. We predict that the productivity differential causes a net positive increase of emissions on global scales. We construct a country-level panel, including emissions and regulations data. We show that, although regulations from high-income countries may decrease their emissions, they also increase the emissions of the average country, causing a net global increase. This result is a call for international coordination and cooperation in order to achieve a sustainable global economy.

Keywords: Climate Laws; Greenhouse Gas Emissions; SDGs; Climate Change

*We have greatly benefited from comments and suggestions from Suzi Kerr, Leonardo Hernandez, Robert Mendelsohn and Juan Pablo Montero. We thank Joana Setzer and Arnaud Koehl for valuable input and clarifications on the Climate Change Laws of the World database. We also thank comments from the participants at the ICSD 2020 and the Bolivian Conference on Development Economics 2020. All errors are ours.

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1 Introduction

The anticipated effects of climate change range from a threat to our standards of living to total catastrophe. In recent years, national leaders from the large majority of countries have had conversations and signed regional and global agreements to reduce greenhouse gas emissions. The two most important examples of such agreements are the Kyoto Protocol (in 1997) and the Paris Agreement (in 2015), which had a worldwide positive effect on the amount of regulations on emissions.

Between 2009 and 2019, at least 1524 laws have been passed, among all countries, either mitigating or adapting to climate change.[1] On the other hand, countries have different levels of commitment to climate change (Mehling et al., 2018). For example, in that same time interval, the 36 richest countries have passed an average of 8.63 climate change laws by country, while the 37 poorest countries have passed an average of 5.59.[2]

The carbon leakage hypothesis predicts that heterogeneity of regulations will cause higher emissions in less-regulated countries. What is worse, typically, the developing and low productivity countries are the ones who cannot afford to regulate their emissions.[3] Thus, one would expect that higher productivity is usually positively associated with more stringent regulations. Indeed, going back to the previous example, the average total factor productivity among the 36 richest countries in the last 10 years is three times higher than that of the 37 poorest countries.[4]

In this study, we analyze the effects that heterogeneous regulations have on global emissions. More specifically, we argue that (due to carbon leakage) 'not in my backyard' policies have not only increased the greenhouse gas emissions in unregulated countries, but because of the productivity gap, they have

[1]For more statistics of the laws, see Eskander et al. (2020).A1 maps the distributions of laws across countries at different points in time.

[2]This is, without considering the effectiveness of each country's policies; which would indeed compound the issue.

[3]For example, see the discussion on fairness such as Raworth (2007) and Baer (2002).

[4]See figure 2.

actually increased net global emissions. The rationale behind this hypothesis is very simple: due to lower productivity, unregulated countries need to use more inputs, and thus more energy, in order to supply the regulated-country's demand for products.

For our estimations, we use fuel emissions data from the International Energy Agency (IEA) and climate laws data from the Grantham Research Institute on Climate Change and the Environment (LSE/GRICCE), to construct a country-level panel from 1971 to 2016. In addition, we use covariates, such as GDP, population, capital, measures for trade and measures for productivity from the Penn World Tables (PWT).

Our contribution to the literature can be listed in three main categories: (*i*) We take a quantitative approach to the study of the LSE/GRICCE's data on climate laws; (*ii*) estimate the effectiveness of climate policy-making on a global scale; and finally, (*iii*) attempt to measure the net global effects that carbon leakage has on emissions, and consequently on global pollution. Moreover, to the best of our knowledge, this is the first study to do any of the three mentioned categories.[5]

Our results show that, the effectiveness of climate laws within the country of origin (the country passing the law) seem to work better among high-income countries. Thus, regulations do not work uniformly across all types of countries. Moreover, when we extend the exercise to study the effect of foreign climate laws on countries' emissions, we show that regulations in high income countries actually accelerate global emissions. Finally, by comparing the predicted emissions of our estimated panel under the observed laws and laws with some degree of coordination, we estimate the additional emissions (or the abatement loss) that came from the lack of coordination.

The policy implications of our findings contribute to the efforts on linking nations' climate policy.

[5] Eskander et al. (2020) have descriptive statistics and qualitative analysis using the climate laws data-set. The direct but isolated economic effects of some climate laws have been studied see for example Andersson (2019); Metcalf and Stock (2020). Finally, the carbon leakage literature has mainly focused on regional effects (such as the EU or the US). See the literature discussion in next section.

Namely, our results are a call for international coordination and cooperation in order to achieve a sustainable global economy. Ideally, high income countries should provide appropriate incentives to low income countries to reduce their emissions too. Since nowadays negative externalities have great international consequences, we believe that it is time for policymakers, as well as academics, to re-think climate change as a global problem.

The remainder of this paper is organized as follows: in section 2, we discuss previous studies that inspired our work, present our hypothesis, and discuss our estimation strategy. In section 3, we summarize the data sets used in this study. In section 4, we present the results from the econometric estimation, and in section 5 we discuss the robustness of our results. In 6 we propose an example to measure the cost of the lack of coordination in terms for emissions. Finally, we conclude in section 7.

2 Theoretical Motivation

Related Literature

Our study is motivated by theoretical and empirical studies from the *carbon leakage* literature and economic integration under the carbon pricing linkage, as well as more general subjects such as energy, environment, economics and law. Carbon leakage can be roughly defined as the displacement of CO2eq emissions from regulated nations towards non-regulated nations. The leakage could vary in magnitude, depending on the sector and the scope of the policy (Baylis et al., 2013). After the two mayor agreements in climate change policy, the Kyoto Protocol in 1997 and (to a lesser extent) the Paris agreement in 2015, some countries implemented binding and non-binding constrains to CO2eq emissions. However, the market effects have lead to offsetting emission increases in the countries without active regulations.

Following Wald (2015) the carbon leakage literature is divided in two large branches: (*i*) the theoretical ex-ante approach, that compares different scenarios against a synthetic counterfactual context where the simulated policy generate economic impacts; and, (*ii*) the ex-post approach, which uses historical data of emissions and production to identify the changes of patterns in emissions.

Two of the most relevant theoretical studies are Bohom (1993) and Copeland and Taylor (1995). They analyze how unilateral regulations reduce fuel usage, causing a downturn in world-market fuel prices, and thus increasing the consumption of fuels elsewhere. Those theories were later complemented with simulations, by several computable general equilibrium (CGE) models. These CGE simulations have consistently found positive leakage effects at the national or sub national level, with even positive net effects (i.e. the leakage effect surpassing the reduction in emission in the country of origin Babiker (2005)).[6]

The empirical literature on carbon leakage focused on regional effects. There are several studies on the environmental policies implemented by the EU, and their effects on their members. For instance, Barker et al. (2007) conclude that after the introduction of carbon taxes in six European members there is small or no evidence on leakages around its industries.[7] On the other hand, there are fewer studies

[6]Fullerton et al. (2011) and Babiker (2005) uses both multi-sector and commodities approach in a global set, with no explicit price of CO2eq estimation. Evidence using a range of carbon prices, multi sector breakdown, and considering Kyoto's Annex I countries and non-Annex I, can be found in Burniaux and Martins (2000), Caron (2012), Carbone (2013), Gerlagh and Kuik (2007), Lanzi et al. (2013), Monjon and Quirion (2009) and Kuik (2009) including mineral sector analysis. Paroussos et al. (2015), Kuik and Hofkes (2010), Baylis et al. (2013), Gerlagh and Kuik (2014), Rocco et al. (2020) and Zhang et al. (2020) present long term simulation forecasting considering the irruption of China as a main player in the emissions composition.

[7]Some other examples study the three phases of implementation of the European Trade System (EU-ETS) in the European Union between 2005 and 2020, which were analyzed separately and jointly in the literature with not significant evidence. For example, Cummins (2013) focus just on the phase II (2008-2012) of the EU-ETS in a panel regression, and finds no evidence of leakage. In the same line, Abrell et al. (2011) and Chan et al. (2013) consider phases I and II, and focus on specific sectors such as energy, cement, iron, and steel; they find no evidence of leakage. More recently Verde (2020) summarized the literature, emphasising on the empirical approach, and the general consensus seems to be that there is no evidence of leakage inside EU-ETS.

on the US economy. One of the most recent ones is Fowlie et al. (2016), who asses the implications of alternative policies imposing constrains to CO2eq emission in the cement industry, to show that regulations exacerbated the market power in the industry, and that carbon leakage of traded goods offsets local reductions.

In addition, our study is related to the Environmental Kuznet Curve (EKC), which addresses the challenges to measure and analyze the relationship between economic development and environmental quality.[8] The EKC proposes an inverse U-shape of emissions as a function of economic development. This relates to our study because it shows how once a country has reached certain threshold, the country starts to abate. On the other hand, developing countries cannot afford to reduce emissions.[9]

Furthermore, following Carson (2010) and Cohen et al. (2018), a major environmental attention is associated with higher levels of development. There is a growing evidence showing that the reductions of pollutants is associated with higher levels of development (Uchiyama, 2016) and more recently (Özcan and Öztürk, 2019). Overall, it is known that high-income countries tend to introduce both pricing and 'command and control' regulations to mitigate environmental problems.

Finally, the trade literature provides some concrete examples of the mechanism through which emission are outsource (or 'carbon leaks'). For instance, Copeland and Taylor (1995) proposes a trade model to show that large income heterogeneity could raise net CO2eq emissions (pollution in their paper). An empirical example of our outsourcing claim is Zaman et al. (2018); where the authors show that there has been a massive investment of coal industries coming from China, Japan and Korea towards African and South East Asian countries.

[8] One of the earliest discussions can be found in Holtz-Eakin and Selden (1995). To date, the EKC approach was tested in different contexts, such as global pollutants (like CO2eq) and local pollutants, like sulfur dioxide, nitrogen oxide, carbon monoxide, suspended particulate matter (PM).

[9] This point also relates to the topic of fairness; namely, who should abate? Some attempts to address this topic are Morrow (2017); Rodríguez-Fernández et al. (2020); Shue (1995), to cite a few.

Hypothesis

To summarize the literature, the carbon leakage hypothesis predicts a non-zero leakage with possible positive net effects on global scales; while its empirical evidence has mixed results focusing only on regional effects (as opposed to the globe). Moreover, the EKC predicts that countries with a high level of development will usually be the ones to regulate their emissions.

Our hypothesis is that the net global effect of carbon leakage is indeed positive. The reason is a combination of two aspects that we believe are widely accepted: (*i*) countries that typically regulate happen to also have higher productivity, and, (*ii*) countries with lower productivity need more inputs for production. Combining those two propositions, it follows that the observed higher levels of regulation in productive countries has outsourced the production of emitting goods to less productive countries. Those less productive countries, in turn, ended up using even more fossil fuels; and, thus, increasing net global emissions.[10]

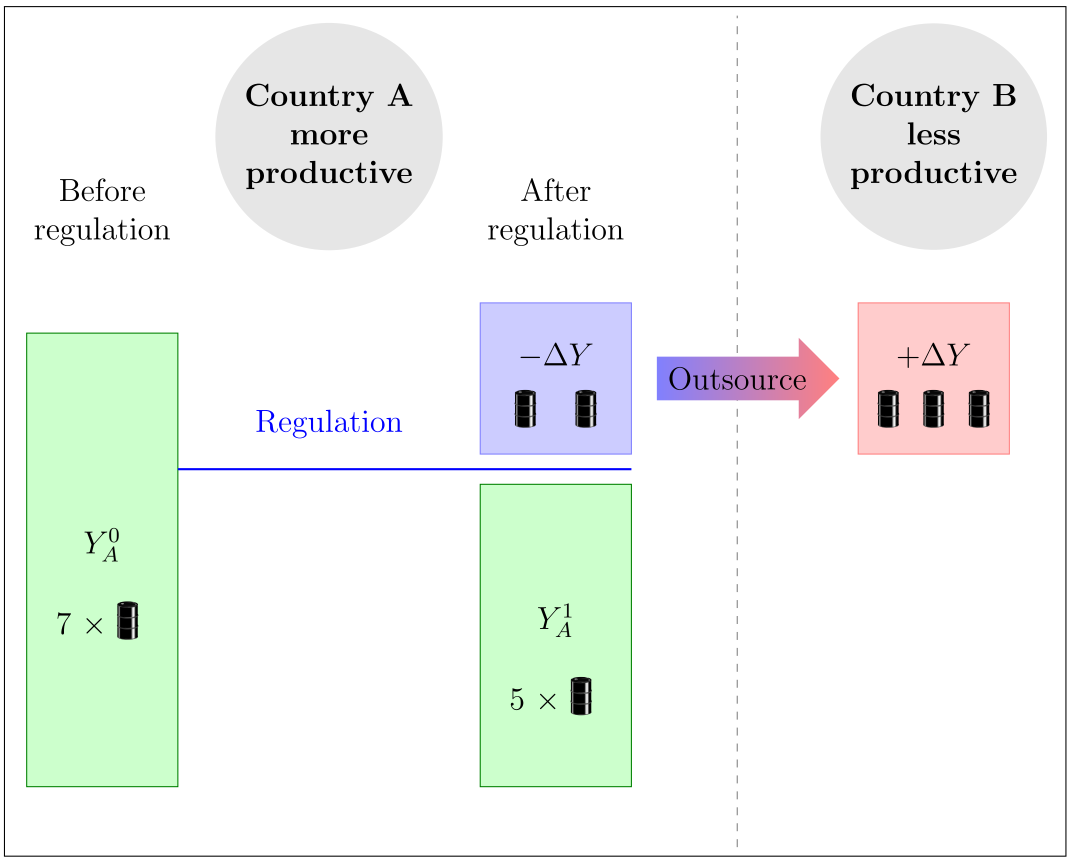
Thus, from our hypothesis, one would expect to find the following empirical results: (i) although climate laws from developed countries may have a negative effect on their own emissions, (ii) those laws will actually have a positive effect on net global emissions, or equivalently, a positive effect on the emissions of the average country.

In other words, the lack of coordination in climate laws had a counterproductive effect in the efforts to reduce climate change. Thus, it would be better to use mechanisms, at the international level, that takes into account the heterogeneity of productivity. Indeed, there are several studies supporting (theoretically) the international linkage of climate laws. For example, Mehling et al. (2018) states that, although targets are not binding, the Paris agreement has achieved a key condition for success: setting

[10] In other words, one can see the marginal cost of abatement as the 'cost of opportunity' from reducing the production of emitting goods. This cost of opportunity is directly related to productivity: the loss from not producing is high if productivity is high.

a precedent of cooperation. Then, they proceeds to analyze and propose possible ways to implement regulations that are linked across nations.[11] Our hypothesis is illustrated in figure 1.

Figure 1: The Effect of Heterogeneous Regulations under Heterogeneous Productivities



Country A uses seven units of energy to produce Y_A^0. By imposing a regulation within its borders, country A reduces its production to Y_A^1 and, thus, reduces its energy consumption by two units. However, now there is a global excess demand of $\Delta Y \equiv Y_A^0 - Y_A^1$ units of the product. Since country B is not affected by the regulation, they supplies the excess demand ΔY. However, since country B is less productive, they used three units of energy. The net effect of the regulation in country A is a global increase of one unit of energy being used.

[11] Other examples that take positive and normative approaches are Agostini et al. (1992); Parry et al. (2016); Chan et al. (2018); Schmalensee and Stavins (2019); Aldy and Stavins (2020); Nordhaus (2015).

Estimation Strategy

We estimate an econometric model that explains emissions as a function of a country's own laws and foreign laws. We construct a panel at the country level, with data on emissions, laws, and macroeconomic variables. We use country and time fixed effects, to capture country specifics (culture, institutions, etc) and time specifics (time trends and fluctuations).[12] In order to measure the effect that foreign laws have on each country, we want to distinguish whether the foreign law came from a wealthy country or not. Thus, we classify the laws in four groups according to GDP per capita quartiles.[13] Finally, we estimate our model using linear regressions.

Although we agree that the approval of a climate law is not a random event, we are skeptical to believe this fact severely affects our results. First of all, it is not clear that climate laws depends on a country's recent emissions. The political economy literature has shown us that politicians mostly react to their prospects of power (see for example Downs (1957); Mayhew (1974)), and this holds true regarding climate laws (Downton and Pielke Jr, 2001). One possible counter-argument could be that due to the recent noticeable changes in climate, the younger generations of voters and especially activists are pushing their governments to address this issue. However, our use of time fixed-effects captures the mentioned changes in the trend. Another counter-argument could be that regional agreements are the forces driving our results. However, the only know agreement that had some degree of commitment was the Kyoto protocol; and, even controlling for it, our results remain robust.[14] Second, and more importantly, we focus on how foreign laws affect a country's own emissions. Thus, we believe it is implausible to find any arguments implying that regulations from one country depend on the emissions

[12]Moreover, we primarily use a combination of time with income-group fixed effect to capture the possibility that, for instance, rich countries have a different trend compared to poor countries.

[13]Alternatively, we also estimate a 'continous' version that captures the effect of the interaction of regulations and GDP. In appendix table C11, we show that our results from table 6 are robust to this continuous version.

[14]As shown in appendix tables C1 and C2.

of another country.

3 Data

We use three data sets: climate laws from the LSE/GRICCE, emissions from the IEA, and macroeconomic variables from PWT. Since our variables come from three different sources, there are mismatches regarding the availability on some countries. We describe the size of our sample in detail below.

3.1 Climate Laws

We use the Climate Change Laws of the World (CCLW) data set from the LSE/GRICCE. There is data from 198 countries from 1947 to 2020, listing all laws on emissions on each of those countries.[15] Our main variable $laws_{i,t}$ will be the sum of all approved laws by country i on year t. Alternatively, our results are robust to mitigation laws and a dummy variables for having any law.[16]

Similarly, we want to define a measure for foreign laws, and, in addition, we want to explicitly classify foreign laws according to 'where in the EKC they are currently located.' To do so, we divided the list of countries of each year t in four groups $G(t) \in \{1, 2, 3, 4\}$, which we achieved by using income data as described in section 3.3.[17] The variable $ext.laws_{i,t,G(t)}$ represents the laws from all countries in group $G(t)$ that are foreign to country i. More precisely, let $I_{i,G(t)}$ be the indicator function for the event 'country i belongs to group $G(t)$.' Then, $ext.laws_{i,t,G(t)} = -I_{i,G(t)} laws_{i,t} + \sum_{j \in G(t)} laws_{j,t}$.

[15]The data-set is meant to be comprehensive; thus, any missing laws should be very exceptional cases. There is an additional region labeled EU. For those laws, we added each of them to the respective EU countries taking into account the year they joined the organization.

[16]See appendix tables C5 and C6.

[17]Countries change income classification over time, thus the group dependence on t.

Table 1: Climate Change Laws of the World

Variable	Obs	Mean	Std. Dev.	Min	Max
All laws	2221				
Mitigation laws	782				
Laws/year		119.57	50.45	28	175
Miti. Laws/year		42.47	21.37	0	68
Laws/country		18.94	11.66	1	55
Miti. Laws/country		7.55	6.55	0	24
Year				1947	2019

CCLW data-set from the LSE/GRICCE. A law is defined as mitigation if either the type of *framework* or the type of *response* of the law have the word *mitigation*. EU laws were duplicated for each EU country.

3.2 Emissions

We use data of emissions from fuel combustion from the IEA.[18] The sample includes 145 countries from 1971 to 2017, and emissions are measured in million metric tons. Thus, we define $emissions_{i,t}$ as country i's own fuel emissions in year t and $log(emissions_{i,t})$ as its natural logarithm.

Table 2: CO2 emissions from fuel in million metric tons

Variable	Obs	Mean	Std. Dev.	Min	Max
National Emissions	6113	166.96	636.25	0.06	9257.93
Growth Rate		3.33%	0.13	-77.03%	377.38%
World Emissions		21715.77	5482.87	13333.23	31461.51
World Growth Rate		1.90%	0.02	-1.27%	5.95%
Year				1971	2017

Emissions data from the IEA. Most of the observations for the growth rate are between -10% and 20%. See the histogram on figure A2.

[18] Note that this does not refer to only transportation. According to the IEA, their emissions data provides a full analysis of emissions stemming from energy use.

3.3 Covariates

Our most relevant covariate is productivity. We use PWT's total factor productivity (TFP) as a measure of productivity. Because carbon leakage severely depends on prices, we have to make the TFP comparable between countries. More specifically, we want a measure of TFP that is standardized by the purchasing power parity (PPP), but, at the same time, captures the TFP's growth over time. In order to achieve this, we use the PPP-adjusted TFP (variable name: $CTFP$ from PWT), which is normalized at USA=1 (in all years). Then, we re-normalize it to real USA's TFP to adjust for productivity growth over time (variable name: $RTFPNA$ from PWT). Thus, our measure of country i's productivity on year t is $TFP_{i,t} = CTFP_{i,t} \times RTFPNA_{USA,t}$.[19]

The remaining covariates for country i in period t are GDP per capita $gdp.pc_{i,t}$, stock of capital per capita $cap.pc_{i,t}$, population $pop_{i,t}$, and exports $csh.e_{i,t}$ and imports $csh.m_{i,t}$ of goods, both as a fraction of GDP. All these variables are also from the PWT. In addition, we also use PWT's gdp to classify countries by income rank. For each year t, we divided the list of countries in four income categories of about the same size: *High Income*, *Medium-High Income*, *Medium-Low Income*, and *Low Income*.[20]

3.4 Policy Effectiveness

Since institutions affect the impact or effectiveness of a law, one should not expect to believe that that laws from different countries have the same impact. We adjust the impact of laws by a measure

[19] Alternatively, we also used GDP per worker as a measure of productivity. Our results remain robust to this modification. The results are shown in table C8.

[20] There is a mismatch between countries with emissions data and GDP data in the sample. Thus, simply using percentiles would end up in very heterogeneous sized groups. In order to solve this issue we: (i) divide countries with existing GDP data in 5 quintiles. Groups 1 to 3 remain untouched. Groups 4, 5 and the remaining mismatched countries, are all collapsed as the 4th group. This is not perfect, but it's a reasonable approximation, since most countries that mismatch are usually small and low income economies. In addition, we also used Human Development Index (HDI) to classify countries into four groups as a robustness check. However, the HDI index only starts from 1990, and there are also mismatched countries. Nevertheless, our results remain robust when using the HDI index. The results are shown on appendix table C10.

Table 3: Productivity and Others

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP	9985	269192.80	1070178	19.78	18400000
Population	9985	30.74	114.57	0.00	1409.52
Capital	9959	908.76	3976.40	0.01	106000
RTFPNA	6006	0.99	0.35	0.23	7.11
CTFP	6006	0.71	0.29	0.02	3.61
TFP	6006	0.62	0.25	0.02	2.84
GDP/Labor Force	8841	29436.33	45683.89	485.81	1343052
Exports/GDP	9985	0.23	0.26	-1.50	3.06
Imports/GDP	9985	-0.31	0.68	-26.74	23.16
Year				1950	2017

Data from the PWT. GDP is expressed in real 2011 million USD, at chained PPP, and capital stock is measured in real 2011 billion USD, at chained PPP.

of policy effectiveness generated from our own data. Although we could use Kaufmann's Government Effectiveness Estimate (GEE).[21], the sample only starts from 1996, and it measures the effectiveness of all laws, while we want to focus on climate laws. Using all data described in the previous sections, we created our own Climate Law Effectiveness (CLE) index, which broadly speaking measure the difference between a country's observed emissions and the fitted emissions from a regression of emissions on macroeconomic variables. The methodology is explained in appendix B.

The advantages of this index are that the sample obviously matches our sample, and that it is specific to climate laws. The disadvantages from both indexes is that the unit of measure is subjective and does not have a clear interpretation.[22] Alternatively, our results are very similar if we use Kaufmann's GEE or if we don't use any adjustment at all.[23]

[21] Kraay et al. (2010)

[22] We matched Kaufmann's units to get an index, roughy speaking, between -2.5 and 2.5. Then, the adjusted measure of *law* will be 100% plus the score of the index used.

[23] See appendix tables C3 and C4.

Table 4: Policy Effectiveness

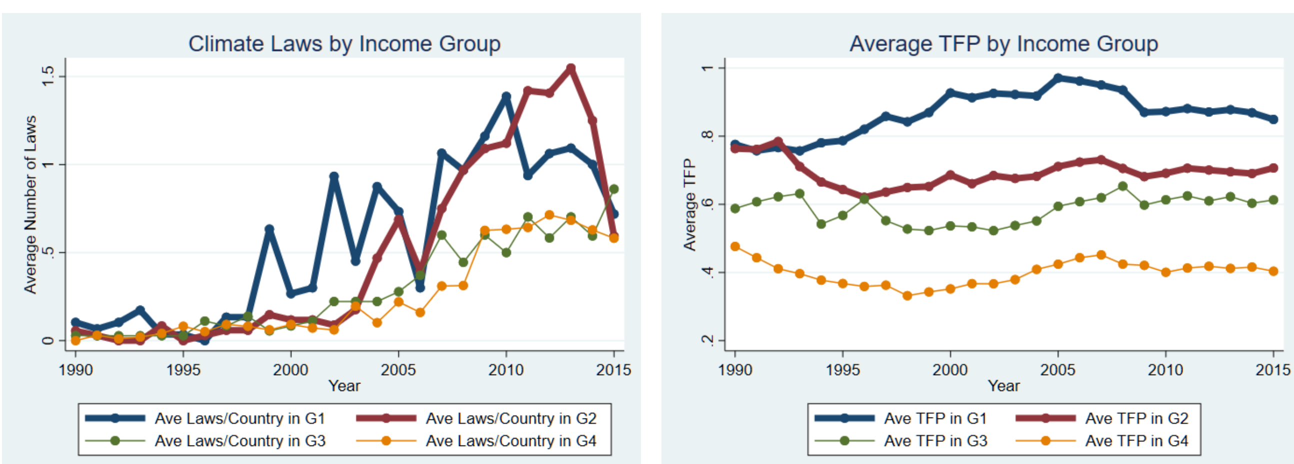
Variable	Obs	Mean	Std. Dev.	Min	Max
GEE	9408	-0.06	0.97	-2.48	2.44
CLE		0.04	1.00	-4.59	2.76

Both indexes were normalized to have a SD of 1. However, there are a few mismatches between Kaufmann's GEE, that is why the measured SD slightly differs from 1. In addition, our CLE was constructed from the existing data. Thus, all observations are available.

4 Results

As previously explained, we divided the set of countries by income group for each year. We argue that income captures development, and thus following the theoretical prediction of the EKC, one would expect that the number of laws are correlated with the income group. In addition, the most relevant driving force that links the inverse U-shape of the EKC and abatement is technological advance, which we measure as the TFP. Thus, to strengthen our claim, we also show that the TFP is associated with the income group. These two relations are displayed in figure 2.

Figure 2: Income, Productivity and Climate Laws



(a) Income Group and Laws

(b) Income Group and Productivity

4.1 Own Regulations

As a benchmark, we first estimate a model on how a country's own regulations affect their emissions. Our dependent variable is the log of emissions. Our main explanatory variables are the measure for laws, productivity, and their interaction. In addition, we control by other variables that should affect emission, such as log of GDP per capita, log of population, log of capital stock, and exports and imports both as a share of GDP. Finally, we use country fixed effects, and either year fixed effects (when income group classification is used) or the interaction of income-group and year fixed effects (when income group classification is used). Thus, our first model is:

$$log(emissions_{i,t}) = \beta_0 + \beta_1 laws_{i,t} + \beta_2 laws_{i,t} TFP_{i,t} + \beta_3 TFP_{i,t} + Controls_{i,t} + \nu_i + u_t + e_{i,t} \quad (1)$$

Table 5 shows the results for the above estimation. Columns (1) and (2) estimate the effects of the average law on the average country's own emissions. The difference between them is that column (1) assumes that the time fixed effect is the same for all countries, while column (2) allows for it to have different effects depending on the income group. Column (2) shows that the the average law of the average country has been ineffective at best.

On the other hand, the previous result that 'the average law' is ineffective is no longer true if we do a sub-sample analysis. Columns (3) to (4) show that regulations of higher income countries actually reduce their own emissions. On the other hand, Columns (5) and (6) show the opposite result: policies in low-income countries are associated with increases in emissions.[24] Thus, one could mistakenly

[24]The results on columns (5) and (6) are robust to using Kaufmann's Governance Effectiveness and not adjusting at all. The coefficients for law on columns (3) and (4), although remain negative, become insignificant when changing the adjustment for law effectiveness.

Table 5: Emissions, Regulations and Productivity

	log emissions					
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
laws	0.0870***	0.0288	-0.0828*	-0.0909*	0.0670**	0.157***
	(0.0205)	(0.0220)	(0.0462)	(0.0452)	(0.0306)	(0.0415)
laws*Productivity	-0.142***	-0.0571**	0.0629	0.106	-0.100*	-0.305***
	(0.0293)	(0.0289)	(0.0477)	(0.0629)	(0.0518)	(0.0910)
Productivity	-0.544***	-0.680***	-0.504***	-0.890***	-0.325	0.116
	(0.0762)	(0.0860)	(0.110)	(0.132)	(0.218)	(0.195)
log gdp/pc	1.364***	0.755***	7.290***	-2.437***	6.078***	-0.888
	(0.187)	(0.235)	(0.712)	(0.533)	(0.609)	(0.529)
$(\log \text{gdp/pc})^2$	-0.0410***	-0.00296	-0.333***	0.192***	-0.303***	0.0814**
	(0.0106)	(0.0134)	(0.0337)	(0.0278)	(0.0329)	(0.0329)
log pop	1.545***	1.514***	1.382***	2.326***	1.430***	1.417***
	(0.0468)	(0.0653)	(0.0772)	(0.0631)	(0.131)	(0.134)
log capital	-0.0805***	-0.128***	-0.00566	-0.0485	0.0216	0.0397
	(0.0189)	(0.0280)	(0.0561)	(0.0477)	(0.0497)	(0.0522)
exports/gdp	-0.135**	-0.127*	0.192**	-0.522***	0.211	-0.714***
	(0.0595)	(0.0691)	(0.0910)	(0.125)	(0.126)	(0.172)
imports/gdp	-0.281***	-0.228***	0.0870	-0.502***	-0.388***	-1.089***
	(0.0487)	(0.0593)	(0.0851)	(0.112)	(0.122)	(0.233)
Constant	-9.657***	-6.387***	-37.29***	4.360*	-31.54***	-0.602
	(0.810)	(0.991)	(3.714)	(2.350)	(2.698)	(1.972)
Observations	4,337	4,337	1,240	1,124	956	1,017
Country F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Time F.E.	Yes	–	Yes	Yes	Yes	Yes
Time*Group F.E.	–	Yes	–	–	–	–
Income Group	All	All	High	Mid-Hi	Mid-Lo	Low

Panel of emissions and own regulations. * $p< 0.05$, ** $p< 0.01$, *** $p< 0.001$. The variable *law* represents the number of regulations of a country in a year, and its effectiveness was adjusted by our CLE index. Errors were clustered by year on column (1) and by year-group on columns (2) to (6). Robust errors are displayed in parenthesis.

conclude that low income countries should not pass environmental policies, or at least heavily improve their effectiveness. Nevertheless, this analysis does not show how the decisions of one country affect the other. That is, the effects of foreign policies are either not taken into consideration.

4.2 Foreign Regulations

Figure 2 and table 5 showed us that the income groups heavily affect the relationship between climate laws, productivity and emissions. Next, we study how foreign regulations affect the emissions of the average country. Our dependent variable is still the log of emissions, we still use own regulations and the control variables from equation (1). In addition, we add and focus on foreign regulations $ext.laws_{i,t,G(t)}$ as the main explanatory variable. Finally, we want to study how the effects of regulations persist over time. Thus, our testable model is describe by the following equation:

$$
\begin{aligned}
log(emissions_{i,t}) &= \beta_0 + \beta_1 laws_{i,t-\tau} + \beta_2 laws_{i,t-\tau} TFP_{i,t-\tau} + \beta_3 TFP_{i,t-\tau} \\
&+ \sum_{g(t-\tau)=1}^{4} \Big[\gamma_{1,g(t-\tau)} ext.laws_{i,t-\tau,g(t-\tau)} + \gamma_{2,g(t-\tau)} ext.laws_{i,t-\tau,g(t-\tau)} TFP_{i,t-\tau} \Big] \\
&+ Controls_{i,t} + \nu_i + u_t + e_{i,t} \text{ , for } \tau = 0, 1, 2 \ldots
\end{aligned} \tag{2}
$$

where τ represents the lag on the policy variable, and we are mainly interested in estimating the set of γ parameters.

Table 6 shows our estimations for the effect of foreign laws on a the average country's emissions from equation (2). Column (1) uses the same period's law, while columns (2)-(5) use regulations from periods $t-1$ to $t-4$ respectively. The coefficients for $ext.laws.G1$ are all positive and significant for columns (2) to (5). This shows that lagged climate laws implemented by the richest countries have

Table 6: Foreign Regulation

	log emissions				
VARIABLES	(1)	(2)	(3)	(4)	(5)
Law	-0.0431	-0.0107	-0.0121	-0.0149	-0.0168
	(0.0297)	(0.0226)	(0.0232)	(0.0233)	(0.0229)
Law*Productivity	0.0535	-0.0108	-0.00791	-0.00351	-0.000793
	(0.0467)	(0.0304)	(0.0315)	(0.0318)	(0.0309)
ext.laws.G1	0.0299*	0.0270**	0.0470***	0.0540***	0.0477***
	(0.0165)	(0.0133)	(0.0137)	(0.0166)	(0.0152)
ext.laws.G1*Prodctvt	-0.00275	0.00194	-0.00351	-0.00397	-0.00244
	(0.00483)	(0.00486)	(0.00648)	(0.00568)	(0.00597)
ext.laws.G2	0.0386***	0.0290**	0.0173	0.00541	0.00283
	(0.0107)	(0.0138)	(0.0174)	(0.0171)	(0.0147)
ext.laws.G2*Prodctvt	-0.00708	-0.00973	-0.00757	-0.00284	-0.00429
	(0.00619)	(0.00673)	(0.00749)	(0.00746)	(0.00604)
ext.laws.G3	-0.00735	0.0175	0.0285	0.0404	0.0559**
	(0.0155)	(0.0170)	(0.0226)	(0.0270)	(0.0272)
ext.laws.G3*Prodctvt	0.00216	-0.00123	0.00481	-0.00547	-0.00689
	(0.0138)	(0.0171)	(0.0227)	(0.0211)	(0.0201)
ext.laws.G4	-0.0398***	-0.0284**	-0.0244	-0.00722	0.00703
	(0.0129)	(0.0134)	(0.0172)	(0.0255)	(0.0238)
ext.laws.G4*Prodctvt	-0.000910	-0.000399	-0.00156	-0.00269	-0.00519
	(0.00433)	(0.00409)	(0.00706)	(0.00849)	(0.00833)
Productivity	-0.663***	-0.668***	-0.672***	-0.675***	-0.680***
	(0.104)	(0.104)	(0.103)	(0.102)	(0.101)
Observations	4171	4171	4171	4171	4171

Panel of emissions and foreign regulations. * $p< 0.05$, ** $p< 0.01$, *** $p< 0.001$. Column (1) uses the same period's law, while columns (2)-(5) use regulations from periods $t-1$ to $t-4$ respectively. Control variables and a constant term were used, but omitted from the table for brevity. All regressions have country fixed effects and year by income-group fixed effects. Errors were clustered by year-group. Robust errors are displayed in parenthesis. Laws were adjusted by our index CLE. See appendix B.

actually increased the emissions of the average country. For instance, the largest coefficient for this variable is 0.0485 in column (4). Since emissions are in logarithms, the estimated coefficient is a semi elasticity with the following interpretation: an increase of one law passed by one of the high-income countries multiplies the emissions by $e^{0.0540}$, which represents about a 5% increase.

5 Robustness of the Results

Next, we discuss how results from table 6 are robust to several modifications. Namely, our results are robust to: (*i*) controlling for the Kyoto Protocol agreement; (*ii*) using Kaufmann's GEE for policy effectiveness or not adjusting at all; (*iii*) using the number of mitigation laws in a year, a dummy indicating if there is any law in a year, and a dummy indicating if there is a mitigation law in a year; (*iv*) restricting the sample to post-cold war era; (*v*) using the ratio of GDP by labor force as a measure for productivity, or not controlling for productivity at all; (*vi*) defining the group quartiles as a function of the Human Development Index; (*vii*) using a 'continuous' version of the interaction of laws and GDP.[25]

5.1 Kyoto Protocol

6 Measuring Non-Coordination

The results from table 6 show that foreign laws from developed countries increase the emissions of the average country, and, to some extent, foreign laws from developing countries decrease the emissions on the average country. In this section, we re-estimate the model specification from table 6, but use

[25] All robustness analysis is shown on appendix C.

simultaneously current and lagged foreign laws up to three periods. That is:

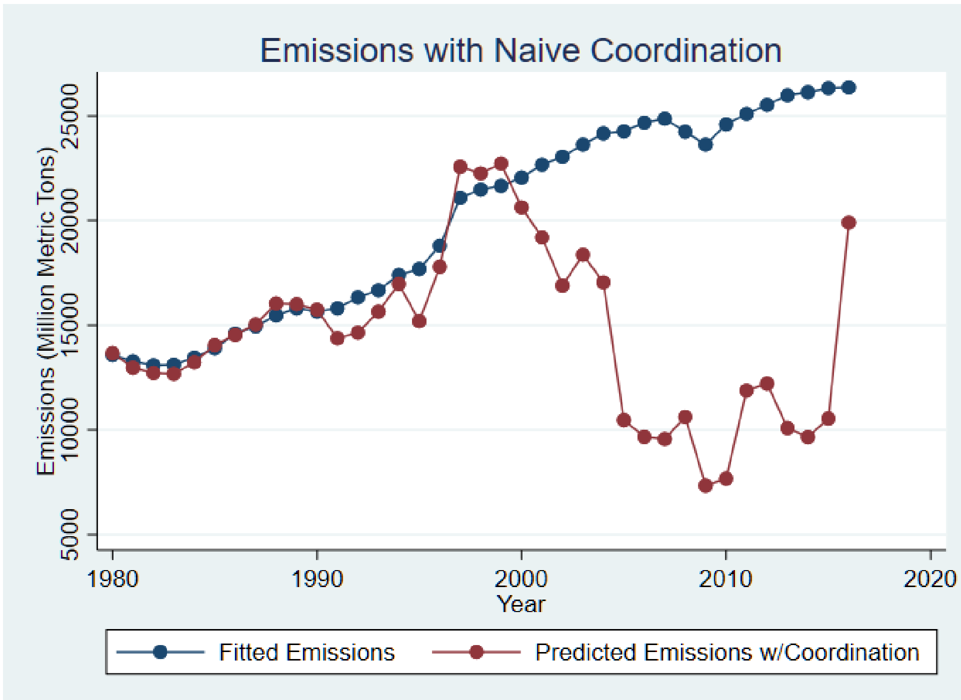
$$
\begin{aligned}
log(emissions_{i,t}) &= \beta_0 + \sum_{\tau=0}^{3}\Bigg[\beta_1 laws_{i,t-\tau} + \beta_2 laws_{i,t-\tau}TFP_{i,t-\tau} + \beta_3 TFP_{i,t-\tau} \\
&+ \sum_{g(t-\tau)=1}^{4}\Big[\gamma_{1,g(t-\tau)} ext.laws_{i,t-\tau,g(t-\tau)} + \gamma_{2,g(t-\tau)} ext.laws_{i,t-\tau,g(t-\tau)}TFP_{i,t-\tau}\Big]\Bigg] \\
&+ Controls_{i,t} + \nu_i + u_t + e_{i,t}
\end{aligned} \tag{3}
$$

Then, using the estimated coefficients, we compare the emissions from two scenarios. The first one is the fitted emissions using the original data. For the second scenario, we keep the coefficients but replace the original (heterogeneous) laws by the yearly average law, and then predict the alternative emissions that would come from 'naive coordination.' That is, we define naive coordination as a sub-optimal coordination such that countries mimic each other instead of taking into account the advantages of the differentials in productivity.[26] Figure 3 shows the comparison of world emissions from these two scenarios.

The above exercise shows that it is possible to reduce emissions with coordination. On the other hand, the exact magnitude is clearly far from being perfectly estimated for several reasons. First, we are restricted to the data. Our sample size is the intersection of three main data-sets, and, thus, even the predicted model without adjustments already has lower (global) emissions to begin with. Second, we assume that other variables are not affected. Namely, GDP did not change between the two scenarios. Third, our exercise exclusively focuses on the trade-off between production and abatement. On the other hand, technological progress can increase abatement without compromising production.

[26] On the other hand, since the right hand side of equation (3) is linear in foreign laws, we believe that the analysis already over-compensates for using a sub-optimal coordination.

Figure 3: Comparing no coordination and naive coordination, from 1980 to 2016.

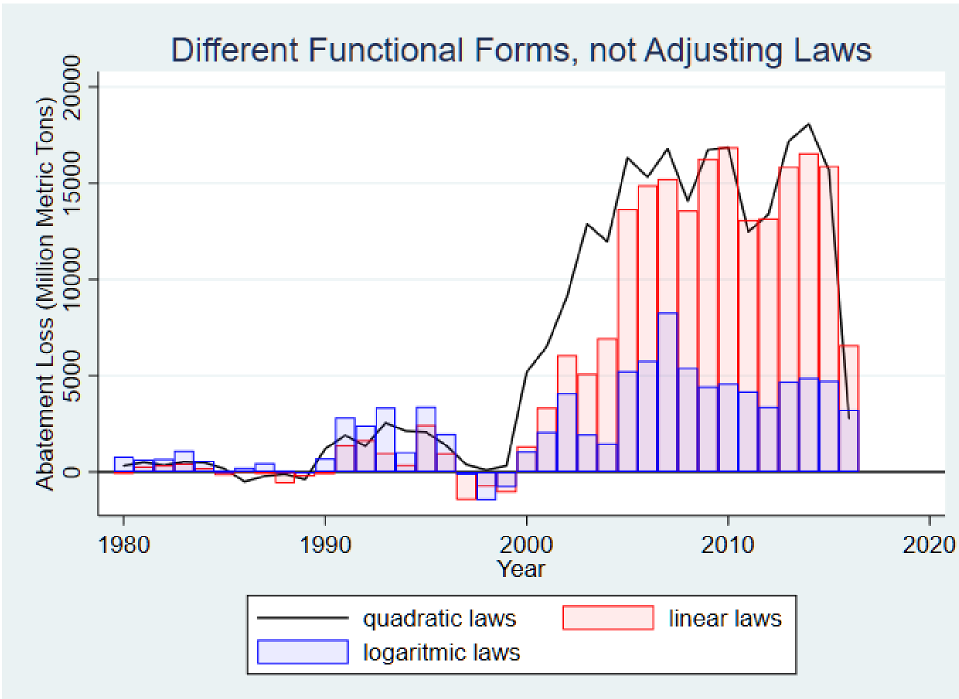


The effectiveness of regulations was adjusted by CLE to estimate equation (3). However, under naive coordination, we assume perfect effectiveness. Thus, laws were not readjusted after calculating the yearly average. To see the effect of re adjusting after coordination, see figure 2(b).

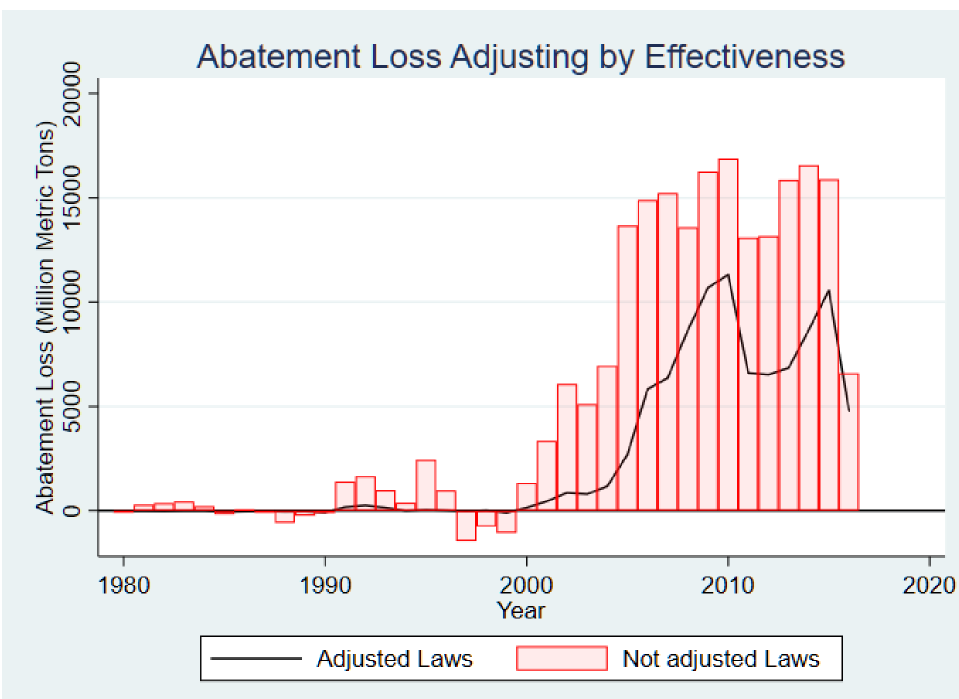
Although technological progress is controlled by TFP, we do not explicitly focus in that variable.

In addition to the points describe above, one adjustment that we can make with the available data is to take into account that productivity is decreasing as as function of production (or production exhibits diminishing returns to scale). This would imply that the change in laws should also have a decreasing impact on carbon leakage, as productivity from regulated and unregulated countries slowly converge. Thus, a concave transformation of the variable *laws* in equation (3) should make the comparison between the predicted emissions with actual laws and with modified laws less dramatic. We used two alternative specifications, one is quadratic and the other one is logarithmic. The comparisons

Figure 4: Abatement Loss from no Coordination



(a) Abatement Loss from no Coordination, Under Three Functional Forms



(b) Abatement Loss from no Coordination, Adjusting by CLE are displayed in figure 2(a). Another adjustment is to take into account that even after coordination, countries will have different rates of effectiveness. Thus, for figure 2(b), we readjust the average yearly laws by our CLE.

Figure 2(a) shows the the differences between the predicted global emissions with actual laws and with modified laws for three different functional forms for the variable *laws*: linear (the difference between the two lines in figure 3), quadratic and logarithmic. The quadratic function is almost identical to the linear one, but the logarithmic one presents a much smaller abatement loss. Similarly, figure 2(b) shows that after readjusting for effectiveness, the loss in abatement is reduced. More importantly, in all cases, the alternative scenario with modified laws had lower emissions than the scenario with observed laws.

Two interesting points from figure 2(a) are that, (*i*) there seems to be a small but positive global abatement attained exactly at the beginning of the Kyoto protocol, which can be attributed to the fact that regulations are effective in the own country, specially for high-income countries. However, (*ii*) the net effect quickly became negative (or positive loss in the graph) after year 2000. This also relates to empirical evidence of recent emissions take-off, especially from developing nations.[27]

7 Conclusion

We have studied the global effect of uncoordinated (or at least only partially coordinated) regulations that originally attempted to reduce greenhouse gas emissions. To estimate how present and past foreign laws affect emissions, we constructed a panel with climate laws and emissions data from the majority of countries. Although we show that industrialized countries' own regulations have decreased

[27] For example, see Zhang et al. (2020); Rocco et al. (2020); Sengupta and Bhardwaj (2004); Arroyo-Currás et al. (2015).

their own emissions, we also show that regulations from those same countries increased emissions in unregulated countries. More importantly, the net effect has been an increase in global emissions. Our results are relevant considering the current state of climate laws distribution and heterogeneous productivity around the world.

Theoretically, the reason to our findings is that abating one additional metric ton of CO2eq represents a higher cost of opportunity in high-productivity countries. Unfortunately, those countries are also the ones regulating. Thus, we would be better off by finding a mechanism such we first reduce emissions in low-productivity countries.

We also compared the predicted emissions from the empirical model with a hypothetical scenario. On the predicted emissions, we used the actual heterogeneous laws observed in the data, and on the hypothetical scenario we assumed that each country implemented the yearly average number of laws. This exercise shows that, in the hypothetical scenario, global accumulated emissions from 2008 until now would be about half as much as emissions with the observed laws. Although these results are only for illustration, rather than for policy evaluation, there is no doubt that moving the regulations in the direction proposed would decrease global emissions.

The immediate implication is clearly adverse: the lack of global coordination and planning has had a detrimental effect on the goals to slowdown and stop climate change. Partial coordination, such as the Kyoto protocol, is not enough to achieve a sustainable global plan for emissions. Although the Kyoto protocol allows for the incumbents to substitute their own abatement for a measurable reduction in a third party's emissions, this mechanism was only meant to be used as a secondary source of abatement. Thus, we believe laws ideally need to be coordinated, which is an idea already proposed in the literature (for example in Mehling et al. (2018)).

Moreover, there are a few different tools that can be used to provide the right incentives to all countries. The one that is most appealing, at least theoretically, is a global cap-and-trade. A second solution would be a global carbon tax, as proposed by the IMF (2019). Based on our productivity rationale, a global version of standard environmental economics policy techniques will make high income countries purchase emission rights from low income countries. We believe this sounds appealing from the efficiency perspective and also from the fairness perspective.

Of course, there are difficulties to such international agreement. Some countries may not be willing to participate. Some countries may sign and misreport their (difficult to measure) emissions. In addition, there are other technical difficulties. For instance, there is no obvious way to setting the emissions cap. Should it be a flat cap for all countries? Or should it be determined by population? Or GDP per-capita? Or based on historical emissions? This discussion of setting the cap goes back to a lingering issue in the environmental economics field: property rights. Another difficulty is that countries have to be willing to maintain their allegiance to the agreement even in the difficult years to come. This relates to the self-enforcing mechanisms on international agreements (Caro-Burnett, 2018).

One relevant variable that is beyond the scope of this study is technology. Implicitly, our theoretical rationale relies on the fact that there is a trade-off between production and abatement. However, technology could allow for an improvement in both directions (i.e. expand the Pareto frontier). Empirically, we controlled for total factor productivity which is a standard measure for technology. However, it would be interesting to explicitly incorporate and focus on technological progress theoretically and possibly empirically. Nevertheless, our conjecture is that, since the marginal cost of abatement is higher in developed countries, the first countries where experimental technologies are adopted should be developing countries.

Countries who can afford for abatement are not the countries who should be abating. Although further research is needed in this topic, our results are clear and, to some extent, embarrassingly obvious. Ideally, all countries should coordinate, and emissions should first be reduced in countries where the marginal cost of (opportunity of) abatement is low. We hope our study is a first step in the right direction towards a better understanding in this exciting and immensely relevant topic.

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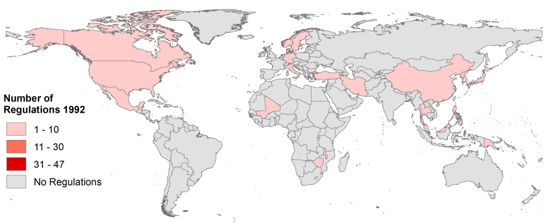
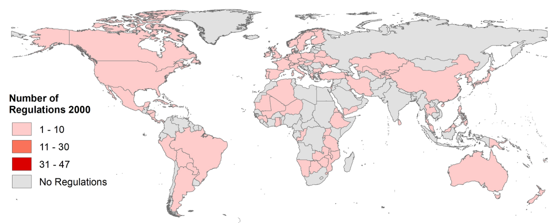
A Figures

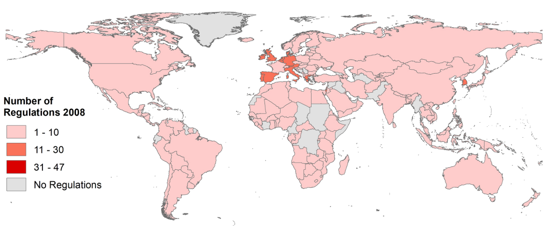
Figure A1: Evolution of the number of laws by country, years 1992, 2000, 2008, and 2016



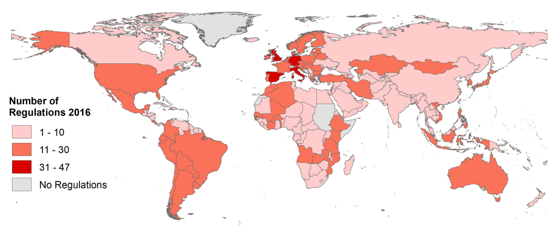
(a) Year=1992



(b) Year=2000

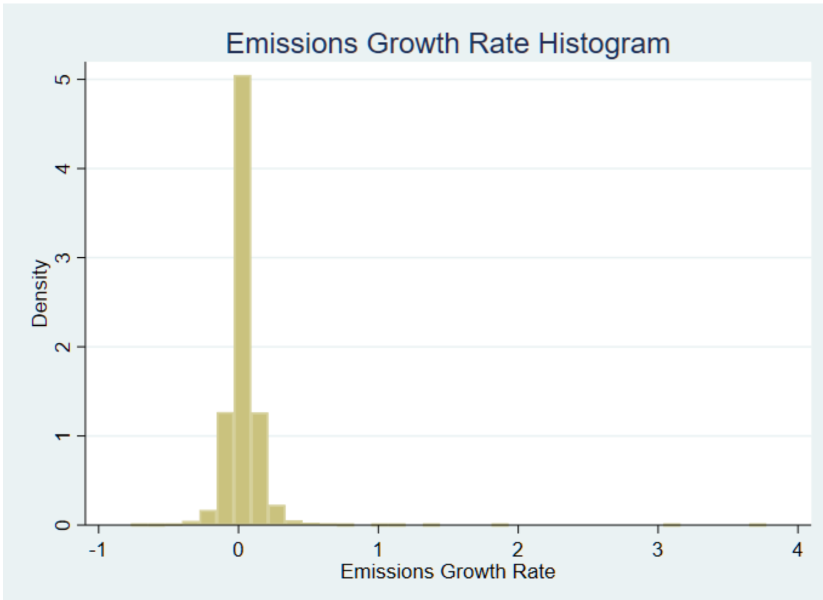


(c) Year=2008



(d) Year=2016

Figure A2: Histogram of emissions growth rates



B Climate Laws Effectiveness

As an alternative to Kaufmann's GEE, we used our data set to measure which country-year pairs have relatively more effective laws. We estimated a model similar to equation (1), but without the $laws$ variables: $log(emissions_{i,t}) = \beta_0 + \beta_1 TFP_{i,t} + Controls_{i,t} + \nu_i + u_t + e_{i,t}$. Then, we compared the predicted log-emissions ($fitted\_log(emissions_{i,t})$) with the observed counterpart. We measure effectiveness as $CLE_{i,t} = (-log(emissions_{i,t}) + fitted\_log(emissions_{i,t}))$, if $laws_{i,t} > 0$. Finally, we re-normalized this index to have a standard deviation of one, similar to Kaufmann's GEE.

C Additional Tables

Table C1: Including Kyoto Protocol Annex 1 Dummy, All Initial Countries

	log emissions				
VARIABLES	(1)	(2)	(3)	(4)	(5)
Law	-0.0538*	-0.0144	-0.0150	-0.0176	-0.0201
	(0.0296)	(0.0230)	(0.0236)	(0.0237)	(0.0234)
Law*Productivity	0.0739	-0.00293	-0.00146	0.00260	0.00598
	(0.0467)	(0.0312)	(0.0327)	(0.0328)	(0.0317)
ext.laws.G1	0.0350**	0.0258*	0.0437***	0.0502***	0.0419***
	(0.0165)	(0.0141)	(0.0146)	(0.0169)	(0.0158)
ext.laws.G1*Prodctvt	-0.00275	0.00176	-0.00379	-0.00413	-0.00214
	(0.00497)	(0.00478)	(0.00641)	(0.00558)	(0.00573)
ext.laws.G2	0.0393***	0.0268*	0.0136	0.00300	-0.00245
	(0.0106)	(0.0143)	(0.0182)	(0.0177)	(0.0151)
ext.laws.G2*Prodctvt	-0.00678	-0.00875	-0.00599	-0.00209	-0.00421
	(0.00626)	(0.00672)	(0.00701)	(0.00679)	(0.00575)
ext.laws.G3	-0.00953	0.0141	0.0268	0.0372	0.0505**
	(0.0150)	(0.0173)	(0.0226)	(0.0262)	(0.0255)
ext.laws.G3*Prodctvt	0.00153	-0.00115	0.00297	-0.00615	-0.00783
	(0.0140)	(0.0175)	(0.0227)	(0.0211)	(0.0199)
ext.laws.G4	-0.0418***	-0.0279**	-0.0236	-0.00658	0.00852
	(0.0130)	(0.0136)	(0.0176)	(0.0257)	(0.0239)
ext.laws.G4*Prodctvt	-0.00105	-0.000841	-0.00140	-0.00230	-0.00474
	(0.00422)	(0.00415)	(0.00684)	(0.00794)	(0.00784)
Productivity	-0.651***	-0.659***	-0.664***	-0.666***	-0.670***
	(0.103)	(0.103)	(0.102)	(0.101)	(0.100)
Kyoto	-0.169***	-0.171***	-0.162***	-0.157***	-0.159***
	(0.0349)	(0.0348)	(0.0347)	(0.0349)	(0.0352)
Constant	-6.244***	-6.268***	-6.241***	-6.318***	-6.408***
	(1.037)	(1.036)	(1.032)	(1.033)	(1.035)
Observations	4,171	4,171	4,171	4,171	4,171

Table C1 estimates the same specification as in table 6, with the addition of a dummy for all initial Kyoto protocol annex 1 countries between 2008 and 2012. * p< 0.05, ** p< 0.01, *** p< 0.001. Control variables were used, but omitted from the table for brevity. All regressions have country fixed effects and year by income-group fixed effects. Errors were clustered by year-group. Robust errors are displayed in parenthesis.

Table C2: Including Kyoto Protocol Annex 1 Dummy, Countries that Ratified

	log emissions				
VARIABLES	(1)	(2)	(3)	(4)	(5)
Law	-0.0544*	-0.0153	-0.0158	-0.0178	-0.0203
	(0.0298)	(0.0230)	(0.0237)	(0.0237)	(0.0234)
Law*Productivity	0.0762	-0.000299	0.00103	0.00445	0.00778
	(0.0470)	(0.0315)	(0.0329)	(0.0329)	(0.0319)
ext.laws.G1	0.0340**	0.0219	0.0397**	0.0460***	0.0367**
	(0.0164)	(0.0150)	(0.0153)	(0.0170)	(0.0156)
ext.laws.G1*Prodctvt	-0.00290	0.00212	-0.00325	-0.00380	-0.00107
	(0.00488)	(0.00478)	(0.00641)	(0.00556)	(0.00591)
ext.laws.G2	0.0389***	0.0271*	0.0150	0.00717	0.00161
	(0.0107)	(0.0140)	(0.0174)	(0.0169)	(0.0151)
ext.laws.G2*Prodctvt	-0.00621	-0.00878	-0.00602	-0.00265	-0.00549
	(0.00639)	(0.00686)	(0.00725)	(0.00700)	(0.00586)
ext.laws.G3	-0.00915	0.0134	0.0263	0.0363	0.0496*
	(0.0149)	(0.0172)	(0.0225)	(0.0261)	(0.0255)
ext.laws.G3*Prodctvt	0.00174	-0.000277	0.00395	-0.00435	-0.00681
	(0.0139)	(0.0173)	(0.0226)	(0.0210)	(0.0201)
ext.laws.G4	-0.0412***	-0.0277**	-0.0233	-0.00650	0.00799
	(0.0131)	(0.0136)	(0.0176)	(0.0256)	(0.0238)
ext.laws.G4*Prodctvt	-0.00141	-0.00140	-0.00218	-0.00278	-0.00471
	(0.00424)	(0.00415)	(0.00687)	(0.00795)	(0.00789)
Productivity	-0.656***	-0.665***	-0.670***	-0.671***	-0.676***
	(0.103)	(0.103)	(0.102)	(0.101)	(0.100)
Kyoto	-0.170***	-0.172***	-0.162***	-0.156***	-0.157***
	(0.0309)	(0.0306)	(0.0309)	(0.0302)	(0.0300)
Constant	-6.181***	-6.201***	-6.174***	-6.256***	-6.338***
	(1.028)	(1.027)	(1.024)	(1.025)	(1.027)
Observations	4,171	4,171	4,171	4,171	4,171

Table C2 estimates the same specification as in table 6, with the addition of a dummy for ratified Kyoto protocol annex 1 countries between 2008 and 2012. * p< 0.05, ** p< 0.01, *** p< 0.001. Control variables were used, but omitted from the table for brevity. All regressions have country fixed effects and year by income-group fixed effects. Errors were clustered by year-group. Robust errors are displayed in parenthesis.

Table C3: Foreign Regulation, without law effectiveness adjustment

	log emissions				
VARIABLES	(1)	(2)	(3)	(4)	(5)
ext.laws.G1	0.0196	0.0254*	0.0456***	0.0525***	0.0466***
	(0.0163)	(0.0133)	(0.0137)	(0.0165)	(0.0151)
ext.laws.G2	0.0353***	0.0276**	0.0160	0.00441	0.00176
	(0.0109)	(0.0136)	(0.0172)	(0.0172)	(0.0146)
ext.laws.G3	-0.00614	0.0154	0.0264	0.0381	0.0528*
	(0.0139)	(0.0171)	(0.0227)	(0.0211)	(0.0202)
ext.laws.G4	-0.0319**	-0.0283**	-0.0246	-0.00694	0.00490
	(0.0128)	(0.0132)	(0.0169)	(0.0252)	(0.0236)
Observations	4171	4171	4171	4171	4171

Table C4: Foreign Regulation, using Kaufmann's GEE

	log emissions				
VARIABLES	(1)	(2)	(3)	(4)	(5)
ext.laws.G1	0.0250**	0.0129	0.0178**	0.0214***	0.0266***
	(0.0121)	(0.00886)	(0.00819)	(0.00746)	(0.00834)
ext.laws.G2	0.0333***	0.0353***	0.0313***	0.0269**	0.0314***
	(0.00825)	(0.00772)	(0.00875)	(0.0105)	(0.0117)
ext.laws.G3	0.00742	0.00682	0.0134	0.0103	0.0162
	(0.0115)	(0.0127)	(0.0168)	(0.0165)	(0.0157)
ext.laws.G4	-0.0417***	-0.0321*	-0.0297	0.0123	0.0157
	(0.00989)	(0.0164)	(0.0279)	(0.0183)	(0.0150)
Observations	2156	2156	2156	2156	2156

Table C3 did not adjust for laws effectiveness. Table C4 adjusted for effectiveness by using Kaufmann's GEE (Data available only from 1996). Column (1) uses the same period's law, while columns (2)-(5) use regulations from periods $t-1$ to $t-4$ respectively. * p< 0.05, ** p< 0.01, *** p< 0.001. Control variables, productivity, interactions of productivity with measure of law and a constant term were used, but omitted from the table for brevity. All regressions have country fixed effects and year by income-group fixed effects. Errors were clustered by year-group. Robust errors are displayed in parenthesis.

In order to distinguish which laws are meant to mitigate, we use two of the variables from the LSE/GRICCE: *type of framework* and *type of response*. We defined a law as having some degree of mitigation if either the framework or the response have the word 'mitigation.' Thus, the regulations that are not exclusively meant to adapt to damages, will be considered to be *mitigation laws*.

Table C5: Foreign Mitigating Regulations

	log emissions				
VARIABLES	(1)	(2)	(3)	(4)	(5)
ext.laws.G1	0.0541*	0.0645**	0.0737***	0.0956***	0.0845***
	(0.0282)	(0.0269)	(0.0214)	(0.0281)	(0.0269)
ext.laws.G2	0.0316	0.0416	0.0419	0.0293	0.0126
	(0.0253)	(0.0298)	(0.0284)	(0.0291)	(0.0243)
ext.laws.G3	-0.0508	0.0328	0.0820	-0.00724	0.0716
	(0.0448)	(0.0564)	(0.0562)	(0.0604)	(0.0708)
ext.laws.G4	-0.0869**	-0.0465**	-0.0222	-0.0130	-0.0413
	(0.0412)	(0.0213)	(0.0353)	(0.0633)	(0.0596)
Observations	4171	4171	4171	4171	4171

Table C6: Foreign Regulation Dummy

	log emissions				
VARIABLES	(1)	(2)	(3)	(4)	(5)
ext.laws.G1	0.0560**	0.0534**	0.0858***	0.102***	0.0899***
	(0.0280)	(0.0239)	(0.0268)	(0.0314)	(0.0310)
ext.laws.G2	0.0801***	0.0709***	0.0501*	0.0529*	0.0311
	(0.0204)	(0.0254)	(0.0276)	(0.0280)	(0.0260)
ext.laws.G3	-0.000589	0.0252	0.0555	0.0587	0.0764**
	(0.0305)	(0.0298)	(0.0348)	(0.0364)	(0.0346)
ext.laws.G4	-0.0668***	-0.0288	-0.0142	0.00361	0.0167
	(0.0201)	(0.0257)	(0.0255)	(0.0323)	(0.0276)
Observations	4171	4171	4171	4171	4171

In table C5, laws are the total number of mitigating regulations in a country and year. In table C6, laws is a dummy indicating whether there was any regulation. Column (1) uses the same period's law, while columns (2)-(5) use regulations from periods $t-1$ to $t-4$ respectively. Laws were adjusted for effectiveness by our CLE. * p< 0.05, ** p< 0.01, *** p< 0.001. Control variables, productivity, interactions of productivity with measure of law and a constant term were used, but omitted from the table for brevity. All regressions have country fixed effects and year by income-group fixed effects. Errors were clustered by year-group. Robust errors are displayed in parenthesis.

Table C7: Post Cold-War era

	log emissions				
VARIABLES	(1)	(2)	(3)	(4)	(5)
ext.laws.G1	0.0304**	0.0188**	0.0270***	0.0293***	0.0361***
	(0.0135)	(0.00936)	(0.00892)	(0.00830)	(0.0104)
ext.laws.G2	0.0359***	0.0377***	0.0342***	0.0296**	0.0346***
	(0.00838)	(0.00754)	(0.00961)	(0.0115)	(0.0124)
ext.laws.G3	-0.00249	0.00284	0.00935	0.00855	0.0165
	(0.0128)	(0.0137)	(0.0181)	(0.0178)	(0.0168)
ext.laws.G4	-0.0392***	-0.0296*	-0.0253	0.0160	0.0200
	(0.0106)	(0.0156)	(0.0267)	(0.0178)	(0.0144)
Observations	2512	2512	2512	2512	2512

Table C7 is restricted to observations after 1992. The rest of the specifications are identical to those in table 6. * p< 0.05, ** p< 0.01, *** p< 0.001. Control variables, productivity, interactions of productivity with measure of law and a constant term were used, but omitted from the table for brevity. All regressions have country fixed effects and year by income-group fixed effects. Errors were clustered by year-group. Robust errors are displayed in parenthesis.

Table C8: GDP divided by Labor Force as an Alternative Measure of Productivity

	log emissions				
VARIABLES	(1)	(2)	(3)	(4)	(5)
ext.laws.G1	0.114***	0.0442***	0.0597***	0.0601***	0.0524***
	(0.0219)	(0.0140)	(0.0127)	(0.0183)	(0.0174)
ext.laws.G2	0.0368***	0.0198	0.0164	0.00704	0.00294
	(0.0106)	(0.0129)	(0.0146)	(0.0137)	(0.0131)
ext.laws.G3	-0.0409**	0.00830	0.0222	0.0246	0.0232
	(0.0169)	(0.0187)	(0.0225)	(0.0278)	(0.0344)
ext.laws.G4	-0.0814***	-0.0125	-0.0127	-0.0386*	-0.0477*
	(0.0156)	(0.0155)	(0.0195)	(0.0199)	(0.0259)
Observations	5288	5288	5288	5288	5288

Table C9: Not Controlling for Productivity

	log emissions				
VARIABLES	(1)	(2)	(3)	(4)	(5)
ext.laws.G1	0.0155	0.0301**	0.0466***	0.0504***	0.0426***
	(0.0119)	(0.0135)	(0.0128)	(0.0167)	(0.0151)
ext.laws.G2	0.0269**	0.0194	0.0143	0.00973	0.00456
	(0.0105)	(0.0139)	(0.0167)	(0.0173)	(0.0147)
ext.laws.G3	-0.0277	-0.00440	0.00179	-0.000654	-8.45e-05
	(0.0170)	(0.0184)	(0.0232)	(0.0296)	(0.0356)
ext.laws.G4	-0.0226**	-0.00505	-0.00341	-0.0291	-0.0375
	(0.0106)	(0.0160)	(0.0205)	(0.0219)	(0.0292)
Observations	5614	5614	5614	5614	5614

In table C8, we used the GDP per worker as a measure for productivity. In table C9, we did not control for productivity. The rest of the variables are identical to those in table 6. Column (1) uses the same period's law, while columns (2)-(5) use regulations from periods $t-1$ to $t-4$ respectively. Laws were adjusted for effectiveness by our CLE. * $p< 0.05$, ** $p< 0.01$, *** $p< 0.001$. Control variables, productivity, interactions of productivity with measure of law and a constant term were used, but omitted from the table for brevity. All regressions have country fixed effects and year by income-group fixed effects. Errors were clustered by year-group. Robust errors are displayed in parenthesis.

Table C10: HDI quartiles to define groups

	log emissions				
VARIABLES	(1)	(2)	(3)	(4)	(5)
ext.laws.G1	-0.0102	0.00842	0.0200	0.0150	0.0228
	(0.0139)	(0.0134)	(0.0129)	(0.0148)	(0.0152)
ext.laws.G2	0.0307*	0.0497**	0.0494*	0.0443	0.0183
	(0.0162)	(0.0235)	(0.0259)	(0.0303)	(0.0296)
ext.laws.G3	-0.0545***	-0.0321**	-0.0167	-0.0105	0.000609
	(0.0145)	(0.0160)	(0.0178)	(0.0269)	(0.0299)
ext.laws.G4	0.0242	0.0156	0.0157	0.0771	0.0946**
	(0.0274)	(0.0305)	(0.0384)	(0.0529)	(0.0449)
Observations	4171	4171	4171	4171	4171

In table C10, we used the HDI's quartiles to define groups; and, as expected, G2 becomes the most relevant since there are top HDI countries that have an industry too small to have an impact on global production. Some example of such countries are Argentina, Chile, Taiwan and Singapore. In addition, due to the absebse of data, we duplicated the HDI before 1990, thus assuming that countries do not change group before 1990. Column (1) uses the same period's law, while columns (2)-(5) use regulations from periods $t-1$ to $t-4$ respectively. Laws were adjusted for effectiveness by our CLE. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Control variables, productivity, interactions of productivity with measure of law and a constant term were used, but omitted from the table for brevity. All regressions have country fixed effects and year by income-group fixed effects. Errors were clustered by year-group. Robust errors are displayed in parenthesis.

To study the effect of a continuous version of table 6, we code a variable that measures the interaction of foreign laws and foreign GDP as follows:

$$ext.lawsbyIncome_{i,t} = \sum_{j \neq i} law_{j,t} \times log(GDP_{j,t}) \tag{4}$$

Table C11: A Continuous Version of the Foreingn Law by GDP per-capita Interaction

	log emissions				
VARIABLES	(1)	(2)	(3)	(4)	(5)
ext.lawsbyIncome t	0.0100	0.0117			
	(0.0115)	(0.0115)			
ext.lawsbyIncome $t-1$	0.00117		0.00164**		
	(0.000794)		(0.000791)		
ext.lawsbyIncome $t-2$	0.00180**			0.00219**	
	(0.000881)			(0.000880)	
ext.lawsbyIncome $t-3$	0.00193*				0.00244**
	(0.00104)				(0.00107)
ext.lawsbyIncome $t-4$	0.00211**				
	(0.000995)				
Observations	4171	4171	4171	4171	4171

Table C11 presents an alternative continuous version of the interaction of laws and GDP per capita, defined on equation (4). The rest of the variables are identical to those in table 6. Column (1) uses the current period's foreign laws as well as lags up to four years. Columns (2)-(5) present the isolated effects of laws from period t to $t-3$ respectively. Laws were adjusted for effectiveness by our CLE. * p< 0.05, ** p< 0.01, *** p< 0.001. Control variables, productivity, and a constant term were used, but omitted from the table for brevity. All regressions have country fixed effects and year by income-group fixed effects. Errors were clustered by year-group. Robust errors are displayed in parenthesis.

Table C11 shows how the interaction of more laws and higher GDP per capita increase the emissions of the average country.