

Political Economy Determinants of Carbon Pricing

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Abstract

Carbon pricing is widely considered a key policy instrument for achieving substantial climate change mitigation. However, implementation remains patchy and price levels vary significantly across countries and regions. In this article, we analyze the structural social, political, and economic conditions under which carbon prices have been implemented so far. We estimate a Tobit regression model to investigate variations in explicit carbon prices over 262 national and subnational jurisdictions. Our results highlight well-governed institutions and public attitudes as the most important conditions for carbon pricing and characterize fossil fuel consumption as a barrier to the implementation of carbon prices. The results suggest that governance and public attitude need to be integrated into political economy analysis. Policy makers should take regulatory capacities and public attitudes seriously when designing carbon pricing policies.

The level of ambition in efforts to reduce greenhouse gas (GHG) emissions and the choice of instruments to achieve them vary greatly across countries. Instruments include policies such as research subsidies and financial support for renewable energies or vehicle performance standards and coal exit policies. There has long been a broad consensus among climate economists that carbon pricing, implemented as a carbon tax, an emissions trading system (ETS), or a hybrid system combining features of both (Wood and Jotzo 2011), should be a core part of the climate policy instrument mix. A carbon price is often regarded as the economically most efficient mitigation policy, as it provides the flexibility to achieve reductions in GHG emissions in the least costly manner across all economic sectors and regions (Intergovernmental Panel on Climate Change 2014; Stiglitz and Stern 2017). Given the substantial costs of decarbonizing the global economy, efficiency will be an essential requirement to sustain political feasibility and minimize distributional conflicts. The carbon price level and trajectory can be chosen either to reflect the social costs of carbon of GHG emissions or to line up with specific targets over time, for example, those required to achieve the objective of the Paris Agreement, that is, keeping temperature rise well below 2°C (Stiglitz and Stern 2017). Companion policies such as subsidies, standards, or incentives for research and development can address specific shortcomings of carbon pricing such as consumer shortsightedness (Blasch et al.

2019), government commitment problems (Kalkuhl et al. 2019), or externalities in knowledge production (Jaffe et al. 2005). It has also been argued that introducing technology policies can help remove barriers to the implementation of significant carbon pricing over time (Meckling et al. 2017; Pahle et al. 2018).

Despite this, many countries refrain from implementing carbon prices, and where they are introduced, price levels vary greatly from just a few US cents to more than US\$ 100 (Metivier and Postic 2018; Narassimhan et al. 2017). This lack of political will to price carbon coincides with a broader lack of climate policy stringency that threatens the achievement of the climate goals agreed upon in the Paris Agreement. We therefore analyze the political economy conditions that determine the stringency of climate policy implemented by means of carbon pricing.

Political economy theory, explaining the successful implementation of a given policy, can address the *characteristics* of the policy itself, the *dynamics* of the political process in which the process is negotiated, and the social-political *structure* of the jurisdiction in which this process occurs (Karapin 2016). Structural conditions are important, as they provide the broader economic, political, and cultural environment in which political processes unfold and policies are implemented (or not).

To better understand the political economy conditions for implementing carbon pricing, we synthesize existing theoretical explanations relevant for the introduction of carbon prices from the current literature and test them empirically with a Tobit regression model. We then offer a more detailed qualitative discussion of the main factors emerging from the quantitative analysis, public belief, and governance and draw conclusions for research and policy.

Our analysis is not restricted to nation-states but also examines subnational jurisdictions, as more than one-third of all carbon pricing schemes have been implemented at the subnational level in US states, Canadian provinces, and Chinese provinces. We therefore investigate political economy conditions in 262 national and subnational jurisdictions (167 nations and 95 subnational jurisdictions), covering more than 99 percent of the world's population. We consider both carbon prices that are implemented as carbon taxes as well as those that are implemented in the form of ETS. While the former define fixed price levels and allow the market to determine the volumes of carbon emissions, the latter cap the volumes of emissions and allow the market to determine the resulting price levels. We do not differentiate between prices from taxes or ETS, because they are economically equivalent in terms of mitigation potential and economic burden. Moreover, it is empirically difficult to disentangle these two forms, because many jurisdictions use ETS as well as carbon taxes in different economic sectors, or even implement hybrid policy schemes that exhibit characteristics of both policies (such as an ETS with a fixed price corridor) (Narassimhan et al. 2017).

As the dependent variable, we therefore examine the average carbon prices provided by the World Bank, converted into US dollars and weighted by the

share of the emissions they cover. The resulting weighted price levels are displayed in Figure 1 (see below for explanation of method). They demonstrate a wide variation, ranging from zero in most jurisdictions (white) to US\$ 53 in Sweden (dark green). As data on some of the political conditions (particularly on public attitude to climate change) were not available in time series format, we needed to restrict our analysis to cross-sectional data. Hence our quantitative analysis is not able to infer causality and should be regarded as an exploration of the correlates of carbon prices that helps to examine different hypotheses regarding the political determinants of carbon prices. It also does not investigate the influence of process factors, such as appropriate sequencing or framing strategies. A further limitation of our approach is that we do not account for the influence of specific policy characteristics, which are often very case specific and hard to quantify. This is particularly true for the variety of revenue recycling mechanisms that are expected to have a substantial impact on the likelihood of policy implementation (Klenert et al. 2018; Murray and Rivers 2015; Rabe 2018).

Theory: Political Economy Determinants of Climate Policy

In this section, we develop several hypotheses concerning structural determinants for the adoption and level of carbon prices, which we derive from surveying the existing literature on the political economy of climate policy. Our hypotheses relate to both different domestic interests and the different domestic political institutions that aggregate those interests (Hiscox 2011).

Variation in Domestic Interest

There are two fundamental opposing interests in climate policy. On one hand, there is a spatially and temporally dispersed interest in avoiding the adverse consequences of climate change. On the other hand, there are well-organized actors that benefit from the continued use of fossil fuels and other sources of greenhouse gases.

Many scholars argue that a country's public interest in climate change mitigation primarily depends on its level of economic development (Fankhauser et al. 2015; Lachapelle and Paterson 2013; Edenhofer et al. 2018). According to this argument, long-term and global environmental concerns are prioritized only when basic economic needs are satisfied. Low-carbon energy technologies and a new infrastructure are often hard to afford for poorer countries (Jakob and Steckel 2016). It is also often argued that the low level of cumulative historical greenhouse gas emissions emitted by low-income countries entitles them to use a higher proportion of the remaining global carbon budget to satisfy their development needs (Kartha et al. 2018). Hence we expect countries with advanced economic development to be more likely to implement substantial carbon prices.

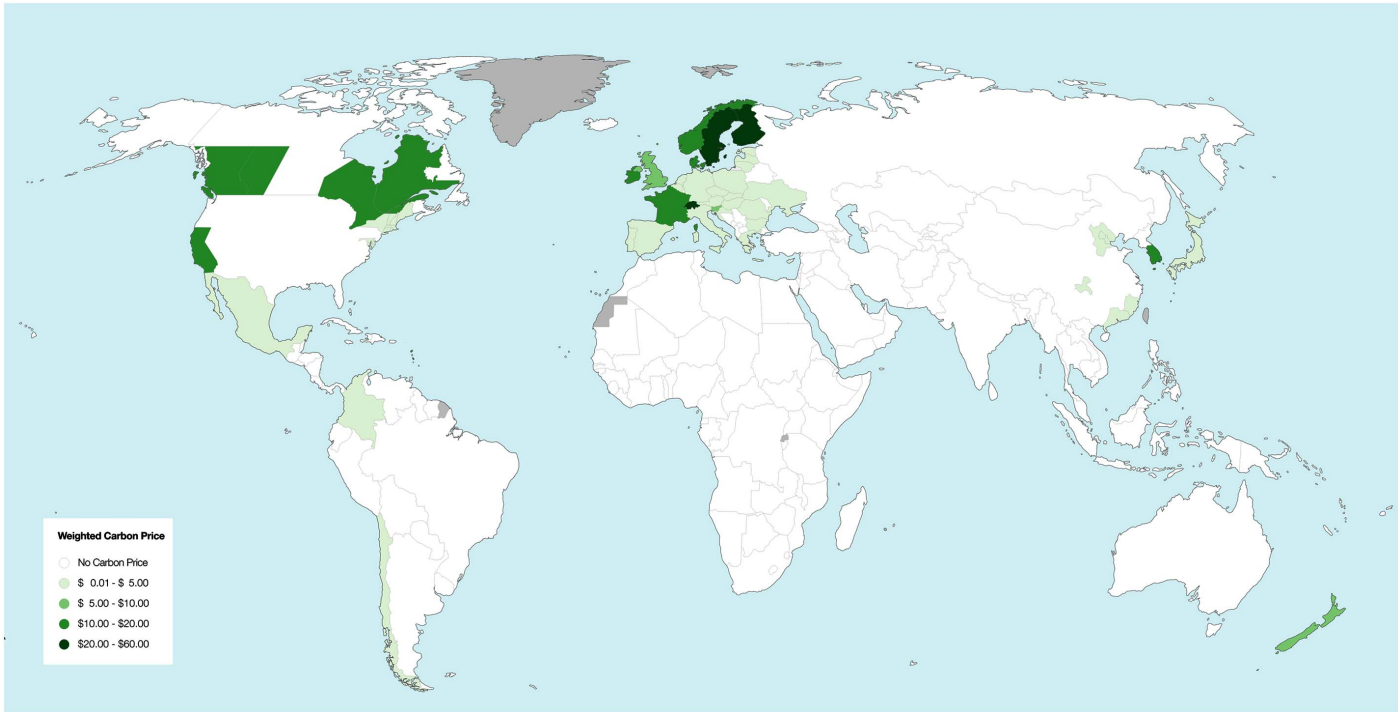


Figure 1
Geographical Distribution of Carbon Prices

Missing data displayed in gray.

Another factor that influences the public interest in climate protection is belief in anthropogenic climate change. Citizens will only have an interest in mitigating GHG if they believe (see Table 1) that climate change exists, that it is the result of anthropogenic greenhouse gas emissions, and that it has adverse impacts on their lives (Drews and van den Bergh 2016; Rabe 2018). Despite the available scientific evidence of anthropogenic global warming, a large proportion of the global population still casts substantial doubt on the human contribution to climate change (Ray and Pugliese 2011; Pelham 2009). Also, in the United States and Europe, only half of the population believes that climate change is mainly due to human agency (Marquart-Pyatt et al. 2019; Marlon et al. 2018). The degree of outright dismissive climate denialism is much lower in Europe than in the United States. However, between 38 percent (Austria) and 68 percent (Poland) of the European population are doubtful about the degree of anthropogenic climate change and believe that global warming is caused naturally or equally by natural processes and human activities (European Social Survey 2018). Such doubts about the human influence on global warming are a fundamental obstacle for stringent climate policy because people doubtful about anthropogenic climate change are unlikely to support costly policies (Millner and Ollivier 2015). Moreover, the attitude of the general public is itself a good proxy for the attitude of the political decision makers. In late 2018, the presidents of both the United States and Russia cast doubt over the existence of human-induced climate change and hence refrain from supporting stringent climate policy such as carbon pricing. Overall, we therefore expect greater public belief in anthropogenic climate change to be associated with more widespread implementation of carbon prices and higher price levels.

Concerns about local air pollution may also support the implementation of carbon prices (McCollum et al. 2013). Carbon pricing will work toward reducing fossil fuel combustion in electricity production or transport and related emission of air pollutants. Yielding cobenefits for local air pollution may facilitate the organization of political support for carbon pricing (Bollen et al. 2009). On the other hand, countries that have already adopted ambitious climate policy may already experience lower levels of air pollution as a result. Hence the correlation between air pollution and carbon prices could be positive, negative, or neutral.

Despite the general public interest in climate change mitigation, both the broader public and special interest groups benefit from continued carbon emissions. Given the high carbon content of cheaply available coal, oil, and gas, fossil fuel energy users as well as industries engaged in the production and use of fossil resources, and related energy services face increased costs from substantial carbon prices. The related concentrated and often well-organized groups such as extractive industries in coal and oil, power plant operators, or traditional automobile producers and related unions can be expected to be among the most vocal groups lobbying against climate policy (Biber et al. 2017; Lachapelle and Paterson 2013; Rabe 2018; Dolphin et al. 2019). Moreover, the financial

burden of climate change mitigation might be an important argument against carbon pricing. If a jurisdiction's energy production leads to high CO₂ emissions, consumers and industries might be more likely to oppose carbon prices (Jenkins 2014). We therefore expect that countries with a high use of fossil fuels will implement lower carbon prices due to concerns over societal costs and lobbying by fossil interest groups.

The Role of Political Institutions

The costs of climate policy tend to be concentrated, while gains tend to be dispersed. Hence many political scientists argue that political institutions favoring broad public interest over concentrated special interests should enable more ambitious climate policy. It is thus expected that democracies are more likely to pass climate change legislation than autocracies (Biber et al. 2017; Fankhauser et al. 2015; Lachapelle and Paterson 2013). We hypothesize that democratic countries will adopt carbon prices more often and will generate higher price levels.

Among democracies, countries that have proportional election systems are considered to be more likely to pass climate legislation, because proportional election systems increase the probability of smaller ecological and left-leaning parties with strong climate change agendas being represented in parliament and government (Karapin 2016). We therefore expect that it is more likely for these countries to implement carbon pricing.

Karapin also argues that a high concentration of power in the executive branch of government decreases the number of veto points and therefore makes strong government intervention in favor of climate policy more likely (Karapin 2016). On the other hand, separation of power and federalism can also provide multiple pathways over which more stringent climate policy can be realized (Biber et al. 2017). We therefore include the level of political concentration in our analysis but do not hypothesize in which direction the level of political concentration will influence the implementation of carbon prices.

Furthermore, for several reasons, good governance is very important for successful climate policy. First, implementing carbon pricing systems is very complex, and they require political institutions equipped with sufficient technical and economic expertise to be designed, implemented, and administered (Joas and Flachsland 2015; Jotzo and Lösche 2014; Karapin 2016; Rabe 2018). Second, well-governed institutions are less prone to corruption and hence can be expected to better serve the public interest (Rafaty 2018). Third, climate change is an environmental dilemma unfolding over a very long time horizon. As in all collective action dilemmas, trust in institutions is fundamental to enable sustained cooperation in order to preserve the resource at stake (Carattini et al. 2015; Ostrom 2014; Smith and Mayer 2018). For all these reasons, we expect that countries with better institutions will adopt more stringent carbon pricing.

Table 1

The Political Economy of Carbon Pricing

	<i>Condition</i>	<i>Expected Relationship to Carbon Price</i>	<i>Causal Mechanism</i>	<i>Operationalization</i>
Interests	Level of economic development	+	Satisfied basic needs increase public interest for environmental protection; greater historical emissions imply a higher responsibility for climate change mitigation (Fankhauser et al. 2015; Lachapelle and Paterson 2013)	Gross Domestic Product (GDP) per capita (World Bank 2017a)
	Public belief in human-made climate change	+	Increased public support for costly climate change policies due to awareness of benefits (Biber et al. 2017; Carlsson et al. 2012; Rabe 2018)	% of population believing in human-made climate change (Ray and Pugliese 2011; Pelham 2009)
	Level of air pollution	±	High level of air pollution creates additional demand for emission reduction policies, but countries with ambitious climate policies likely display lower air pollution (Bollen et al. 2009)	Mean ambient air pollution of particulate matter with an aerodynamic diameter of 2.5 µm or less (PM _{2.5}) (World Health Organization 2017)

Institutions	Fossil fuel combustion	-	Stronger lobby groups against climate policy and higher costs of climate policy (Biber et al. 2017; Lachapelle and Paterson 2013; Rabe 2018)	% of electricity produced from coal and oil (World Bank 2015)
	Energy-intensive industries	-		% of GDP produced in industry sector (World Bank 2017b)
	Level of democracy	+	Preferential aggregation of dispersed interest for environmental protection over to concentrated interest in pollution (Lachapelle and Paterson 2013)	Polity IV index (Marshall et al. 2017)
	Proportional voting system	+	Smaller ecological parties are more likely to be influential in countries with proportional voting (Karapin 2016)	Proportional or majoritarian voting system (PARLINE 2017)
	Concentration of political power	±	Higher concentration of power can facilitate ecological intervention by decreasing number of veto points (Karapin 2016), but separation of power can also provide multiple pathways over which climate	POLCON index (Wharton School 2017)

Table 1
(Continued)

<i>Condition</i>	<i>Expected Relationship to Carbon Price</i>	<i>Causal Mechanism</i>	<i>Operationalization</i>
Good governance	+	policy could be strengthened (Biber, Kelsey, and Meckling 2017) Capacity for sophisticated climate policy, absence of corruption (Karapin 2016; Rafaty 2018; Rabe 2018)	World Governance Indicators (World Bank 2017b)
Multilevel governance	+	Multiple pathways for change (Dorsch and Flachslan 2017; Rabe 2018)	Part of Chinese Pilot ETS, part of EU ETS

Multilevel regional governance may also increase the likelihood of the implementation of climate policies, because it opens an additional channel for potential policy change and a wide range of bargaining and compensation channels among jurisdictions with differing climate policy preferences (Dorsch and Flachsland 2017; Rabe 2018). Jointly implementing harmonized climate policy in multiple jurisdictions also reduces concerns over carbon leakage and competitiveness with respect to close neighbors between whom trade intensity tends to be high (Pahle et al. 2018). Since multilevel governance regimes are very diverse and, in varying forms and degrees, a universal feature of virtually all jurisdictions today, we do not systematically investigate the influence of such structures in general. Having said that, we conceptualize these in our analysis as governance arrangements that have implemented carbon pricing in several subordinated jurisdictions. This has only occurred in the case of the European Union (EU) ETS and the Chinese Pilot ETS where a carbon pricing scheme was introduced top-down by the higher-level unit in the multilevel governance scheme, rather than from the individual units that are part of the scheme. We control for the existence of these two arrangements and discuss how controlling for those regimes affects our results.¹

Table 1 summarizes our hypotheses and their operationalization for our empirical analysis (for a detailed discussion, see Methods).

An Empirical Political Economy Model

For our empirical analysis, we assembled data on all countries with a population of more than 500,000, except Rwanda and Western Sahara, for which most of the data were not available. For countries where carbon prices have been implemented at the subnational level, we included these entities rather than the nation-state. This was the case for the United States, Canada, and China. We also incorporated all countries of the EU rather than the EU itself, as these lower-level entities are able to implement their own carbon prices. In total, our analysis features 262 observations from 167 nation-states and 95 subnational jurisdictions.

Operationalization of Variables

Data Sources and Operationalization

For measuring carbon prices, we used the data provided by the Carbon Pricing Dashboard from the World Bank (2017a) as updated on April 1, 2017. The carbon price of all jurisdictions without a carbon pricing scheme was set to zero.

1. At the time of publication, Canada had also implemented a nationwide multilevel carbon pricing scheme supplementing the carbon prices of its subnational jurisdictions. However, given that we use an older data set, we do not control for the Canadian multilevel system in this analysis.



Figure 2
Weighted and Nominal Carbon Prices

Prices for jurisdictions not displayed are zero.

For all other jurisdictions, we calculated a weighted carbon price from the nominal average price per ton of CO₂ in US\$ multiplied by the share of emissions that are covered by this price in the respective jurisdiction. If a country had implemented multiple prices for CO₂, those prices were combined into a single score based on the share of national CO₂ emissions they covered. Figure 2 provides a visual representation of nominal and and weighted carbon prices per country.

We also provide a table containing the nominal and weighted prices in our Supplemental Information (SI; see Table S3 here: https://www.mitpressjournals.org/doi/suppl/10.1162/glep_a_00549). For example, in Denmark, the EU ETS covers 36 percent of the country's CO₂ emissions, and the Danish carbon tax covers another 40 percent. As the ETS price was US\$ 4.99 in April 2017 and the Danish carbon tax US\$ 24.78, we calculate the weighted carbon price as follows:

$$P_w = P_1 * c_1 + P_2 * c_2$$

$$P_{w_{\text{Denmark}}} = (\text{US\$ } 4.99 * 0.36) + (\text{US\$ } 24.78 * 0.4) = \text{US\$ } 11.71.$$

We natural log-transformed the weighted carbon price for our model estimation. This substantially increases the model fit, which indicates that the relationship between our political economy conditions and carbon prices is more accurately described by a logarithmic rather than a linear relationship (see SI, Table S9). We also fitted a model using untransformed carbon prices as a robustness check and found that our main insights remain robust (see SI, Table S9).

We used data for the year 2015 from the World Bank for most of our national-level variables. Moreover, we used data from Gallup for public belief in climate change, WHO for air pollution, PolityIV for democracy, and POLCON for political concentration. Table S1 in the SI provides details on operationalization of all variables for both national and subnational variables.

Missing Values

We used multiple imputation techniques to estimate missing values to minimize the bias that could arise from excluding observations with one or more missing values. These observations are often small, low-income countries and therefore exhibit characteristics that could be systematically related to the specific value which is expected to obtain (see SI, section 5 for details). Therefore multiple imputation is the appropriate strategy to deal with missing observations (Kang 2013). As a robustness check, we also specified a model using

case-wise deletion instead of multiple imputation and found no major differences between the two model estimations (see SI, Table S9).

Specification of the Statistical Model

We used a cross-sectional Tobit model for our statistical analysis because Tobit models are particularly suited to describe data in which many observations are censored at a value of zero. Furthermore, we decided to use a cross-sectional analysis rather than a time series analysis, because we are primarily interested in structural factors that often differ significantly across sections but change little over time. Such effects can be underestimated or even completely obscured when using fixed effects in time series regression models. Furthermore, worldwide time series data are not available for several variables of interest, particularly public opinion on climate change.

The Tobit model is a regression model developed by Tobin (1958) to describe the relationship between one or multiple independent predictors and a non-negative dependent variable that is censored, meaning that all the observations of the dependent variable that lie below a certain threshold only display the value of this threshold. Often this threshold is zero. The model thereby assumes a latent variable γ^* that equals the observed values if the observed values are above the threshold t . Below t , the latent variable is unobservable:

$$\begin{aligned}\gamma_i &= \gamma^*_i \text{ if } \gamma^*_i > t \\ \gamma_i &= t \text{ if } \gamma^*_i \leq t.\end{aligned}$$

The latent variable again depends on the predictor x_i via a linear parameter and an error term u_i :

$$\gamma^* = x_i + u_i.$$

The standard Tobit model operates under the assumption of normality and homoskedasticity of the underlying latent variable model. Because we could not fully satisfy these assumptions with our carbon pricing data, we used a heteroskedastic Tobit model that also allows for conditional heteroskedasticity and non-normal distributions (see SI, Figures S1 and S2). We assumed a logistic distribution and tested the model specification by generating and examining quantile residuals (Dunn and Smyth 1996). Moreover, we also generated a standard Tobit model as a robustness test to compare model quality and model results. We found that the heteroskedastic censored regression model returns the best model quality and that the magnitude of coefficients and the levels of statistical significance stay robust for our main results, with only a little variation across distributional assumptions.

When reporting our results, we focused on the linear parameter (the Tobit coefficient), which estimates the linear increase in the latent variable. Since the latent variable equals the observed variable for $y_i > t = 0$, it also describes the linear increase for the observed variable if $y_i > t = 0$. The Tobit coefficient β thereby estimates the linear increase in carbon prices for all observations that already have a carbon price in place, hence where the likelihood of being uncensored is 1.

To avoid multicollinearity, we calculated the cross-correlation coefficients of our independent variables and excluded those combinations of variables that correlate by more than 0.75 (see SI, Table S4). Moreover, we conducted a variance inflation factor (VIF) test for each model specification (see SI, Table S5). The variable *Democracy* produced a VIF of around 9. Therefore we excluded the variable from the central model. However, as displayed in model specification 3, including democracy does not substantially affect the results for the other variables.

Results and Analysis

For better interpretation, we converted the coefficient so that it shows the expected percentage changes in the (untransformed) carbon prices for every unit increase of the independent variable. The associated percentage changes are displayed in Figure 3.

Table 2 displays the Tobit coefficients, the respective levels of significance and standard errors, and model qualities for different specifications. Model 1 describes our central model, which we believe most accurately captures relevant determinants for implementing carbon prices and influencing price levels. Model 2 includes air pollution, model 3 includes democracy, and model 4 incorporates political concentration and type of voting system. In model 5, we used per capita emissions as an alternative measure for fossil fuel combustion, while in models 6 and 7, we exchanged the good governance indicator *Regulatory Control* with *Government Effectiveness* and *Corruption Control*. Model 8 excludes our dummy variables. We found the main results, reported for the case of multiple imputation of missing data, to be robust to the exclusion of observations with missing values as well as to the exclusion of outliers and to different distributional assumptions of the Tobit model (see SI, Table S9). Figure 3 visually summarizes the results of the most important variables.

The Relationships Between Domestic Interests and Carbon Prices

Contrary to our expectations, we find that GDP per capita and carbon price levels are not correlated in most model specifications and even negatively correlated in some specifications. One explanation is that GDP per capita correlates highly with good governance and public belief in anthropogenic climate change. If these variables are included, GDP per capita does not contribute to higher carbon prices.

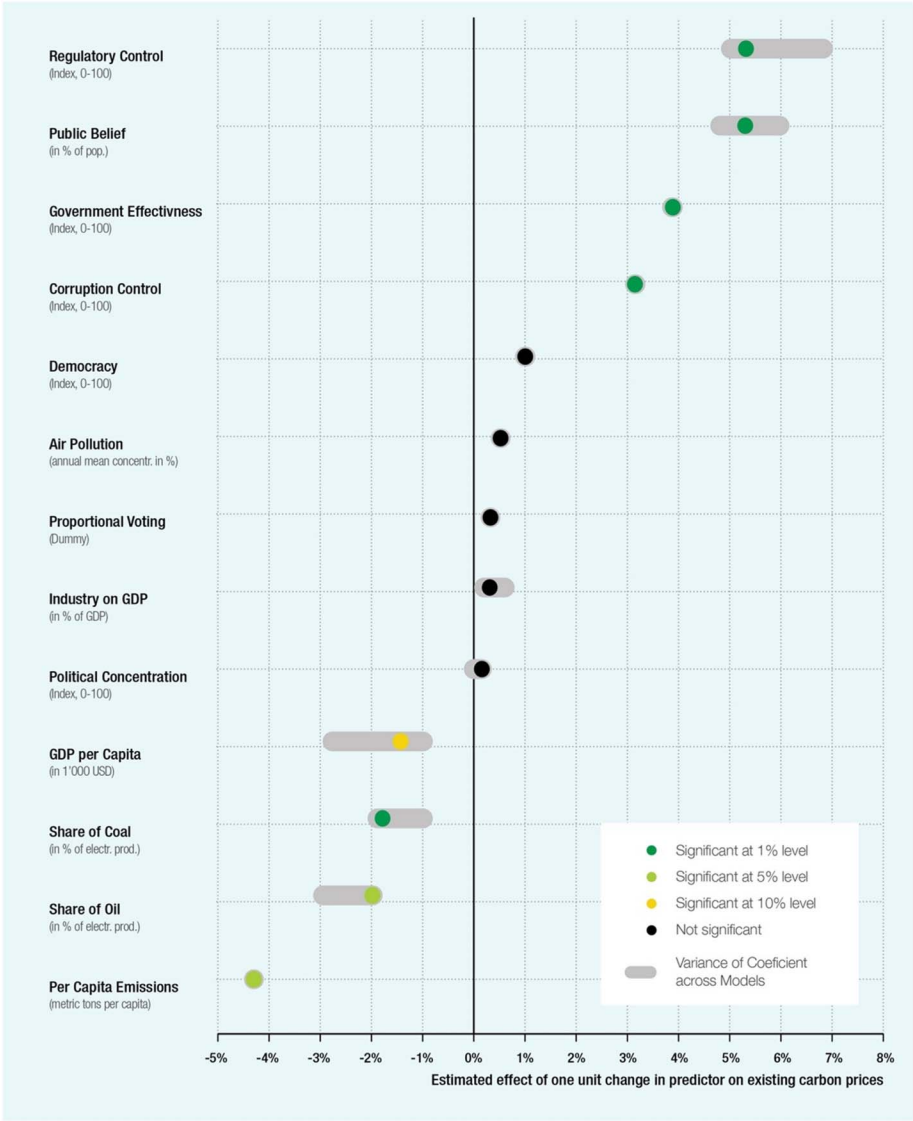


Figure 3
 Estimated Percentage Change of Carbon Prices for Every Unit Increase in the Independent Variables

The position on the horizontal axis indicates the back-transformed Tobit coefficient so that it displays the expected percentage change in carbon prices for every unit increase in the independent variables. The gray stripes indicate the variance of the coefficient across model variations. The colors indicate their respective statistical significance in the central model.

Table 2
Regression Results

<i>Variable</i>	<i>1: Central model</i>	<i>2: With air poll.</i>	<i>3: With democracy</i>	<i>4: With poll. variables</i>	<i>5: Alt. carbon</i>	<i>6: Gov. effect.</i>	<i>7: Corrup. cntrl.</i>	<i>8: Without dummies</i>
<i>GDP Per Capita</i>	-0.014* (0.008)	-0.017* (0.008)	-0.014* (0.008)	-0.013 (0.008)	-0.006 (0.007)	-0.01 (0.008)	-0.009 (0.007)	-0.028** (0.011)
<i>Public Belief (%)</i>	0.052*** (0.012)	0.052*** (0.012)	0.05*** (0.012)	0.052*** (0.012)	0.047*** (0.013)	0.05*** (0.012)	0.052*** (0.012)	0.058*** (0.015)
<i>Level of Air Pollution</i>		0.005 (0.011)						
<i>Coal in Electricity Generation (%)</i>	-0.018*** (0.005)	-0.019*** (0.005)	-0.018*** (0.005)	-0.018*** (0.005)		-0.016*** (0.005)	-0.015*** (0.005)	-0.01 (0.006)
<i>Oil in Electricity Production (%)</i>	-0.02** (0.008)	-0.02** (0.009)	-0.02** (0.008)	-0.021** (0.009)		-0.02** (0.009)	-0.02** (0.009)	-0.03* (0.015)
<i>Industry on GDP (%)</i>	0.003 (0.013)	0.002 (0.013)	0.006 (0.013)	0.003 (0.013)		0.003 (0.013)	0.004 (0.012)	0.024 (0.015)
<i>Per Capita Emissions</i>					-0.044** (0.022)			
<i>Democracy</i>			0.01 (0.012)					
<i>Proportional Voting System</i>				0.003 (0.003)				
<i>Concentration of Political Power</i>				0.002 (0.011)				

Table 2
(Continued)

Variable	1: Central model	2: With air poll.	3: With democracy	4: With poll. variables	5: Alt. carbon	6: Gov. effect.	7: Corrup. cntrl.	8: Without dummies
Regulatory Control	0.052*** (0.014)	0.059*** (0.015)	0.049*** (0.014)	0.053*** (0.014)	0.057*** (0.015)			0.066*** (0.017)
Government Effectiveness						0.038*** (0.013)		
Corruption Control							0.031*** (0.009)	
EUETS	0.021*** (0.003)	0.021*** (0.003)	0.021*** (0.003)	0.02*** (0.003)	0.019*** (0.003)	0.022*** (0.003)	0.023*** (0.003)	
CNETS	0.044*** (0.007)	0.043*** (0.007)	0.051*** (0.011)	0.046*** (0.007)	0.039*** (0.006)	0.036*** (0.006)	0.035*** (0.006)	
No. observations	262	262	262	262	262	262	262	262
Log-likelihood	-112.34	-110.55	-111.92	-111.56	-117.87	-115.7	-114.7	-167.98

Censored regression model on log-transformed weighted carbon price in US\$. Values in brackets indicate standard errors.

*** $p < .01$. ** $p < .05$. * $p < .01$.

We find a strong positive association between public belief and carbon prices that is highly statistically significant and consistent across all considered model specifications. Together with good governance, public belief is the most important codeterminant of high carbon prices. For each additional percentage point of the population believing in human-made climate change, carbon prices increase, on average, by 5.3 percent. With a change in public belief from its minimum (Tajikistan with 7%) to its maximum (Japan with 86%), expected carbon prices increase almost fiftyfold (4,991%). To our knowledge, this is the first study that finds a significant association between the level of public belief in anthropogenic climate change and the stringency of climate change policy implemented across the world. The causal effect may be partially the reverse, in the sense that proactive governments influence the domestic salience of climate change and hence public belief. However, the literature on climate change attitudes suggests that public belief depends on a wide range of other factors, such as worldviews, access to public communications, and situational cues (Hornsey et al. 2016). Moreover, qualitative research on the political economy of carbon prices suggests that public belief in anthropogenic climate change has an independent effect on climate policy (see Discussion below).

Also in line with our expectations, we observe a negative and statistically significant association between fossil fuel combustion and carbon prices. For each additional percentage point of electricity produced from coal and oil, carbon prices decrease by 1.8 percent and 2 percent, respectively. If coal in the electricity mix increases from its minimum of 0 percent to its maximum of 95.8 percent (Botswana), associated carbon prices decrease by 82 percent. Likewise, if the share of oil in electricity production increases from its minimum of 0 percent to its maximum of 100 percent (the Canadian province of Nunavut), carbon prices decrease by 86.5 percent. The correlation with industry in GDP was close to zero and statistically insignificant. We also tested a model that uses per capita emissions as a measure for fossil fuel usage and found a negative and statistically significant relationship. Each additional ton of CO₂ emitted per capita corresponds to a decrease of 4.3 percent in carbon prices. Carbon prices decreased by more than 99 percent when per capita emissions changed from their minimum (Burundi with 0.04 tons) to their maximum (the US-American state of Wyoming with 108.2 tons). Part of the correlation between fossil fuel combustion and carbon pricing may result from reverse causality because a higher carbon price can expect to reduce fossil fuels in electricity production. Finally, we observed the correlation between air pollution (model 2) and carbon prices to be positive but very small and statistically insignificant.

The Relationships Between Domestic Political Institutions and Carbon Prices

Democracy is positively associated with carbon prices, but its coefficient is small and statistically insignificant. It correlates highly with good GDP per capita,

regulatory control, and public belief in climate change, which is why we have not included democracy in our central model.

Regulatory control is quantitatively the most important factor in our model. A 1-point increase in regulatory control corresponds to an increase in weighted carbon prices of roughly 5.3 percent. If regulatory control changes from its minimum (North Korea with 3.4) to its maximum (Singapore with 93.6), carbon prices are expected to increase about 100-fold (10,631%).

When considering multilevel governance schemes, our analysis returns substantively large and highly significant coefficients for the EU ETS and the Chinese Pilot ETS. The variables accounting for the inclusion of a country or province in the EU ETS or the Chinese Pilot ETS give rise to increases in the effective carbon price by about 7 and 50 times, respectively. The relationship between carbon prices and the Chinese Pilot ETS system is much larger than the relationship with the EU ETS, because carbon pricing in most countries in the EU ETS is already well explained by other variables in the model. In contrast, the Chinese provinces are more deviant cases, demonstrating how they would have very likely not adopted carbon pricing schemes if it had not been required by the Chinese national government (Jotzo and Löschel 2014; Stensdal 2014). If we do not control for being part of the EU ETS or the Chinese Pilot ETS, the association of coal in electricity production and carbon prices diminishes. This occurs because several countries in the EU ETS and most Chinese provinces have a carbon price despite their heavy reliance on coal. Once we stop controlling for them being part of a multilevel governance arrangement, their elevated use of coal influences the model's relationship between coal and carbon prices. For instance, some heavy coal users, such as Poland, Estonia, Bulgaria, Germany, and the Czech Republic, had significant carbon prices imposed by the EU ETS—often against their initial opposition. Likewise, several Chinese jurisdictions are affected by the carbon price implemented by the Chinese national government. This suggests that a multilevel governance scheme can be an important tool to promote climate policy, not least in jurisdictions with unfavorable conditions.

Concerning the correlation of carbon prices with electoral systems, the difference between proportional and majoritarian voting systems was highly insignificant and close to zero (model 4). The level of political concentration was also close to zero and statistically insignificant.

Robustness Checks

We ran several robustness checks in which we applied different sampling techniques, model specifications, and distributional assumptions to our model and found that our results are highly robust to all distributional assumptions and vary only a little with different sampling techniques (see SI, Table S9).

When estimating a model with untransformed carbon prices, the model quality in terms of log-likelihood decreases substantially, which indicates that the relationship between our political economy conditions and carbon prices is more accurately described by a logarithmic rather than a linear relationship. However, most statistical significances and relative coefficient magnitudes remain robust (see SI, Table S9). Moreover, our main results remain robust to the exclusion of observations with missing values, to the exclusion of outliers and different distributional assumptions (see SI, Table S9). We also ran a model with national-level observations alone as a robustness test. In this model, regulatory control, public belief, and coal combustion remained robust. The share of oil in electricity lost its statistical significance but continued to be negatively correlated with carbon prices (see SI, Table S9).

Discussion

Our quantitative analysis highlights that public belief in human-made climate change and good governance is particularly strongly associated with higher carbon prices. This observation adds to qualitative analyses that have also found these factors to have influenced carbon pricing policies in many jurisdictions. In this section, we draw on qualitative analyses to discuss how public belief and good governance have led to the particularly high national carbon prices in Sweden, Finland, and Switzerland, as well as in the subnational jurisdictions of the United States, Canada, and China. We also briefly discuss the relationship between fossil fuel combustion and carbon pricing.

Attitudes on Climate Change Inform Political Preferences of Both the Public and Political Decision Makers

Many studies have found public belief in human-made climate change to be a fundamental prerequisite for public support of more costly climate policies, such as carbon pricing (Rhodes et al. 2017; Kotchen et al. 2017). Rabe (2018, 85–88) argues that growing concern over climate change and other environmental risk has paved the way for the substantial carbon pricing in the Nordic states, such as Sweden and Norway. Likewise, Krange et al. (2019) argue that an “Eco modern consensus” has emerged among the majority of the Norwegian population, which in turn has enabled political support for substantial carbon prices. A similar case is made for Switzerland by Brönnimann et al. (2014), who argues that strong belief in human-made climate change among the Swiss population has generated substantial support for climate change policy. He argued that the concern for and belief in climate change has been stimulated by Switzerland’s unique topographic setting with mountain regions and lowlands on both sides of the Alpine ridge, in which the Swiss people experience both direct climate change impacts, such as retreating glaciers, and its adverse impact on tourism and water management. Rabe (2018, 22–24) argues that public belief

in human-made climate change has also been a fundamental condition for substantial carbon prices at the US state level. Karapin (2016) agrees and concludes that ambitious climate policy depends on whether the public perceives climate change as being a “large enough” problem. Comparing subnational climate policies across the United States and Canada, Lachapelle et al. (2012) suggest that different levels in public attitude on climate change might be related to the different levels of climate policies in the Canadian provinces and US states. Likewise, Stensdal (2014) argues that the belief in climate change has also played a substantial role in the formulation of Chinese climate policy. Although Chinese citizens’ beliefs may not be as influential as the beliefs of citizens are in US states, Stensdal discusses how Chinese policy elites have “learned” about climate change through a discourse coalition consisting of international NGOs and scientists.

Lack of Actual and Perceived Good Governance as a Fundamental Obstacle to Carbon Pricing

Our quantitative analysis suggests that good governance is strongly associated with substantial carbon prices. The jurisdictions with the highest carbon prices in the world, such as Sweden, Finland, and Switzerland, rank among the top ten countries in terms of the World Bank’s governance indicators. We observed the relationship between regulatory control and carbon prices to be robust across a range of alternative governance indicators, such as government effectiveness and absence of corruption. These three governance indicators correlate strongly with each other, which makes it hard to identify, from our regression analysis alone, which specific indicator has a causal effect on high carbon prices. It is therefore hard to say, for example, whether it is the perception of corruption, the lack of technical capacity, or the absence of independent institutions that makes the implementation of carbon prices more likely and increases their expected price level. The available qualitative research suggests that all three governance indicators influence the ability of a jurisdiction to successfully implement carbon prices.

Although administrative capacity might not be critical for implementing carbon prices as a simple tax on fossil fuels, it might be more relevant when designing sophisticated ETS. In his discussion of carbon pricing in the United States and around the world, Rabe (2018, 200–203) argues that the technical capacity to design and implement cap-and-trade schemes may also determine whether it succeeds or fails over time. He argues that the establishment of an ETS in the US states forming part of the Regional Greenhouse Gas Initiative required sophisticated management that was only possible because the multistate network could draw on an “unusually deep and established body of policy professionals and government institutions with previous expertise in many core functions.” He notes that cap-and-trade implementation in California was very labor intensive and complex, in part because the design of the scheme was “riddled

with conflicts” (Rabe 2018, 202). It only worked because the California Air Resource Board (CARB) could draw on much expertise and a generous base of resources and staff. Karapin (2016) agrees with Rabe’s assessment, arguing that the administrative capacity has been among the most influential structural conditions for implementing emission trading. Lo (2016) argues that it is exactly the lack of such resources that poses a substantial challenge to the implementation of the current Chinese ETS. Incomplete regulatory infrastructures for monitoring, reporting, and verification, as well as a lack of transparency and enforcement, present profound challenges to the Chinese ETS.

Lo also argues that the lack of independence of political pressures constitutes the second political challenge for the Chinese ETS. Government interference in prices risks preventing such prices being passed to consumers by regulated electricity companies, which would cause the price signal to disappear (Teng et al. 2014; Lo 2016). According to Meckling and Nahm (2018), this independence from political pressure is the second important causal pathway from good governance to carbon pricing. They argue that independence of state bureaucracy from political pressures has facilitated ambitious carbon pricing in California.

Finally, perceived corruption and the lack of trust in political institutions are often found to be obstacles to carbon pricing. Polls among Americans, Swedes, and the Swiss population show that support for carbon pricing is highly related to the trust people have in their government to implement policies that are effectively mitigating climate change. Thereby, both the general trust in politicians (Jagers et al. 2010; Carattini et al. 2015; Smith and Mayer 2018) and trust in the effectiveness of carbon prices are observed to have an impact on public support (Huber et al. 2019; Carattini et al. 2017; Smith and Mayer 2018). In his qualitative analysis of carbon pricing schemes in US states, Karapin found that public confidence in government agencies, such as CARB or the New York State Energy Research and Development Authority, made ambitious climate policy possible. When the public does not trust politicians to implement carbon prices that effectively protect the environment, the schemes may be perceived as elite projects conducted by corrupt politicians at the expense of the general population (Lockwood 2018). The lack of trust in political institutions, perceived environmental ineffectiveness, and perceived regressive impacts have sparked popular resistance Yellow Vest protesters against the recent French carbon tax proposal (Kimmelman 2018; Douenne and Fabre 2019). Likewise, the perception that the carbon tax is an ineffective policy that puts a burden on ordinary people has also been the reason why the newly elected premier Doug Ford retracted the carbon tax in Ontario in 2018 (Lachapelle and Kiss 2019).

Fossil Fuel Reliance Influences Popular and Interest-Based Opposition Against Carbon Prices

Finally, we observe that jurisdictions with lower proportions of fossil fuel combustion tend to implement higher carbon prices. One limitation of a cross-sectional

analysis is that we cannot exclude the possibility of reverse causality. Hence a reduction in fossil fuel usage may partly result from the price signal introduced by the carbon price. However, both theory and existing qualitative research suggest that fossil fuel–intense economic activities may be an obstacle to carbon pricing that would cause economic costs to increase and potentially give rise to interest group opposition. Polls suggest that even in Sweden, people are concerned about the economic burden of carbon prices and prefer lower carbon prices even when the revenues generated are redistributed (Jagers et al. 2019). Rabe (2018) also considers economic costs to be an obstacle for the implementation of the Swedish and Finnish carbon prices and argued that they were only implemented because the government negotiated industry exceptions. The introduction of the Swiss carbon tax was also accompanied by concerns over economic costs. For quite some time, implementation was stalled in a deadlock between a pro-economy coalition, formed by right-wing parties and industry, and a pro-environment coalition (Ingold and Varone 2012). This deadlock was eventually overcome through the introduction of a limited CO₂ tax that only covered heating and process fuels, with a smaller “climate penny” on motor fuels (Ingold 2011). The tax rate was initially set low and subsequently raised, while many industrial groups were excluded from the tax. Rabe (2018, 13–20) also concludes that concerns over economic costs are among the most important factors making American politicians reluctant to implement carbon prices at the federal level.

It is interesting to note, however, that even though industry is opposed to the economic costs resulting from ambitious climate policy, there is evidence that they would prefer carbon pricing over other regulatory tools (Meckling 2011). This may also explain why we did not observe a correlation between the share of industry in GDP and carbon prices.

Conclusions: Good Governance and Public Belief as Fundamental Conditions for Climate Policy

We find that substantial carbon prices are primarily implemented in jurisdictions featuring well-governed political institutions and a population aware of the human causes of global warming. We also observe that carbon prices are less frequently implemented in jurisdictions that use a high proportion of fossil fuels to generate electricity. Moreover, multilevel governance may offer pathways to introduce carbon pricing in jurisdictions with otherwise unfavorable conditions. To our knowledge, our analysis is the first study that finds quantitative evidence for a strong relationship between public belief and ambitious climate policy. Our finding that good governance is strongly related to carbon pricing is consistent with recent results generated in panel analyses of the political economy determinants of carbon pricing (Dolphin et al. 2019; Rafaty 2018).

As noted in the introduction, our cross-sectional approach alone does not allow us to infer a causal relationship between public belief and carbon pricing.

For further research, we therefore suggest collecting time series data on public attitudes on climate change in a larger number of countries and conducting panel analyses that include this crucial factor. Moreover, to substantiate quantitative evidence with qualitative insights, we recommend conducting further qualitative case studies on carbon pricing in non-Organisation for Economic Co-operation and Development countries, which are currently underrepresented in the literature.

As practical implications resulting from our work, we suggest strengthening efforts to enhance public understanding in jurisdictions with little belief in anthropogenic climate change and to pursue government capacity building. The World Bank, for example, has been advancing initiatives like the Partnership for Market Readiness for several years. In the meantime, the design of carbon pricing policies should be sensitive to the regulatory capacities and public attitudes of the jurisdictions in which they are scheduled to be implemented. This means that jurisdictions with limited institutional capacities might consider implementing carbon taxes rather than an ETS, since implementing the former has been observed to involve fewer administrative complexities (Rabe 2018). Moreover, putting additional effort into communicating the way in which carbon taxes mitigate climate change might increase public support. Likewise, adequate and visible revenue recycling may prevent the perception of carbon taxes as being an elite project that disproportionately affects the poor (Carattini et al. 2018; Carattini et al. 2019; Drews and van den Bergh 2016). Finally, given that high carbon prices provoke opposition from the public and interest groups alike, it might be useful to start with moderate carbon prices and targeted industry exemptions and then increase the price level and coverage over time (Pahle et al. 2018).

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