Regulatory Hybridity and Decarbonization: When Does “Better Regulation” Reduce CO_2 Emissions Intensity?

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Abstract

Regulatory quality is widely promoted as “better regulation” that improves competitiveness and government effectiveness. Public administration scholarship, however, has paid less attention to when market-friendly regulatory reforms translate into progress on societal grand challenges such as decarbonization. We conceptualize regulatory quality as a hybrid package that bundles (1) credible enforcement and policy commitment, which can strengthen environmental compliance and reduce carbon intensity, and (2) market-enabling streamlining, which can expand output and offset environmental gains. We test these countervailing mechanisms in a global country–year panel (1995–2022), combining the World Governance Indicators’ regulatory quality index with World Development Indicators data on CO2 emissions per unit of GDP. Country fixed-effects models with standard controls show modest average associations and strong heterogeneity. Apparent high-income advantages largely reflect differences in energy mix and economic structure. Regime type conditions translation: regulatory quality improvements are associated with lower CO_2 intensity in democracies, but not in non-democracies once fundamentals are held constant. The findings caution against one-size-fits-all “better regulation” templates and specify the governance conditions under which regulatory reforms are more likely to yield climate-relevant performance.

Keywords: regulatory governance | regulatory quality | better regulation | decarbonization | CO_2 emissions intensity | regime type

Evidence for Practice

• Improvements in regulatory quality are associated with lower CO_2 intensity primarily in democracies; in non-democracies the association fades once energy mix and economic structure are taken into account.

• Generic “better regulation” toolkits are not climate policy. Pair process reforms with climate-specific rules and credible enforcement capacity if decarbonization is the goal.

• Streamlining that lowers business frictions can increase output scale. Climate gains are more likely when regulatory reforms are coordinated with energy transition and industrial upgrading.

• International advisors should tailor regulatory-quality prescriptions to local administrative capacity and political incentives, and monitor the composition of reform (enforcement versus streamlining), not only formal adoption.

Introduction

Regulatory reform has become a staple of contemporary governance. Across OECD principles, EU guidance, and international development programs, governments are encouraged to adopt “better regulation” practices—streamlining administrative procedures, improving transparency, and increasing predictability—to strengthen competitiveness and state effectiveness (OECD 2005; European Commission 2001; Radaelli and Meuwese 2009; Zhang 2010).

In public administration, these reforms sit alongside the state’s responsibility to manage externalities and safeguard the public interest (Hood et al. 2000; James 2000). The tension is especially acute for climate change and decarbonization—an archetypal societal grand challenge that requires sustained policy commitment, credible enforcement, and cross-sector coordination (Dietz et al. 2003; Ferraro et al. 2015; George et al. 2016). A core question is therefore not whether regulation is "better" in general, but when market-friendly regulatory reforms translate into climate-relevant performance.

We argue that the answer depends on regulatory hybridity. Contemporary regulatory "quality" bundles at least two latent components. An enforcement and credible-commitment component increases clarity, reduces discretion, and raises expected compliance—mechanisms that can lower CO2 emissions per unit of output. A market-enabling component reduces business frictions (e.g., faster permits, simpler entry rules), potentially expanding activity and energy demand and offsetting environmental gains (Levi-Faur 2006; Lodge and Wegrich 2012; Nielsen and Parker 2009). Because widely used governance indicators bundle these elements, the net effect of improvements in measured regulatory quality on decarbonization is theoretically indeterminate.

We describe this context dependence as regulatory refraction: a globally diffused reform script ("better regulation") passes through domestic political and administrative institutions and is recombined into different packages of enforcement, discretion, and market facilitation (Hood 1998; Kirkpatrick 2014). Refraction implies that similar-looking improvements in regulatory quality can have different environmental consequences across countries.

These arguments motivate three hypotheses:

H1: The effect of regulatory quality on CO2 intensity is more negative in high-income countries than in low- and middle-income countries.

H2: The effect of regulatory quality on CO2 intensity is more negative in democracies than in non-democracies.

H3: When regulatory-quality improvements mainly ease market entry and streamline procedures—without credible enforcement or feasible abatement—the marginal effect on CO2 intensity can be small, null, or positive.

Our analysis complements a small quantitative literature on regulatory quality and CO2 emissions (Addai et al. 2023; Baloch and Wang 2019; Gani 2012; Halkos and Tzeremes 2013), which has typically relied on restricted country sets or small samples and has rarely unpacked what "regulatory quality" represents in practice.

We test H1–H3 using a global country–year panel (1995–2022) linking the World Governance Indicators' regulatory quality index to CO2 emissions intensity. We estimate country fixed-effects models with standard controls and examine heterogeneity across income groups and regime types (QoG). Average effects are modest and context-dependent: apparent high-income advantages largely disappear once energy mix and economic structure are accounted for. Regime type, however, conditions translation—improvements in regulatory quality are robustly associated with lower CO2 intensity in democracies, but become statistically indistinguishable from zero in non-democracies after conditioning on fundamentals. We contribute to public administration debates on regulatory governance, policy transfer, and administrative capacity by unpacking “regulatory quality” as a hybrid bundle and specifying where market-friendly reforms are more likely to deliver climate-relevant performance.

Regulatory Hybridity, Regulatory Quality, and Environmental Performance

Regulation occupies a central place in public administration theory because it is one of the state’s primary tools for steering markets and protecting the public interest. Classic accounts justify regulation as a corrective to market failures and rent-seeking (Pigou 1932; James 2000; Hantke-Domas 2003). Competing accounts emphasize government failure, capture, and distributive politics—highlighting how regulatory processes can be shaped by concentrated interests (Coase 1960; Stigler 1971; Becker 1983). These perspectives are useful for climate governance because they imply that “stronger” regulation can mean stronger enforcement, but also greater influence of market actors over the design and implementation of rules.

Empirically, contemporary governance has not moved toward “less regulation” in any straightforward sense. Instead, many states have expanded rule-based steering while reorienting regulatory practice toward market compatibility and performance management—developments often described as the regulatory state and regulatory capitalism (Moran 2002, 2003; Braithwaite 2008; Levi-Faur 2005).

The “better regulation” agenda institutionalized this orientation through process-focused reforms such as transparency and predictability, alongside efforts to reduce unnecessary burdens on business (Radaelli and Meuwese 2009; Lodge and Wegrich 2012). This produces regulatory hybridity: regulators combine deterrence and cooperation, and blend public-interest goals with market-enabling logics (Levi-Faur 2006; Nielsen and Parker 2009; Six 2013).

For environmental performance, hybridity implies a built-in tradeoff. Credible enforcement and commitment can increase compliance with pollution rules and strengthen incentives to invest in abatement, reducing emissions per unit of output. At the same time, market-enabling streamlining can expand activity and energy demand, potentially offsetting intensity gains. This ambiguity motivates our focus on regulatory quality as an observed bundle and our use of heterogeneity tests to identify where “better regulation” is more likely to translate into decarbonization outcomes.

Regulatory Best Practice and Measurement

International organizations have codified regulatory “best practice” into standards and diagnostics. OECD principles and EU guidance emphasize transparency, proportionality, and burden reduction, while widely used governance indicators operationalize a similar private-sector enabling orientation (OECD 2005; European Commission 2001; Kaufmann et al. 2011).

These templates travel easily, but their effects may not. Research on regulatory reform and policy transfer cautions that reforms designed in high-capacity settings can misfire when administrative capabilities, political incentives, and economic structures differ (Hood 1998; Zhang 2010; Kirkpatrick 2014). For climate policy, such misfit matters because decarbonization requires both credible enforcement and feasible technological and sectoral pathways.

We leverage this insight by treating the WGI regulatory-quality measure not as a single “good governance” attribute but as an observed bundle whose components are likely weighted differently across contexts. The next section formalizes the two-channel mechanism and derives testable implications for when improvements in regulatory quality are more likely to reduce CO2 emissions intensity.

Theory, Data, and Methods

Political and Economic Mechanisms

We interpret the observed 'regulatory quality' index (q) as a bundle with two latent channels. An enforcement/credibility channel raises expected compliance and reduces emission intensity; while a market-enabling streamlining component - simpler entry, faster permits and lower business frictions - expands output scale. Our analysis (of course) is centered on the question of whether in striving towards an ideal that is acutely business-friendly or neoliberal, this regulatory framework enhances compliance in relation to decarbonization goals, as well as stimulating business activity.

The net effect on CO_2 intensity (I) is, therefore, the balance of a negative (enforcement) and a potentially positive (scale) force, refracted by (i) economic structure and energy mix (marginal abatement costs and baseline intensity) and (ii) political institutions (responsiveness, capture and the composition of q). Let baseline (unabated) emissions per unit output be $\bar{\iota}(\phi, m)$, where ϕ summarizes marginal abatement costs and m the energy mix; with abatement a and output Y,

$$I \equiv \frac{E}{Y} = \bar{\iota}(\phi, m) - \frac{a}{Y}.$$

Regulatory quality mixes two latent components, $q_e = \alpha q$ (enforcement) and $q_b = (1-\alpha)q$ (market-enabling), with composition $\alpha \in [0,1]$ varying by context. Effective stringency is amplified or diluted by the political-administrative medium (capacity $s > 0$, democratic responsiveness $\pi \in [0,1]$, capture $\kappa \in [0,1]$, and optional dilution $\theta \geq 0$):

$$S(q) = s\pi[(1-\kappa)\alpha - \theta(1-\alpha)]q.$$

Given S, firms choose abatement $a^*(S, \phi)$ with $a_S^* > 0$, while marketisation can raise scale $Y = Y_0\Lambda(q_b)$ with $\Lambda'(\cdot) \geq 0$. Combining these yields a sign decomposition for the marginal effect of q on intensity:

$$\frac{\partial I}{\partial q} = - \underbrace{\frac{a_S^*(S,\phi)}{Y_0\Lambda((1-\alpha)q)}\frac{\partial S}{\partial q}}_{\text{enforcement/credibility channel (reduces } I \text{)}} + \underbrace{\frac{a^*(S,\phi)\Lambda'((1-\alpha)q)}{Y_0\Lambda((1-\alpha)q)^2}(1-\alpha)}_{\text{marketisation/scale channel (can raise } I \text{)}}.$$

A formal derivation and propositions appear in Appendix A.

Next, H1, H2 and H3 are restated in terms of our model (where “effect” means the marginal effect $\partial I/\partial q$):

- **H1 (development heterogeneity).** The effect of regulatory quality on CO_2 intensity is *more negative* in high-income countries than in low/middle-income countries.

- **H2 (regime heterogeneity).** The effect of regulatory quality on CO_2 intensity is *more negative* in democracies than in non-democracies.

- **H3 (implementation-conditional).** Reductions in CO_2 intensity require that improvements in regulatory quality be accompanied by credible enforcement and feasible abatement; absent these—especially when reforms mainly ease entry and streamline processes that expand output—-the marginal effect on CO_2 intensity might be small or null.

We evaluate H1-H3 using cohort-split fixed-effects regressions (income and regime cohorts; Tables 2-3); the full derivation and propositions are given in Appendix A.

As an improvement, Appendix A.5 considers a special case in which output also responds to enforcement/abatement. If one wishes to express enforcement' s suppression of scale, include

$$Y(q) = Y_0 \cdot \Lambda(q_b) \cdot \Psi(S(q)), \Psi'(\cdot) \leq 0$$

so stronger enforcement S further compresses output (via compliance burdens or exit of backward capacity). This adds an additional negative term to dI/dq and, therefore, strengthens the emission-reducing effect of the enforcement channel relative to the baseline case $Y(q) = Y_0\Lambda(q_b)$.

Data

Our analysis uses a 1995-2022 panel (1995 marks the earliest World Governance Indicator coverage for regulatory quality). Development indicators are obtained from the World Bank[1], while regime type (democracy vs. non-democracy) and additional covariates are sourced from the Quality of Government (QoG) Institute[2].

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[1] https://wdi.worldbank.org/.

[2] The QoG Institute (University of Gothenburg) compiles several databases from other sources. We use the QoG Standard dataset: https://qog.pol.gu.se/data/datadownloads/qogstandarddata.

Our dependent variable is the *intensity* of CO_2 emissions— 'Carbon dioxide emissions (kg per 2015 US$ of GDP)' (World Development Indicators (WDI) code EN.ATM.CO2E.KD.GD). For the regressions, we rescale the series to 'kg per 2015 100 US$ of GDP' to avoid excessive leading zeros (descriptive statistics below are shown in the original world development indicator (WDI) units). The WDI reports nitrous oxide and $PM_{2.5}$ series, but we focus on CO_2 as the primary GHG component.[3]

Regulatory quality is the World Bank World Governance Indicator (WGI) 'regulatory quality' index, which 'captures perceptions of the ability of government to formulate and implement sound policies and regulations that permit and promote private-sector development' (Kaufmann et al. 2011, 223). The index aggregates information on issues such as competition and trade regimes, investment climate, regulatory burdens, price controls, and entry/start-up rules. Its private-sector orientation allows us to ask whether a 'best practice' agenda infused with neoliberal assumptions is appropriate in delivering decarbonization.

Following common practice, we include controls for income and growth (GDP per capita, constant 2015 US$) and GDP growth (annual %); economic structure, Industry (including construction), value added (% of GDP) and agriculture, forestry, and fishing, value added (% of GDP); urbanization (Urban population (% of total)); forest cover (forest area (% of land area)); energy composition (electricity from fossil sources; and renewable energy consumption); and education (government expenditure on education (GDP %) (Golley and Meng 2012; Shafiei and Salim 2014; Shahbaz et al. 2014; Werf et al. 2009; Zhang et al. 2017). Descriptive statistics appear in Table 1.

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[3] See https://data.worldbank.org/indicator for the full set of environmental indicators. For EN.ATM.CO2E.KD.GD, see https://data.worldbank.org/indicator/EN.ATM.CO2E.KD.GD.

Table 1: Variables, descriptive statistics and sources

Variable	N	Mean	Median	SD	Min	Max
Carbon dioxide emissions (kg per 2015 US$ of GDP)	6791	0.5522	0.3767	0.6845	0.0000	14.2074
Regulatory quality	4516	-0.0654	-0.1822	0.9867	-2.5477	2.2522
GDP per capita (constant 2015 US$)	5216	1.27E+04	4515.4544	2.00E+04	209.9115	2.29E+05
Agriculture, forestry, and fishing, value added (% of GDP)	6691	11.5196	8.2100	10.6176	0.0115	79.0424
Industry (including construction), value added (% of GDP)	4934	26.8351	24.9020	12.1005	2.3908	92.7639
GDP growth rate (annual %)	5247	3.6774	3.7630	6.5670	-58.3182	153.4926
Urban population (% of total)	5348	55.8628	56.2985	23.3688	7.2110	100
Forest area (% of land area)	5145	32.9567	31.4390	24.4944	0.0000	98.4567
Electricity production from oil, gas and coal sources (% of total)	6736	63.9539	69.5663	31.5484	0.0000	100.0000
Renewable energy consumption (% of total final energy consumption)	5149	33.2418	24.1000	30.1717	0.0000	98.3000
Government expenditure on education, total (% of GDP)	3592	4.4214	4.2389	1.8873	0.0000	15.8635
Government expenditure on education, total (% of government expenditure)	3273	14.4240	13.8001	4.9385	1.7047	44.8018

Empirical Strategy

We estimate cohort-split panel regressions using country fixed effects (FE). A Hausman test guides the RE vs. FE choice (Hausman 1978); we adopt FE throughout. Our baseline specification is

$$y_{it} = c + \beta\,\mathrm{rqe}_{it} + \boldsymbol{\lambda}^{\top}\mathbf{x}_{it} + \alpha_t + \xi_i + u_{it},$$

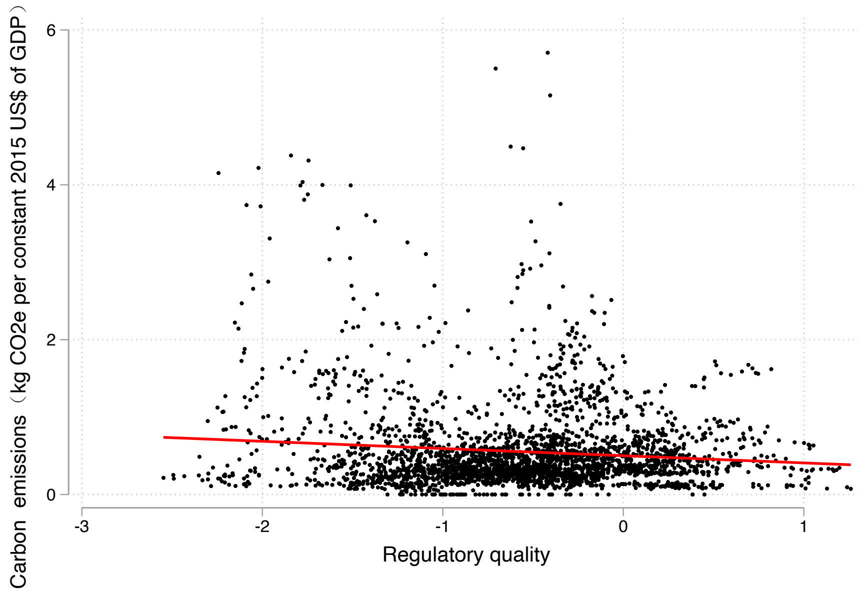
where y_{it} is CO_2 intensity (rescaled to kg per 2015 100 US$ for regressions), rqe_{it} is regulatory quality, $\mathbf{x}_{it}$ is the control set, α_t and ξ_i are time and country effects, and u_{it} is the disturbance term. We split the sample by (i) income group (low/middle vs. high-income) and (ii) regime type (democracy vs. non-democracy) and compare the cohort-specific coefficients on regulatory quality across columns (Tables 2 and 3) as empirical counterparts to H1-H2. Standard errors are clustered at the country level; we assess multicollinearity via VIFs (all < 5 across candidate models)[4]. Where figures suggest curvature (Figure 6), we include a squared regulatory quality term in baseline regime splits and examine its attenuation once controls enter.

Results

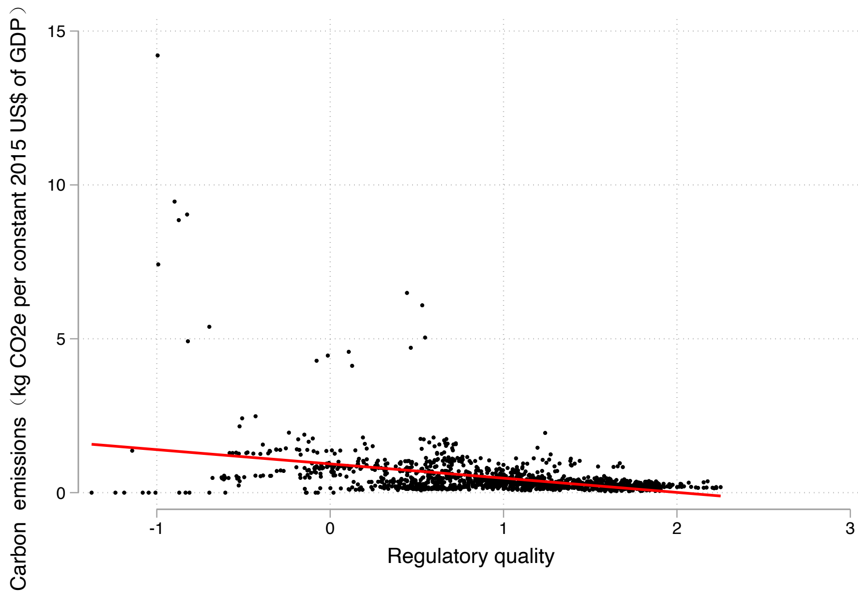
Regulatory quality and development level

We commence with the World Bank's four-way income classification (World Bank Group 2018) and, for parsimony, aggregate this classification into two groups: high-income and low/middle-income countries.

[4] We adopt the common VIF < 5 rule of thumb: when VIF > 5 (≈ an $R^2 \geq 0.80$ from regressing that regressor onto the others), the coefficient's variance is inflated by the VIF and inference becomes unstable.



(a) Relationship between regulatory quality and carbon dioxide emissions （Low- and middle-income countries）



(b) Relationship between regulatory quality and carbon dioxide emissions （High-income countries）

Figure 1: Carbon dioxide emissions, economic development and regulatory quality

Figure 1 plots our concept of regulatory quality against CO_2 intensity for the two income groups using country-year observations (1996-2022). The fitted line in each panel is an OLS linear fit. Two regularities stand out. First, the bivariate association is negative in both panels but *steeper* for high-income countries: as this notion of regulatory quality improves, CO_2 intensity falls more sharply amongst high-income countries. Second, dispersion differs markedly across groups: low/middle-income countries exhibit a wide vertical spread, indicating substantial heterogeneity and many high-intensity outliers; the high-income panel is tighter, with fewer extreme observations. These plots are descriptive and don't control for income, economic structure, or energy mix, motivating the multivariate estimates in Table 2.

In the bivariate plots and uncontrolled regressions, high-income economies show a much steeper negative slope. However, once we move to within-country comparisons (country fixed effects) and explicitly control for GDP per capita, growth, sectoral composition, urbanization, forests, the energy mix, and government spending on education, the high-income advantage largely disappears. The earlier gap reflected covariates that track income (e.g. cleaner electricity, a larger service share, slower scale growth, etc.), not "income per se." Our income splits still compare like with like, but the FE + controls specification answers a different question: *holding those fundamentals constant within each income cohort, does higher regulatory quality predict lower intensity?*

On the regression scale (kg CO_2 per 2015 $100 of GDP), a one-standard-deviation improvement in regulatory quality (≈0.99) is associated with about −0.07 kg/100 $ in low/middle-income countries and −0.03 kg/100 $ in high-income countries—both well under 0.2% of the sample mean intensity (~55 kg/100 $). This cautions against expecting large decarbonization gains from generic "better regulation" alone, especially where CO_2 intensity is largely shaped by energy composition and sectoral structure—factors that account for much of the cross-country and within-country variation in emissions intensity.

Our analysis, therefore, offers mixed support for H1 (see table 2). The simple (uncontrolled) association appears more negative among high-income economies, but once fundamentals are held constant the development gradient is small and not the dominant source of heterogeneity. This is why we emphasize regime heterogeneity (Table 3) over development heterogeneity when assessing external validity and policy transfer.

Table 2: Economic development, regulatory quality and carbon dioxide emissions

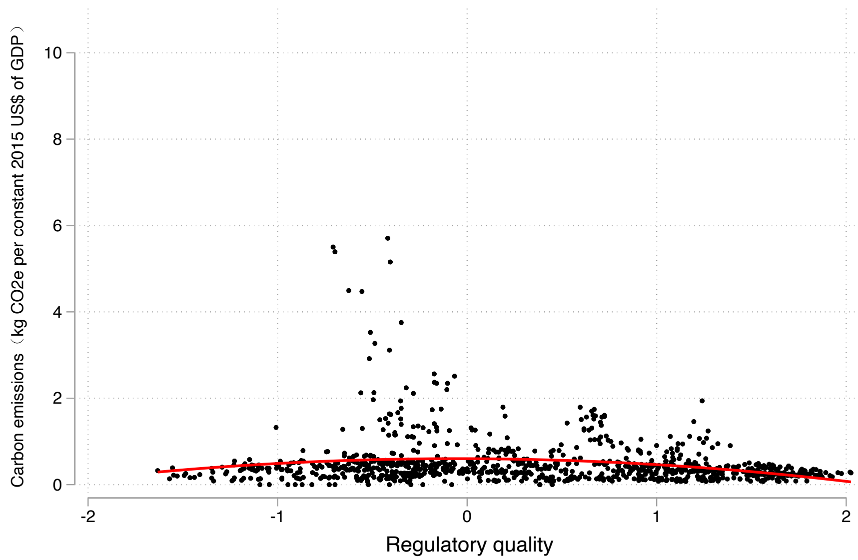
	The low- and middle-income group	**The High-income group**	**The low- and middle-income group**	**The High-income group**
Regulatory quality	-0.0956***	-0.3064***	-0.0667***	-0.0340**
	(-5.46)	(-7.82)	(-4.20)	(-2.17)
GDP growth rate (annual %)			0.0012**	-0.0007
			(1.67)	(-0.94)
GDP per capita (constant 2015 US dollar)			-0.0001***	-0.0000***
			(-12.15)	(-8.33)
Agriculture, forestry, and fishing, value added (% of GDP)			0.0038***	0.0387***
			(3.06)	(14.32)
Industry (including construction), value added (% of GDP)			0.0016*	0.0062***
			(1.74)	(6.24)

Urban population (% of total)			-0.0023	0.0118***
			(-1.63)	(8.09)
Forest area (% of land area)			0.0000	-0.0344***
			(0.00)	(-8.16)
Electricity production from oil, gas and coal sources (% of total)			0.0014***	0.0019***
			(4.59)	(4.86)
Renewable energy consumption (% of total final energy consumption)			-0.0118***	-0.0033***
			(-14.72)	(-3.78)
Government expenditure on education, total (% of government expenditure)			0.0014	0.0086***
			(1.27)	(4.72)
Constant	0.4997***	0.7843***	1.1247***	0.4950***
	(46.60)	(20.36)	(9.28)	(2.85)
N	2889	1418	1580	1092
R^2	0.0107	0.0431	0.2472	0.5331
No. of countries	124	60	118	57
Fix country	-	-	Yes	Yes
Fix time	-	-	No	No
F	29.7624	61.1651	47.6894	117.0513

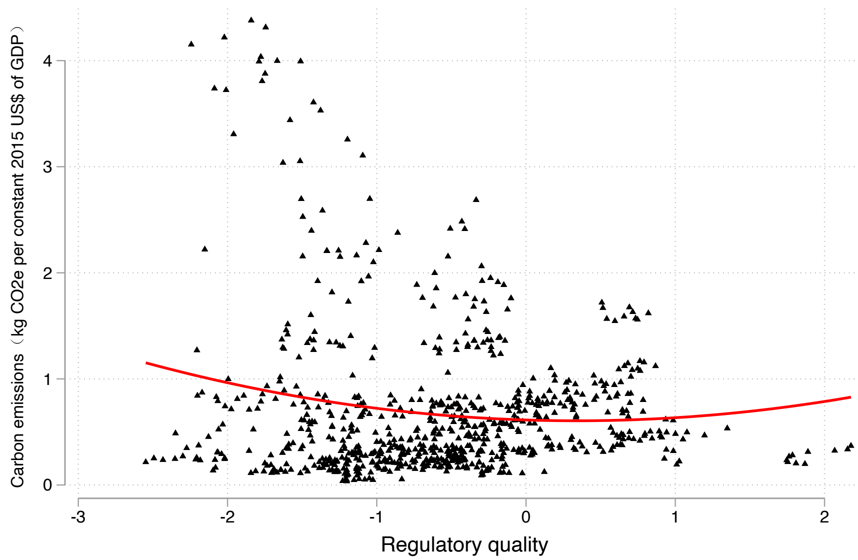
*Note: t statistics in parentheses, * p<0.1, ** p<0.05, *** p<0.01. The notations are consistent throughout this paper.*

Regulatory quality and regime type

To assess whether political regimes condition the regulation-emissions link, democracies and non-democracies are compared. Using the QoG regime classification, we collapsed the six regime types into two cohorts (democracies vs. non-democracies) and restricted attention to countries with stable regimes over 1996-2022.



(a) Democracies



(b) Non-Democracies

Figure 2: Carbon dioxide emissions, democracy and regulatory quality

Figure 2 compares the bivariate relationship between regulatory quality (WGI) and CO_2 intensity (kg CO_2 per constant 2015 US$ of GDP) for democracies and non-democracies, using country-year observations for 1996-2022. The fitted curve in each panel is an OLS quadratic fit. Amongst democracies, the curve has an inverted-U shape: CO_2 intensity rises slightly at lower levels of regulatory quality and then declines at higher levels (a turning point in the mid-upper governance range). Amongst non-democracies, the relationship is U-shaped: intensity falls at low-mid regulatory quality and rises at higher levels; the cloud is more dispersed, with several high-intensity outliers at low regulatory quality. These plots are descriptive and, even with the sample restricted to countries with stable regimes, they don't control for income, economic structure, or energy mix—hence the multivariate estimates in Table 3, which condition on GDP per capita, growth, sectoral composition, energy mix, and government spending on education.

Table 3 quantifies the regime split. In the baseline specifications (cols. 1-2), regulatory quality is negative and significant for democracies ($-0.0716, \mathrm{t} = -2.89$). For non-democracies, the linear term is negative but only weakly significant at $10\% (-0.0854, \mathrm{t} = -1.71)$ and the squared term is positive $(0.0415, \mathrm{t} = 1.87)$, implying a mild U -shape with a turning point around $\mathrm{RQE} \approx 1.0$.

With the full control set (cols. 3–4), the pattern sharpens. In democracies, the coefficient on regulatory quality becomes more negative and remains statistically significant ($\beta = -0.1024$, $t = -2.88$), while the squared term is not statistically distinguishable from zero ($\beta_2 = 0.0184$, $t = 0.85$), indicating no robust curvature. In non-democracies, both the linear and squared terms are small and statistically indistinguishable from zero ($\beta = -0.0193$, $t = -0.51$; $\beta_2 = 0.0075$, $t = 0.35$). The implied 95% confidence interval for the linear effect in non-democracies is approximately [−0.093, 0.055], so we cannot reject the null of no average effect once income, structure, energy mix, and government spending on education are controlled.

In terms of magnitude, the democratic effect remains modest but non-trivial: given the regression scale ($\mathrm{kgCO_2}$ per $2015\$100$ of GDP) and the WGI's ≈ 1 s.d. spread, a $1 -$ s.d. gain in regulatory quality in democracies is associated with about $-0.10 \mathrm{~kg}/100\$, \sim 0.2\%$ of the sample mean intensity ($\sim 55 \mathrm{~kg}/100\$$). For non-democracies, the point estimate is near zero after controls.

Our findings endorse H2: the regulatory-quality–intensity link is reliably negative in democracies and indistinguishable from zero in non-democracies once fundamentals are held constant. These findings, therefore, highlight the importance of the governance context in determining the appropriateness of this notion of regulatory quality for furthering decarbonization goals.

Table 3: Political regimes, regulatory quality and carbon dioxide emissions

	Democracy	Non-Democracy	Democracy	Non-Democracy
	(1)	(2)	(3)	(4)
Regulatory quality	-0.0716***	- -0.0854*	-0.1024***	-0.0193
	(-2.89)	(-1.71)	(-2.88)	(-0.51)
Squared regulatory quality	-0.0193	0.0415*	0.0184	0.0075
	(-1.09)	(1.87)	(0.85)	(0.35)
GDP per capita (constant 2015 US dollar)			-0.0000***	-0.0000***
			(-5.11)	(-4.47)
GDP growth rate (annual %)			-0.0017	-0.0020
			(-0.96)	(-1.20)
Industry (including construction) value added growth rate (% of GDP)			-0.0003	0.0005
			(-0.13)	(0.35)
Urban population (% of total)			0.0031	-0.0041
			(0.73)	(-1.11)
Forest area (% of land area)			-0.0270***	-0.0111
			(-3.15)	(-1.33)
Electricity production from oil, gas and coal sources (% of total)			0.0013	0.0002
			(1.61)	(0.30)
Renewable energy consumption (% of total final consumption)			-0.0044**	-0.0050**
			(-2.23)	(-2.55)
Government expenditure on education, total (% of GDP)			-0.0139	-0.0050

			(-1.28)	(-0.57)
Government expenditure on education, total (% of government expenditure)			0.0004	-0.0009
			(0.10)	(-0.38)
Constant	0.5272***	0.6130***	1.5393***	1.4787***
	(29.75)	(26.59)	(3.94)	(3.95)
N	991	766	568	297
No. of counties	117	90	93	65
Fix country	Yes	Yes	Yes	Yes
Fix year	No	No	No	No
R^2	0.0121	0.0282	0.1887	0.1348
F	5.3537	9.7927	9.8082	3.1305

Synthesis: Regulatory refraction in practice

The results map neatly onto the model's parameters. The income split shrinks after controls because proxies for ϕ (abatement costs via industrial structure) and **m** (energy mix) are absorbed, leaving little "income-per-se" variation. In contrast, the democracy split survives controls, consistent with democracies having higher π (responsiveness), lower κ (capture), and a larger enforcement share α in the observed regulatory-quality bundle. Where $\alpha \cdot \pi$ is high (and κ, θ are low), the enforcement/credibility channel dominates; where reforms tilt to market streamlining, Λ' (scale) offsets the gains. Appendix A.5 further shows that if enforcement also suppresses scale ($\Psi' \leq 0$), the negative effect strengthens—helping to explain why democracies exhibit clearer reductions in intensity.

Discussion and Implications

Our theory treats regulatory quality as a hybrid bundle that combines a credible-enforcement component with a market-enabling component. The results are consistent with this two-channel account. Apparent differences between high-income and low-/middle-income countries in simple bivariate relationships largely reflect underlying economic structure and energy mix. Once these fundamentals are held constant within countries, average associations between regulatory quality and CO_2 intensity are modest. By contrast, regime type conditions translation: improvements in regulatory quality are associated with lower CO_2 intensity in democracies, but become statistically indistinguishable from zero in non-democracies after conditioning on fundamentals.

Contributions to public administration theory

First, the paper clarifies a common measurement problem in cross-national governance research: composite indicators such as the WGI regulatory-quality index embed multiple institutional attributes and normative assumptions. By conceptualizing the index as an observed bundle of enforcement/credible commitment and market streamlining, we provide a mechanism-based interpretation of why “regulatory quality” can appear beneficial in some settings but not others. This moves debates about “better regulation” from a binary question (good governance versus bad governance) toward a composition question (which elements of reform are being strengthened, and through which administrative routines).

Second, the findings connect regulatory governance to grand-challenge performance. Decarbonization requires both policy design and implementation capacity, and our results underscore that business-oriented process reforms are not inherently climate-improving. Where enforcement capacity is muted or abatement is costly, streamlining can increase output scale without changing the emissions intensity of production. The regulatory-capacity literature makes a similar point in other domains: performance depends on specialized capabilities, not only general institutional quality (de la Riva Agüero 2025).

Third, the democracy split refines public administration arguments about accountability and credible commitment. In democracies, electoral competition, organized interests, and greater transparency can strengthen the enforcement side of regulatory quality and limit selective implementation. In non-democracies, regulatory reforms that reduce burdens may not be accompanied by credible enforcement and may be more vulnerable to discretionary or selective application, limiting environmental payoffs. This is consistent with organizational accounts that emphasize how voice mechanisms, peer support, and institutional design shape bureaucratic behavior under undemocratic pressures (Silveira et al. 2026).

Implications for practice

• Do not assume that adopting “better regulation” toolkits is equivalent to climate policy. If the objective is decarbonization, pair process reforms with climate-specific standards, monitoring, and enforcement capacity.

• Anticipate scale effects. Streamlining that reduces business frictions can increase economic activity; climate gains are more likely when reforms are coordinated with energy transition and industrial upgrading.

• Tailor reform advice to political and administrative realities. Where accountability and credible enforcement are weak, “regulatory quality” improvements may not translate into lower emissions intensity without complementary institutional safeguards.

Limitations and future research

Our study is designed to assess within-country associations rather than to make strong causal claims. Regulatory quality is a perception-based indicator and may respond endogenously to economic and environmental performance. Country fixed effects, year effects, and standard controls mitigate—but do not eliminate—these concerns.

Second, emissions intensity captures decarbonization relative to output, not the level of emissions. Regulatory reforms that reduce intensity can still coincide with rising total emissions if output grows quickly. Future work could pair intensity outcomes with level outcomes and explore distributional tradeoffs across sectors.

Third, unpacking the bundle remains a priority. The strongest next step is to move from broad indicators to more disaggregated measures of regulatory design and enforcement (e.g., environmental inspections, permitting stringency, and compliance outcomes), and to exploit reform episodes or policy discontinuities to strengthen causal identification.

Conclusion

Regulatory quality reforms are widely promoted as best practice, but their climate relevance is contingent. By theorizing regulatory quality as a hybrid bundle and testing heterogeneity across income groups and regime types, this paper shows that the decarbonization payoffs of “better regulation” are modest on average and more robust in democracies than in non-democracies. The practical implication is clear: climate-relevant regulatory governance requires not only streamlined rules but also credible enforcement and supportive economic fundamentals.

References

Addai, K., B. Serener, and D. Kirkikkaleli. 2023. "Environmental sustainability and regulatory quality in emerging economies: Empirical evidence from Eastern European region." *Journal of the Knowledge Economy* 14, no. 3: 3290-3326.

Baloch M., and B. Wang. 2019. "Analyzing the role of governance in CO_2 emissions mitigation: The BRICS experience." *Structural Change and Economic Dynamics* 51: 119-125.

Becker, G. 1983. "A theory of competition among pressure groups for political influence." *Quarterly Journal of Economics* 96, no. 3: 371-400.

Braithwaite, J. 2008. *Regulatory Capitalism*. Edward Elgar.

Coase, R., 1960. "The Problem of Social Cost." *Journal of Law and Economics* 5, no. 4: 87-137.

de la Riva Agüero, R. 2025. "Complexity in Service Provision: Unpacking Administrative Capacity to Understand Differential Performance." Public Administration Review 0: 1-15.

Dietz T., E. Ostrom, and P. Stern. 2003. "The struggle to govern the commons." *Science* 302, no. 5652: 1907-1912.

European Commission. 2001. Simplifying and Improving the Regulatory Environment. European Commission.

Ferraro, F., D. Etzion, and J. Gehman. 2015. "Tackling grand challenges pragmatically: Robust action revisited." *Organization Studies* 36, no.3: 363-390.

Gani, A., 2012. "The relationship between good governance and carbon dioxide emissions: Evidence from developing economies." *Journal of Economic Development* 37, no.1: 77-93.

George, G., J. Howard-Grenville, A. Joshi, and L. Tihanyi. 2016. “Understanding and tackling societal grand challenges through management research.” *Academy of Management Journal* 59, no.6: 1880–1895.

Golley, J., and X. Meng. 2012. “Income Inequality and Carbon Dioxide Emissions: The Case of Chinese Urban Households.” *Energy Economics* 34, no.6: 1864-1872.

Halkos, G., and N. Tzeremes. 2013. “Carbon dioxide emissions and governance: A nonparametric analysis for the G-20.” Energy Economics 40: 110-118.

Hantke-Domas, M. 2003. “The public interest theory of regulation: Non-existence or misinterpretation.” *European Journal of Law and Economics* 15, no.2: 165-194.

Hausman, J. 1978. “Specification Tests in Econometrics.” *Econometrica* 46, no.6: 1231-1271.

Hood, C. 1998. *The Art of the State; Culture, Rhetoric and Public Management*. Clarendon Press.

Hood, C., O. James, and C. Scott. 2000. “Regulation of government: Has it increased, is it increasing, should it be diminished.” *Public Administration* 78, no 2: 283-304.

James, O. 2000. “Regulation inside government. Public interest justification and regulatory failures.” *Public Administration* 78, no. 2: 327-343.

Kaufmann, D., A. Kraay, and M. Mastruzzi. 2011. “The worldwide governance indicators: methodology and analytical issues.” *Hague Journal on the Rule of Law* 3, no.2: 220-246.

Kirkpatrick, C. 2014. “Assessing the impact of regulatory reform in developing countries.” *Public Administration and Development* 34, no.3: 162-168.

Levi-Faur, D. 2005. “The global diffusion of regulatory capitalism.” *Annals of the American Academy of Political and Social Sciences* 598, no.1: 12-32.

Levi-Faur, D. 2006. “Regulatory capitalism: The dynamics of change beyond Telecoms and Electricity.” *Governance* 19, no. 3: 497-525.

Lodge, M., and K. Wegrich. 2012. *Managing Regulation.* Palgrave Macmillan.

Moran, M., 2002. “Understanding the Regulatory State.” *British Journal of Political Science* 32, no. 2: 391-413.

Moran, M., 2003. *The British Regulatory State*. Oxford University Press.

Nielsen, V., and C. Parker. 2009. “Testing responsive regulation theory in enforcement.” *Regulation and Governance,* 3, no.4: 376-399.

OECD. 2005. *Guiding Principles for Regulatory Quality and Performance*. OECD.

Pigou, A. 1932. *The Economics of Welfare*. Macmillan.

Radaelli, C., and A. Meuwese. 2009. “Better regulation in Europe: Between public management and regulatory reform.” *Public Administration* 87, no. 3: 639-654.

Shafiei, S., and R. Salim. 2014. “Non-renewable and renewable energy consumption and CO_2 emissions in OECD countries: A comparative analysis.” *Energy Policy* 66, no. 3: 547-556.

Shahbaz, M., G. Salah Uddin, I. Ur Rehman, and K. Imran. 2014. “Industrialization, Electricity Consumption and CO_2 Emissions in Bangladesh.” *Renewable Sustainable Energy Reviews* 31, no. 2: 575-586.

Silveira, M. C., G. S. Lotta, L. Cingolani, J. V. Guedes-Neto, A. de Á. Gomide, and P. M. S. S. Souza. 2026. “The Organizational Dynamics of Bureaucratic Resistance to Undemocratic Pressures: A Conjoint Experiment in Brazil.” Public Administration Review 0: 1-15.

Six, F. 2013. “Trust in regulatory relations.” *Public Management Review* 15, no. 2: 163-185.

Stigler, G. 1971. "The Theory of Economic Regulation." *Bell Journal of Economics* 2: 3-21.

Werf, van der, G., D. Morton, R. DeFries, J. Olivier, P. Kasibhatla, R. Jackson, G. Collatz, and J. Randerson. 2009. "CO_2 emissions from forest loss." *Nature Geoscience* 2, no. 11: 737-738.

World Bank Group. 2018. *World Development Report 2018*. World Bank.

Zhang, N., K. Zu, and N. Chen. 2017. "How Does Urbanization Affect Carbon Dioxide: A Cross-Country Panel Data Analysis." *Energy Policy* 107: 678-687.

Zhang, Y. 2010. "Towards Better Regulatory Governance? Regulatory reform in selected developing countries, 2003-7." *Public Management Review* 12, no. 6: 873-891.

Appendix - A Simple Political-Economic Model: Regulatory Refraction

A.1 Actors, technology, and timing

In each country i and year t, a representative firm produces output Y and emits E. Baseline (unabated) emissions per unit output are $\bar{\iota}(\phi, m)$, where $\phi > 0$ summarizes the marginal abatement cost (MAC) schedule (heavier industry ⇒ higher ϕ) and m summarizes the energy mix (more fossil share ⇒ higher $\bar{\iota}$). The firm can abate $a \geq 0$ at convex cost $C(a;\phi)$ with $C_a > 0$, $C_{aa} > 0$. Realized emissions intensity is

$$I \equiv \frac{E}{Y} \;=\; \bar{\iota}(\phi, m) \;-\; \frac{a}{Y}.$$

A.2 Policy package and political medium

A government chooses a regulatory package with two latent components:

- Enforcement/credible-commitment q_c (clarity, predictability, capability to implement), raising expected penalties and reducing discretion;
- Marketisation/business-friendliness q_b (process streamlining, low entry barriers, lighter procedure), reducing compliance frictions and often raising scale.

The observed index q mixes these components: $q_\varepsilon = \alpha q, q_b = (1-\alpha)q$, where $\alpha \in [0,1]$ varies by context.

Political medium.

Effective stringency:

$$S(q) = s\pi[(1-\kappa)\alpha - \theta(1-\alpha)]q, \quad S_q = s\pi[(1-\kappa)\alpha - \theta(1-\alpha)],$$

with capacity $s > 0$, responsiveness $\pi \in [0,1]$, capture $\kappa \in [0,1]$, dilution $\theta \geq 0$. Firm choice and scale. Given S, the firm minimizes $C(a;\phi) + P(S)[iY - a]$, implying $C_a(a^*;\phi) = P(S)$ and hence $a_S^* = P'(S)/C_{aa} > 0, a_\phi^* < 0$. Marketisation raises scale $Y = Y_0\Lambda(q_b)$ with $\Lambda'(\cdot) \geq 0$ and $q_b = (1-\alpha)q$.

A.3 Marginal effect of regulatory quality

$$I(q) = \bar{\iota}(\phi, m) - \frac{a^*(S(q);\phi)}{Y_0\Lambda((1-\alpha)q)}$$

Differentiating:

$$\frac{\partial I}{\partial q} = -\frac{a_S^*(S,\phi)}{Y_0\Lambda((1-\alpha)q)}S_q + \frac{a^*(S,\phi)\Lambda'((1-\alpha)q)}{Y_0\Lambda((1-\alpha)q)^2}(1-\alpha)$$

A.4 Propositions (with proof sketch)

Proposition 1 (H1: development heterogeneity). If ϕ is smaller and α larger in high-income economies, then $\left.\frac{\partial I}{\partial q}\right|_{\mathrm{HI}} < \left.\frac{\partial I}{\partial q}\right|_{\mathrm{LMI}}$.

Proposition 2 (H2: regime heterogeneity). If π is larger and κ smaller, with larger α, then $\left.\frac{\partial I}{\partial q}\right|_{\text{Dem}} < \left.\frac{\partial I}{\partial q}\right|_{\text{NonDem}}$.

Proposition 3 (H3: when 'better regulation' fails). If $(1-\kappa)\alpha < \theta(1-\alpha)$ or *if the scale elasticity* Λ' is large while a_S^* is small (high ϕ), then $\partial I/\partial q \geq 0$ can occur.

Proof sketch. Since $a_S^* = P'(S)/C_{\text{aa}} > 0$ decreases in ϕ, and S_q increases in π, α and decreases in κ, θ, the signs follow directly from the derivative above.

A.5 What if output Y changes because of abatement?

Suppose abatement directly reduces scale:

$$Y(q) = Y_0\Lambda(q_b)\Xi(a), q_b = (1-\alpha)q, \Lambda'(\cdot) \geq 0, \Xi'(a) \leq 0, \Xi(a) > 0$$

Then

$$I(q) = \bar{\iota}(\phi, m) - \frac{a^*(S(q), \phi)}{Y_0\Lambda(q_b)\Xi(a^*)}$$

and the total derivative is

$$\frac{dI}{dq} = \underbrace{-\frac{a_S^* S_q}{Y_0\Lambda\Xi}}_{\text{enforcement} \to \text{more abatement (negative)}} + \underbrace{\frac{a^*\Lambda'(q_b)}{Y_0\Lambda^2\Xi}(1-\alpha)}_{\text{marketisation} \to \text{larger scale (positive)}}$$
$$+ \underbrace{\frac{a^*\Xi'(a^*)a_S^* S_q}{Y_0\Lambda\Xi^2}}_{\text{abatement reduces scale (negative, since } \Xi' \leq 0)}$$

with $S_q = s\pi[(1-\kappa)\alpha - \theta(1-\alpha)]$. Relative to the baseline, the third term is new and strengthens the negative effect of enforcement on intensity whenever $\Xi'(a^*) < 0$. Hence the condition for $\frac{dI}{dq} < 0$ is easier to satisfy than in the mainline model.

Illustration (closed form). With $C(a;\phi) = \frac{\phi}{2}a^2$ (so $a^* = P(S)/\phi), P(S) = S, \Lambda(q_b) = e^{\ell q_b}(\ell \geq 0)$, and $\Xi(a) = e^{-\eta a}(\eta \geq 0)$,

$$I(q) = \bar{\imath} - \frac{S/\phi}{Y_0 e^{\ell(1-\alpha)q} e^{-\eta a^*}}, a^* = \frac{S}{\phi}$$

$$\frac{dI}{dq} = -\frac{1}{Y_0}\frac{1}{e^{\ell(1-\alpha)q-\eta a^*}}\left[\frac{1}{\phi}S_q - \frac{S}{\phi}\ell(1-\alpha) - \frac{S}{\phi}\eta\frac{1}{\phi}S_q\right]$$

The last term (proportional to $\eta > 0$) is the abatement-scale effect and is negative, making $\frac{dI}{dq}$ more likely to be negative.