

The Fossil-Fueled Roots of Climate Inaction in Authoritarian Regimes


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Why do some authoritarian regimes contribute more to climate change than others? I suggest that climate inaction in nondemocracies is shaped by a combination of fossil fuel wealth and executive constraints. Fossil fuel wealth undermines climate action by giving leaders of authoritarian regimes incentives to capture oil and gas rents that help them maintain power. Executive constraints, however, can restrict carbon-intensive rent-seeking and therefore moderate the role of fossil fuel wealth in undermining climate action. This argument provides a novel explanation for variation in efforts to address climate change among nondemocracies: the lack of institutional constraints on autocratic leaders' use of fossil fuel wealth for political gain. I evaluate this argument using panel data on greenhouse gas emissions, oil and gas income, and executive constraints in 108 countries governed by authoritarian regimes between 1990 and 2021, finding that oil and gas income leads to higher emissions, but that these effects decline significantly with executive constraints.

The unprecedented rise in greenhouse gas emissions since the latter half of the nineteenth century has led to changes in Earth's climate unlike any witnessed in modern human history. Since the time before the Industrial Revolution, the average temperature on our planet has risen by more than 1.0°C and could exceed 1.5°C in as little as 10 years (WMO 2023). Each of the last four decades was warmer than the previous one, and all were warmer than any decade before 1850 (IPCC 2018). These changes contribute to rising sea levels; increasing ocean acidification; more extreme heat waves; and more severe droughts, hurricanes, and wildfires that cause staggering amounts of physical and economic damage (IPCC 2018). Importantly, however, not all countries contribute equally to the climate crisis. Some countries emit more carbon pollution than others and thus bear greater responsibility for rising temperatures. Conversely, some countries contribute more than others to reducing emissions.

To understand such variation, scholars often emphasize broad differences between climate action in countries with democratic and nondemocratic regimes (Bättig and Bernauer 2009; Farzin and Bond 2006; Li and Reuveny 2006) and between some democracies compared with others (Finnegan 2022; Mildener 2020; Povitkina 2018). Few, however, examine variation among nondemocracies, despite the fact that countries governed by various forms of authoritarian rule have accounted for more than 40% of all per capita emissions since 1990 (cf. Böhmelt 2014; Brain and Pál 2019; Carlitz and Povitkina 2021; this percentage was computed using data from Crippa et al. 2023). In addition, most existing research on environmental politics in nondemocracies focuses on the single case of China (Beeson 2018; Ding 2020; Gilley 2012; Huang 2020; Schreurs 2011) without adopting a broader comparative approach. As a result, we know surprisingly little about whether and why efforts to address climate change—or the lack thereof—vary across authoritarian regimes.¹

I argue that variation in climate inaction among nondemocracies depends primarily on a combination of fossil fuel wealth and executive constraints. On the one hand, fossil fuel wealth undermines prospects for climate action by giving dictators incentives to capture oil and gas rents that help them maintain power. Existing research suggests that money from oil and gas production helps autocrats maintain power by financing political survival strategies based on repression, co-optation, and rentierism (Ross 2013; Svoboda 2012; Wright, Frantz, and Geddes 2015),

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incentivizing them to oppose climate action because reducing emissions means forgoing valuable oil and gas rents.

On the other hand, executive constraints can moderate the effects of fossil fuel wealth on climate inaction through oversight rules that restrict autocrats' ability to maintain power using these rents. Previous work highlights the role of political institutions in constraining unilateral executive action and facilitating power sharing in authoritarian regimes, including through the use of hearings, investigations, and other forms of oversight (Finkel 2012; Meng 2020; Wright 2008). By forcing autocrats to share power with other elites, executive constraints limit their ability to maintain power using oil and gas rents alone, thereby moderating the role of fossil fuel wealth in undermining climate action. This argument provides a novel explanation for climate inaction among nondemocracies: the lack of institutional constraints on autocratic leaders' use of fossil fuel wealth for political gain.

I evaluate this argument using panel data on greenhouse gas emissions, oil and gas income, and executive constraints in all authoritarian regimes with available data between 1990 and 2021. I find that oil and gas income leads to higher emissions, suggesting that fossil fuel wealth weakens climate action in nondemocracies. I also find, however, that fossil fuel wealth produces a significantly lower rise in emissions in regimes with strong executive constraints, suggesting that political institutions also affect climate inaction among nondemocracies.

This article makes three scholarly contributions. First, it offers a novel explanation for variation in climate inaction among nondemocracies. Although emissions have, in general, increased in autocracies since 1990, this trend largely reflects rising emissions in unconstrained authoritarian regimes (figure 1).² Existing research documents variation in efforts to reduce emissions among established democracies (Aklin and Urpelainen 2018; Finnegan 2022; Meckling 2011; Mildenberger 2020). Here I contribute to the political economy literature on climate change by demonstrating that such variation exists among autocracies as well. Importantly, I do so by analyzing both structural and institutional dynamics of authoritarian regimes; neither fossil fuel wealth nor executive constraints shape efforts to address climate change in nondemocracies independently from one another.

Second, this article contributes to ongoing debates about environmental authoritarianism. Some scholars posit that effectively addressing climate change may necessitate or inevitably lead to nondemocratic forms of governance (Beeson 2010; Gilley 2012; Mittiga 2021). On this view, core features of liberal democracy, including checks and balances and the separation of powers, impair governments' ability to impose costly and unpopular policies needed to reduce emissions (Beeson 2010). Thus, these scholars argue, combating climate change may require

centralizing key decision-making powers in the executive branch (Mittiga 2021). This article complicates the idea that concentrating power in the hands of the executive helps reduce emissions in authoritarian regimes. Indeed, I demonstrate that distributing power more equitably in ways that constrain unilateral executive action decreases the role of fossil fuel wealth in driving climate inaction in nondemocracies.

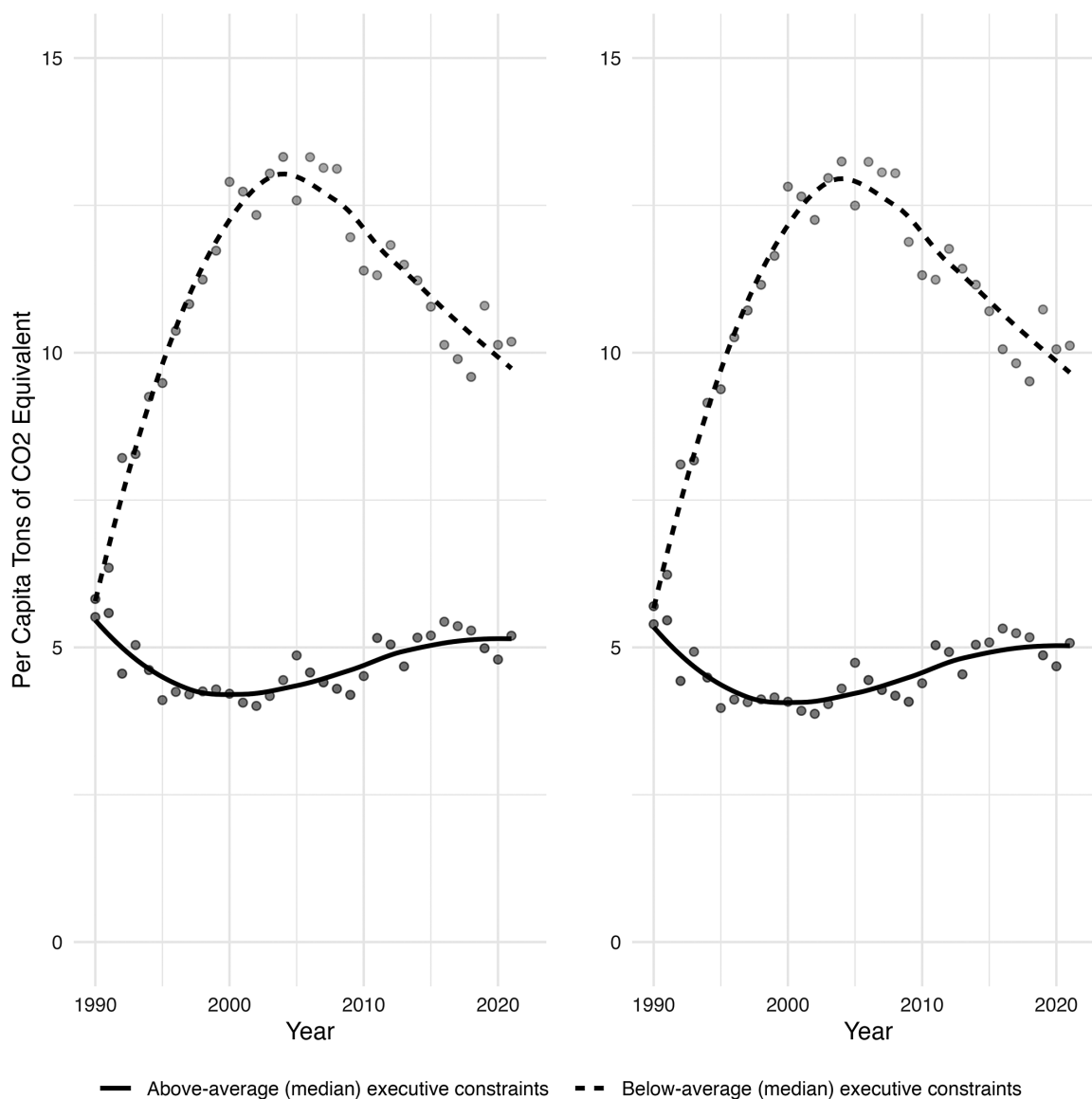
Third, this article connects disparate research on natural resource governance, the political economy of climate change, and political institutions in authoritarian regimes, suggesting that these literatures have considerable analytical utility when combined. A vast body of scholarship debates whether and how natural resources influence regime outcomes (Haber and Menaldo 2011; Mahdavi 2020b; Ross 2013; Wright, Frantz, and Geddes 2015). In parallel, growing research indicates that political institutions can shape efforts to reduce emissions in established democracies (Finnegan 2022; Mildenberger 2020; Scruggs 1999). Still another literature examines the conditions under which institutions constrain executives in authoritarian regimes (Boix and Svolik 2013; Gandhi and Przeworski 2006; Meng 2020; Wright 2008). On their own, none of these literatures has sufficient insight to explain why some authoritarian regimes contribute more to climate change than others, but together they do.

Regimes and the Political Foundations of Climate Inaction

Existing research questions whether political regimes shape countries' approach to reducing emissions (Bättig and Bernauer 2009; Bernauer and Koubi 2009; Burnell 2012; Farzin and Bond 2006; Fredriksson and Neumayer 2013; Kneuer 2012; Li and Reuveny 2006). Some argue that, because reducing emissions is a public good, countries where leaders are chosen by large groups of people should agree to reduce their emissions more than those governed by only a few individuals (Congleton 1992; Neumayer 2002; Payne 1995). In other words, because most people benefit from the public good of climate action, pro-democracy frameworks expect regimes that represent the interests of most people (democracies) to take more action to reduce emissions than those that do not (nondemocracies). As a result, scholars claim that voter preferences (Congleton 1992), civil society openness and environmental interest group mobilization (Payne 1995), international cooperation (Neumayer 2002), and elite competition (Bättig and Bernauer 2009) make democracies more climate friendly than autocracies.

Contemporary research demonstrates strong similarities to these pro-democracy frameworks. Böhmelt, Böker, and Ward (2016) find that more inclusive regimes have more climate policies but not necessarily lower emissions, providing evidence of the same "words–deeds gap" identified

Figure 1
Mean Total (left) and Fossil (right) Emissions, 1990–2021



by Bättig and Bernauer (2009). Aklin and Urpelainen (2014) find that newly democratic regimes establish environmental ministries in an effort to signal their commitment to climate governance, reflecting the focus on international relations shared by Neumayer (2002) and Payne (1995). Hanusch (2018) finds that “democratic quality” promotes “climate change performance,” similar to the claim that some democracies “have a better record with regard to environmental protection” than others (Lijphart 2012, 274–75). However, despite their importance, pro-democracy frameworks struggle to explain climate inaction in authoritarian regimes because they

generally examine variation across regime types, rather than within them.

Moreover, theorists of environmental authoritarianism raise two principal critiques of these pro-democracy frameworks (Beeson 2010, 2018; Gilley 2012; Mittiga 2021). First, they claim that environmental authoritarianism represents a “possible, even likely, response to intensifying environmental problems” as autocratic regimes survive and democracies wither under increasingly severe climate impacts (Beeson 2018, 36–37). Second, they claim that environmental authoritarianism offers a more effective way of dealing with climate change than democratic

approaches (Gilley 2012). Both claims are unpersuasive on theoretical and empirical grounds.

Theoretically, the argument that effectively addressing climate change could necessitate authoritarian governance depends on incoherent assumptions about the relationship between climate change and political legitimacy. For instance, Mittiga (2021) suggests that protecting foundational sources of political legitimacy—such as rights to life, safety, and security—in the wake of climate change may require abandoning contingent sources of political legitimacy—such as rights to freedom of speech and association—that prevent governments from imposing costly and unpopular policies needed to reduce emissions. This argument suffers from tautological reasoning that reduces environmental authoritarianism to the claim that violating human rights is justified by “authoritarian climate governance” (Mittiga 2021, 10) to prevent human rights from being violated by runaway climate change. In this case, environmental authoritarianism cannot explain climate inaction among authoritarian regimes because it relies on self-contradictory assumptions.

The second argument offered by environmental authoritarianism represents an *empirical* claim about the effectiveness of authoritarian governance in promoting climate action. Some proponents of environmental authoritarianism claim that concentrating power in executive institutions can help promote climate action (Gilley 2012; Mittiga 2021; cf. Shahar 2015). This argument suggests that checks and balances and the separation of powers hinder governments’ ability to overcome barriers to reducing emissions when climate-friendly leaders in the executive branch struggle to advance climate action because of institutional constraints on their ability to do so unilaterally. This argument also suggests that strong executives acting independently of other institutions—perhaps even acting undemocratically—can effectively address climate change by intervening directly in the economy.

The flaws in this argument stem partially from the conceptualization of authoritarian regimes as homogeneous, despite their institutional diversity. Neither do all nondemocracies have equally centralized decision-making procedures (Geddes, Wright, and Frantz 2014), nor are they all equally environmentally friendly, as scholars in this tradition sometimes admit (Beeson 2010). More importantly, however, when authoritarian leaders in the executive branch display climate-friendly behaviors, such as supporting domestic climate policy measures or signing international climate agreements, it does not necessarily indicate they have preferences for reducing emissions. Instead, these behaviors may be motivated by the political incentives they have to promote climate action or inaction. Still, the literature on environmental authoritarianism tends to assume that executives are climate-friendly but institutionally constrained actors without rigorously

questioning the political foundations of climate inaction in authoritarian regimes.

These two frameworks in the literature on climate politics and environmental authoritarianism help frame the limitations of existing research. We cannot account for variation in autocracies’ effort or lack of effort to combat climate change using pro-democracy frameworks because these explanations apply comparatively to democracies and autocracies. But we cannot rely on environmental authoritarianism either because of its unpersuasive theoretical assumptions and weak empirical foundations. Thus, we need an alternative explanation for why some nondemocracies contribute more to climate change than others.

Fossil Fuel Wealth, Executive Constraints, and Climate Inaction in Authoritarian Regimes

I offer an alternative explanation for climate inaction in authoritarian regimes: the lack of institutional constraints on autocratic leaders’ use of fossil fuel wealth for political gain. At its core, this argument emphasizes the combination of incentives and opportunities that autocratic leaders have to maintain power through carbon-intensive rent-seeking behaviors and thus to support or oppose reducing emissions. On the one hand, fossil fuel wealth creates incentives for autocratic leaders to undermine efforts to reduce emissions and capture oil and gas rents they can use to maintain power. On the other hand, executive constraints that limit autocrats’ ability to maintain power with the help of oil and gas rents through oversight rules can moderate the role of fossil fuel wealth in undermining climate action. Considering that climate inaction in nondemocracies is shaped by both fossil fuel wealth and executive constraints provides a more theoretically attractive position than those discussed earlier and also helps explain empirical variation among authoritarian regimes.

Fossil Fuels, Rent-Seeking, and Political Survival

Fossil fuel wealth creates incentives for autocratic leaders to promote inaction on climate change and capture oil and gas rents they can use to maintain power. Previous research suggests that fossil fuel wealth makes it easier for autocratic leaders to stay in power by providing financing for repression, co-optation, rentierism, and other political survival strategies (Frantz and Kendall-Taylor 2014; Gandhi and Przeworski 2007; Mahdavi 2020b; Svoblik 2012; Wright, Frantz, and Geddes 2015). In other words, oil and gas production generates economic rents that help autocrats gain support from other elites and from the public. Both the literature on the rentier state³ and historical evidence overwhelmingly show that money from oil and gas

production can be used to shut down protests, jail political opponents, pay bribes, grant titles, fund welfare states and development projects, and gain support from business and labor groups. In short, autocrats repeatedly use fossil fuel wealth to try to maintain their hold on power.

By supporting their political survival, fossil fuel wealth also creates incentives for autocrats to undermine efforts to reduce emissions. Leaders of authoritarian regimes rich in fossil fuels have consistently avoided, delayed, and outright opposed both national and international climate action. For example, when asked whether he would sign the Kyoto Protocol, Vladimir Putin said in 2003, “Maybe climate change is not so bad in such a cold country as ours? 2–3 degrees wouldn’t hurt—we’ll spend less on fur coats, and the grain harvest would go up” (Moscow Times 2021). And though he has grown to accept the scientific evidence on climate change over time, Putin cast doubt on the benefits of renewable energy technologies as recently as 2019. Putin also owns oil-related assets worth millions of dollars that he hides in offshore accounts, intermediaries, and proxies (Harding 2016) and helped dismantle restrictions on executive power after he became president again in 2012.

Mohammed bin Salman, for another example, bases the Saudi net zero commitment primarily on unproven carbon capture and storage technologies, which his government lobbied the Intergovernmental Panel on Climate Change (IPCC) to include in place of references to proven mitigation actions in the IPCC sixth assessment report (Gerken and Rowlatt 2021). The Saudi welfare state—one of the main sources of support for the regime—is funded primarily through the country’s sovereign wealth fund, which is financed using oil and gas rents. These and other examples suggest that autocratic leaders governing regimes rich in fossil fuels often obstruct climate action because they have an interest in using oil and gas rents to maintain power. Thus, one observable implication of my argument is:

H₁: Fossil fuel wealth weakens climate action in authoritarian regimes.

Executive Constraints for Climate Action

Importantly, however, executive constraints can moderate autocratic leaders’ climate obstruction by limiting their ability to maintain power using oil and gas rents. As with the fossil fuel-funded political survival strategies described earlier, there is no shortage of previous research on executive constraints in authoritarian regimes. Existing scholarship suggests that political institutions constrain autocratic leaders by creating credible commitments to power sharing with other elites (Boix and Svoblik 2013; Gandhi and Przeworski 2006; Meng 2020; Wright 2008). In other words, independent legislatures (Boix and Svoblik 2013), succession rules (Meng 2020), hearings and

investigations (Finkel 2012), and other institutions reflect agreements between autocrats and other elites to divide power and economic resources among themselves. By institutionalizing power and rent sharing between dictators and other elites, executive constraints make it harder for autocrats to maintain power using oil and gas rents alone.

Such “limited authoritarian government” (Boix and Svoblik 2013) illustrates the role that executive constraints play in shaping variation in climate inaction among non-democracies. Indeed, when executive constraints force dictators to share power, they make it harder to repress, co-opt, rent, or otherwise purchase support from other elites or members of the public using money from oil and gas production. Simply put, leaders of authoritarian regimes with strong executive constraints cannot maintain power through carbon-intensive rent-seeking as easily as can leaders of authoritarian regimes with weak executive constraints. Rather, they negotiate with other elites, make concessions, coordinate over policy matters, and make and implement laws. Comparativists often assume that politics in authoritarian regimes only reflects raw power struggles among elites, but as Przeworski (2023, 979) incisively notes, “Autocracies do collect garbage, regulate traffic, issue dog licenses, and fill street holes: they govern.” When executive constraints foster governance over rent-seeking, they decrease the role that fossil fuel wealth plays in undermining climate action. Thus, in effect, institutions that make it harder for autocrats to exploit fossil fuel wealth for their own political gain promote climate action, leading to a second observable implication:

H₂: Fossil fuel wealth weakens climate action in authoritarian regimes, conditional on executive constraints; stronger (weaker) constraints produce weaker (stronger) effects of fossil fuel wealth on climate action.

But how do executive constraints restrict carbon-intensive rent-seeking and moderate the effects of fossil fuel wealth on climate inaction in authoritarian regimes? I argue that oversight rules, by which I mean official rules that give institutional actors the power to conduct investigations and hold hearings about executive activities increase the amount of information other elites have about the executive branch (Finkel 2012; Gandhi, Noble, and Svoblik 2020; Williamson and Magaloni 2020). This information sheds light on executive action and allows other elites to detect and punish carbon-intensive rent-seeking behaviors. Then, because autocrats risk losing the benefits of oil and gas rents due to a damaging hearing or investigation, their obstruction of climate action no longer plays the same role in protecting their fossil fuel wealth as it does without oversight. Empirically, oversight can be exercised by legislative actors, such as committees or individual legislators, or non-legislative actors such as ombudsmen and prosecutors. Because this theory is one of executive

constraint through oversight, I remain agnostic about the sources of these constraints. Any effective oversight that constrains executives transforms fossil fuel wealth into a political liability, not just an asset, for dictators. These claims raise two more observable implications:

H₃: Fossil fuel wealth weakens climate action in authoritarian regimes, conditional on legislative oversight; stronger (weaker) oversight produces weaker (stronger) effects of fossil fuel wealth on climate action.

H₄: Fossil fuel wealth weakens climate action in authoritarian regimes, conditional on non-legislative oversight; stronger (weaker) oversight produces weaker (stronger) effects of fossil fuel wealth on climate action.

Whereas unbridled autocrats like Putin and bin Salman have busied themselves profiting from fossil fuels and obstructing climate action, comparatively more constrained autocrats have raised fewer obstacles to reducing emissions, even in countries rich in oil and gas. Consider Mohammed VI of Morocco. In 2009, he spearheaded national energy reforms that aimed to increase the country's renewable electricity capacity from 0 to 42% by 2020 (Falk 2021). He aimed to do so primarily through subsidies and public procurement for renewable energy technologies, including support for the construction of the world's largest concentrated solar plant (Alami 2021). In the process, the country also reformed its environmental agencies and set up a state-owned renewable energy company, Masen, only barely falling short of its 42% goal. By 2020, the country's renewable capacity had grown to around 37% (BBC 2021), and electrification had expanded to cover nearly 100% of the population (Nygard and Dafrallah 2016).

Importantly, however, Mohammed VI did not enact these reforms unilaterally. Instead, he negotiated with Moroccan legislators, who agreed to support the project only after submitting more than a dozen questions about feasibility, progress on previous renewable projects,

budgetary allocations, and other details (Agora 2023; see Denoeux and Desfosses [2007] for a broader discussion of legislative oversight in Morocco). Rather than purchasing support for his reforms using carbon-intensive resource rents, strong executive constraints—especially oversight rules used to question the executive—facilitated elite power sharing and coordination over the country's transition to low-carbon energy. Admittedly, Morocco is an easy case for my theory because its low fossil fuel wealth provides few opportunities for carbon-intensive rent-seeking.

Consider, then, the case of Kuwait, whose vast fossil fuel wealth makes a hard case for my theory. In 2009, the same year in which Morocco embarked on its transition to low-carbon energy, members of the Kuwait National Assembly voted to cancel several multibillion-dollar contracts to expand the country's oil refining capacity. Legislators alleged that the emir, Sabah al-Sabah, and the oil minister, Mohammed al-Olaim, had misappropriated funds earmarked for economic recovery after the global financial crisis and skirted Kuwait's public tender process in signing the contracts (El Gamal and Kasolowsky 2009). The legislators threatened to hold a hearing to question al-Olaim and raised the possibility of a no-confidence vote against Prime Minister Nasser al-Mohammed, nephew and appointee of the emir. As a result, contracts were cancelled, new tenders had to be issued, and plans to expand Kuwait's refining capacity were delayed (MEED Editorial 2010). To be clear, unlike Morocco, Kuwait is *not* a shining example of climate action. But like Morocco, it illustrates how executive constraints can limit opportunities for carbon-intensive rent-seeking, moderating the role that fossil fuel wealth plays in driving climate inaction, even in oil-rich autocracies.

Descriptive data on per capita emissions, oil and gas income, and executive constraints in nondemocracies support this argument. Table 1 gives several examples of nondemocracies with relatively high or low fossil fuel

Table 1
Emissions, Fossil Fuel Wealth, and Executive Constraints in Nondemocracies

	Strong executive constraints	Weak executive constraints
Low fossil fuel wealth	Examples: Jordan (2015–22), Lebanon (1990–2021), Morocco (1992–96, 2015–22) <i>N</i> = 773 (30.8%) Mean total emissions: 2.88 tCO ₂ e Mean fossil emissions: 2.72 tCO ₂ e	Examples: Djibouti (2013–22), Eritrea (1993–2011), Mauritania (1992–2005, 2015–19) <i>N</i> = 498 (19.8%) Mean total emissions: 2.54 tCO ₂ e Mean fossil emissions: 2.40 tCO ₂ e
High fossil fuel wealth	Examples: Algeria (1993–94, 2000–20), Jordan (1991–2014), Kuwait (1992–2014), Morocco (1990–91, 1997–2014) <i>N</i> = 499 (19.9%) Mean total emissions: 7.05 tCO ₂ e Mean fossil emissions: 6.98 tCO ₂ e	Examples: Algeria (1990–92, 1995–99, 2021–22), Tunisia (1990–2010), Saudi Arabia (1990–2022), Qatar (2000–22) <i>N</i> = 740 (29.5%) Mean total emissions: 14.29 tCO ₂ e Mean fossil emissions: 14.23 tCO ₂ e

wealth and relatively strong or weak executive constraints—defined as above- or below-average (median) values—as well as the number and percentage of nondemocratic country-years and average per capita emissions in each category since 1990. The cases in [table 1](#) all come from the Middle East and northern Africa to facilitate comparison with the examples from Morocco and Kuwait, but each category contains cases from other regions of the world as well.⁴

[Table 1](#) reveals three insights. First, in contrast to the conventional wisdom in comparative politics, relatively oil-rich autocracies with relatively strong executive constraints are numerous, making up almost 20% of all cases. Second, the amount of fossil fuel wealth and the degree of executive constraints in nondemocracies often vary within countries over time. Third, and importantly, it provides suggestive evidence for my theory. Autocracies with low fossil fuel wealth and strong executive constraints emit less on average than those with high fossil fuel wealth and weak executive constraints. But autocracies with high fossil fuel wealth and strong executive constraints *also* emit less on average than those with high fossil fuel wealth and weak executive constraints. And autocracies with low fossil fuel wealth and strong executive constraints emit roughly the same amount on average as those with low fossil fuel wealth and weak executive constraints.

Thus, I argue that fossil fuel wealth and executive constraints shape incentives and opportunities for autocrats to engage in carbon-intensive rent-seeking behaviors and therefore also shape variation in efforts to combat climate change in authoritarian regimes. Autocrats with large amounts of fossil fuel wealth have strong incentives to undermine climate action. But executive constraints can limit carbon-intensive rent-seeking through oversight rules, moderating the deleterious effects of fossil fuel wealth on emissions.

Points of Clarification

Before outlining how I test this argument, I offer four points of clarification. First, I define climate inaction strictly in terms of emissions, not climate policies. Authoritarian regimes may strategically avoid reducing emissions by passing symbolic climate policies that are not designed to reduce emissions, weakly implementing climate policies that are designed to reduce emissions, or both. As Svoblik (2012, 14) observes, “Dictatorships inherently lack an independent authority with the power to enforce agreements among key political actors.” As a result, agreements to reduce emissions in the form of climate policies do not provide as much information about the real level of climate inaction in nondemocracies as do emissions. What matters, in other words, is not what authoritarian regimes *say* they are doing about climate change but rather what they actually *do*.

Second, I allow for any possible combination of carbon-intensive rent-seeking behaviors to shape the incentives that autocrats have to stoke climate inaction. Leaders of authoritarian regimes may use oil and gas rents to bankroll security forces (repression), bribe other elites (co-optation), finance government spending (rentierism), or maintain power through other means at the same time, all of which incentivize them to stymie efforts to reduce emissions. Leaders may also benefit from fossil fuel wealth in other ways, such as by enriching themselves through kleptocracy (Heathershaw, Sharman, and Cooley 2018) or subsidizing fossil fuel consumption (Skovgaard and van Asselt 2018). Indeed, fossil fuel wealth supports leaders of authoritarian regimes in different ways around the world. However, it does not matter *how* leaders of authoritarian regimes benefit from fossil fuel wealth for my theory, only *that* they do.

Third, I define autocracy as a type of political regime in which governments are not chosen through free and fair elections. Although a broader discussion of autocracy, democracy, and their different varieties lies beyond the scope of this article (see Coppedge et al. 2020; Dahl 1972; Geddes, Wright, and Frantz 2014; Schumpeter 1976 [1943]), two points follow from this definition. On the one hand, my argument says nothing about democracies. Fossil fuel wealth can also undermine efforts to combat climate change in democracies, though often in different ways than in autocracies. In autocracies, fossil fuel wealth shapes climate inaction *directly* by providing financing for repression, co-optation, rentierism, and other strategies autocrats use to maintain power more or less easily depending on the degree of executive constraint. In democracies, fossil fuel wealth shapes climate inaction *indirectly* by supporting lobbying, campaigning, misinformation, and other forms of interest group politics (Mildenberger 2020; Stokes 2020).

On the other hand, my theory suggests that, conditional on executive constraints, fossil fuel wealth leads to climate inaction in diverse types of autocracies. Whether they rule over closed or electoral autocracies (Lührmann, Tannenberg, and Lindberg 2018); competitive authoritarian regimes (Levitsky and Way 2010); monarchies; or party-based, personalist, or military dictatorships (Geddes, Wright, and Frantz 2014), leaders who maintain power more or less easily with the help of fossil fuels have incentives to promote inaction on climate change. Regardless of its role in democracies, fossil fuel wealth leads to climate inaction in *autocracies*, not in particular *types* of autocracies.

Finally, I make no assumptions about elite preferences in authoritarian regimes beyond those of the dictator. By assuming that institutions operate as constraints on leaders' behavior (North 1990; Weingast 1998), my theory allows for a heterogeneous distribution of non-leader elite preferences without requiring that they have

preferences over climate change per se. Indeed, other elites may constrain autocrats' efforts to maintain power using fossil fuel wealth for a wide variety of reasons, not just because they prefer lowering emissions. They may do so, for example, because they prefer that autocrats not be able to use fossil fuel-funded mechanisms of repression, co-optation, or rentierism against them. Thus, it is important *that* elites use institutions to constrain leaders of authoritarian regimes, not that they do so for any *particular* reason.

Data and Methodology

To evaluate this argument, I collect panel data on greenhouse gas emissions, oil and gas income, executive constraints, and relevant covariates in all authoritarian regimes with available data between 1990 and 2021. These data come from the Emissions Database for Global Atmospheric Research (Crippa et al. 2023), Ross and Mahdavi (2015), the Varieties of Democracy Institute (V-Dem; Coppedge et al. 2023), and the World Development Indicators (World Bank 2023), and have been updated through the present.⁵

Greenhouse gas emissions are the main cause of climate change (IPCC 2018). Therefore, I track climate inaction as the sum of country-year carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and fluorinated gas (F-gas) emissions from fossil and non-fossil fuel sources measured in per capita tons of CO₂ equivalent. Some scholars distinguish between emissions and the policies governments enact to reduce emissions, often referring to this as a distinction between climate policy outputs and outcomes (Bernauer and Böhmelt 2013). However, this distinction raises methodological problems. Most importantly, climate policy outputs are not directly comparable when they differ in stringency, policy instrument type, enactment timing, level of implementation, and other factors. Variation on these characteristics means that climate policy outputs do not necessarily correspond to actual reductions in emissions, such as when policies have low stringency, inadequate financing, late enactment timing, or poor implementation. Therefore, I use emissions data to measure countries' real level of climate inaction, assuming that more emissions indicate less climate action.

I measure fossil fuel wealth using the real per capita value of crude oil and natural gas production per country-year (Ross and Mahdavi 2015). Comparatively less debate exists about measures of fossil fuel wealth than climate inaction, but some scholars argue that oil and gas income does not capture fiscal reliance on oil and gas rents (Haber and Menaldo 2011; Lucas and Richter 2016). Fiscal reliance measures, however, assume that government budgets accurately reflect the full amount of countries' fossil fuel wealth. This assumption means that "off the books" transfers of oil and gas rents go unobserved (Wright and Frantz 2017), introducing measurement error when

autocratic leaders engage in rent-seeking activities not recorded in government budgets. Therefore, I adopt oil and gas income as a measure of the overall level of fossil fuel wealth that autocratic leaders could exploit for political gain.

I measure executive constraints using V-Dem's aggregate index of legislative constraints on the executive, *v2xlg_legcon* (Coppedge et al. 2023). This index measures the degree of executive constraint *both* from legislatures *and* non-legislative institutions, such as government agencies. Therefore, I decompose this index into the parts of it that measure oversight exercised by the legislature (*v2lginvestp*) or other institutional actors (*v2lggotovst*). Doing so both isolates the effects of oversight by excluding the components of the index that measure other forms of executive constraint and reduces measurement error from idiosyncratic question wording.

I sample all countries governed by authoritarian regimes with available data since 1990 for three reasons. First, climate change largely remained absent from the international agenda until 1990, when the first IPCC report confirmed the existence of anthropogenic warming trends (Weart 2008). Second, panel data provide causal leverage by reducing selection effects from country- and year-specific idiosyncrasies (Mummolo and Peterson 2018). Third, I exclude country-years governed by democracies based on Lüthmann, Tannenber, and Lindberg's (2018) Regimes of the World classification to limit the scope of analysis to authoritarian regimes.⁶

I analyze these data primarily using two-way fixed-effects estimators. First, I fit a restricted model without time-varying covariates, yielding an initial estimate of the marginal effects of oil and gas income on emissions. Then I consider potential confounders by including countries' level of electoral democracy, real per capita gross domestic product (GDP), real per capita volume of international trade, and population density (Coppedge et al. 2023; World Bank 2023) in a less restrictive model specification. These models provide a test of H_1 . If fossil fuel wealth weakens climate action in authoritarian regimes, then oil and gas income should lead to higher emissions.

Next, I estimate the conditional marginal effects of oil and gas income on emissions by fitting separate models for each measure of executive constraints. To do this, I specify what Hainmueller, Mummolo, and Xu (2019) call a "fully moderated" regression model in which I interact executive constraints with oil and gas income and all other covariates, allowing the marginal effects estimated previously to vary based on the overall levels of executive constraint, legislative oversight, and non-legislative oversight. Examining conditional relationships provides a test of H_2 when considering that the marginal effects of oil and gas depend on overall levels of executive constraint and H_3 and H_4 when considering that they depend on legislative and non-legislative oversight.

Two-way fixed-effects estimators help combat two threats to inference. First, they eliminate bias from confounding due to unobserved cross-sectional heterogeneity through the inclusion of unit fixed effects. Second, they eliminate bias from common time trends through the inclusion of time fixed effects. The use of observational data undoubtedly raises concerns about causal identification. Therefore, to further interrogate the credibility of the results, I conduct a sensitivity analysis (Cinelli and Hazlett 2020), as well as several placebo tests in [online appendix C](#) and model diagnostic tests in [online appendix D](#). I also examine whether the results differ when explicitly incorporating information about executive corruption, analyzing consumption-based emissions estimates, specifying lagged dependent and independent variable models, specifying different linear and nonlinear interaction terms, estimating multiway clustered standard errors, and considering alternative measurement and sampling choices (see [online appendices A–E](#)). These tests facilitate triangulation by comparing the main results to those of alternative tests based on different assumptions and overwhelmingly support the results of the main analysis.

Fossil Fuel Wealth Weakens Authoritarian Climate Action Conditional on Executive Constraints

Here I examine whether fossil fuel wealth leads to weaker climate action in authoritarian regimes (H_1) and whether the effects of fossil fuel wealth on climate action depend on levels of executive constraint (H_2) and oversight (H_3 and H_4).⁷

Main Results

[Figure 2](#) plots estimates of the marginal effect of oil and gas income on emissions from several models with two-way fixed-effects and country-clustered standard errors. This figure contains four model specifications of the effect on total or fossil emissions per capita with and without control variables. The results in [figure 2](#) indicate that for every \$1,000 increase in real per capita oil and gas income, emissions rise by roughly 0.5 ton per capita on average ($p < 0.01$), corresponding to roughly 6.9–7.2% of the sample means of total and fossil emissions. Thus, the results in [figure 2](#) support H_1 : fossil fuel wealth from oil and gas income leads to weaker climate action in authoritarian regimes, reflected in higher emissions.

Perhaps more importantly, however, the results in [figure 3](#) suggest that the amount by which emissions rise in response to rising oil and gas income depends on authoritarian regimes' levels of executive constraint. For autocracies at the tenth percentile of executive constraints (Executive Constraints = 0.064), oil and gas income leads to an estimated rise in emissions of roughly 0.483 ton per capita. But oil and gas income only increases emissions by

about 0.125 tons per capita in autocracies at the ninetieth percentile of executive constraints (Executive Constraints = 0.737). In other words, the effect of oil and gas income on emissions is significantly lower ($p < 0.01$) in constrained compared with unconstrained authoritarian regimes. This finding supports H_2 : fossil fuel wealth from oil and gas income leads to weaker climate action in authoritarian regimes, reflected in higher emissions, but the size of this increase depends on executive constraints.

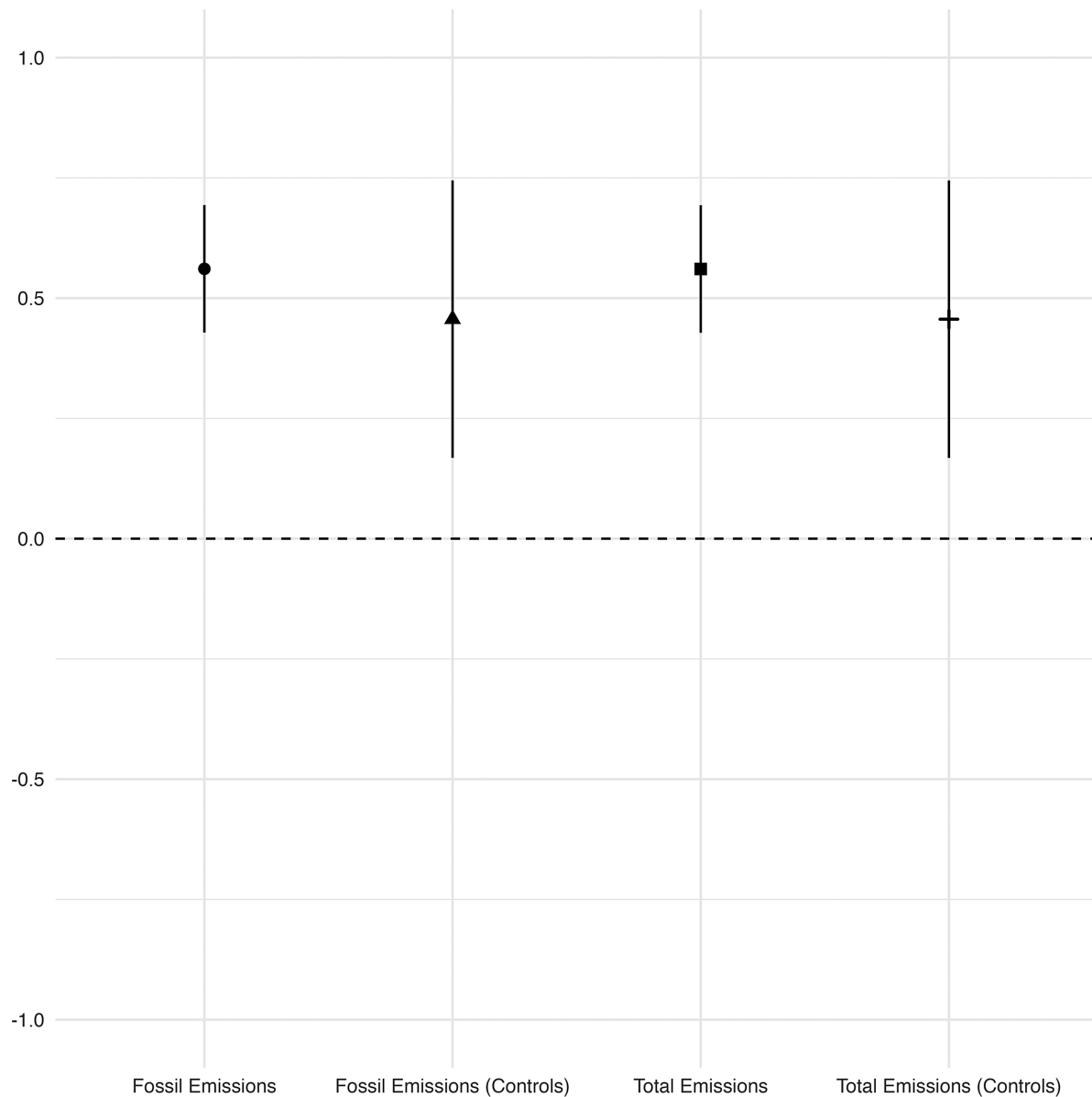
These results are consistent with the argument that, conditional on executive constraints, fossil fuel wealth weakens climate action in authoritarian regimes. But my theory also suggests that oversight rules are an especially effective form of executive constraint. Therefore, in [figure 4](#), I plot the conditional marginal effects of oil and gas on emissions separately for models of oversight exercised by actors in legislative and non-legislative institutions. [Figure 4](#) suggests that legislative and non-legislative oversight both moderate the effects of oil and gas on emissions, leading to significantly lower ($p < 0.05$) effects in constrained compared with unconstrained autocracies. This finding supports H_3 and H_4 : fossil fuel wealth from oil and gas income leads to weaker climate action in authoritarian regimes, reflected in higher emissions, but the size of this increase depends on legislative and non-legislative oversight.

Competing Explanations

The main results support H_1 – H_4 . Among nondemocracies, fossil fuel wealth leads to weaker climate action conditional on executive constraints. In this section, I consider four potential competing explanations and show that none convincingly accounts for the results of the main analysis. Moreover, I show that any competing explanation based on a theory of unobserved confounding would need to identify an omitted variable that is more than four times stronger a confounder as real per capita GDP to reduce the effects observed in the main analysis to 0.

First, I consider whether oil and gas exports confound the relationship between fossil fuel wealth and climate action in nondemocracies. Exporting oil and gas products could allow authoritarian regimes to capture carbon-intensive rents while avoiding responsibility for the environmental impact of burning fossil fuels (Ross 2001). Second, I examine whether state capacity accounts for climate action. Scholars have proposed that state capacity helps governments overcome opposition to reducing emissions and achieve climate policy goals (Meckling and Nahm 2022). Third, I consider whether state-owned oil companies confound the results. If state-owned oil companies affect opportunities for carbon-intensive rent-seeking, they may influence leaders' incentives to obstruct climate action (Luong and Weinthal 2010). Fourth, I

Figure 2
Marginal Effects of Oil and Gas Income and 95% CIs



examine whether legislative opposition, not formal institutions, creates executive constraints in nondemocracies. Executive constraints from oversight rules could simply reflect political opposition from legislators unaligned with the ruling coalition (Simison 2022).

I address these competing explanations, first, through statistical control. Holding constant real per capita net oil and gas exports (Ross and Mahdavi 2015), state capacity (Hanson and Sigman 2021), the presence of a nationalized oil company (NOC) (Mahdavi 2020a), or the proportion of seats held by opposition legislators (Lindberg et al.

2022) generally does not change the statistical or substantive conclusions of the main results. The results in tables 2–5 show that, conditional on executive constraints, oil and gas income leads to higher emissions in authoritarian regimes. Importantly, however, controlling for additional variables introduces additional assumptions.

If, for example, oil and gas exports depend on domestic production, then controlling for exports could introduce post-treatment bias. For another example, controlling for legislative opposition risks sampling bias by shifting the unit of analysis to the country-election year and systematically

Figure 3
Conditional Marginal Effects and 95% CIs
(Executive Constraints)

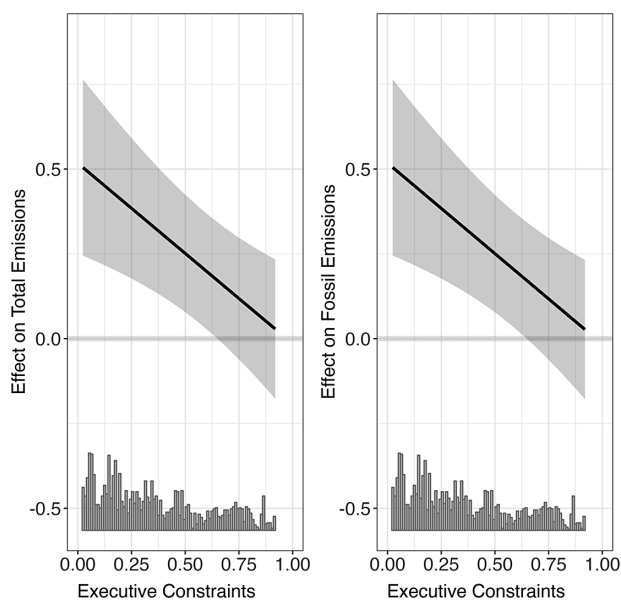
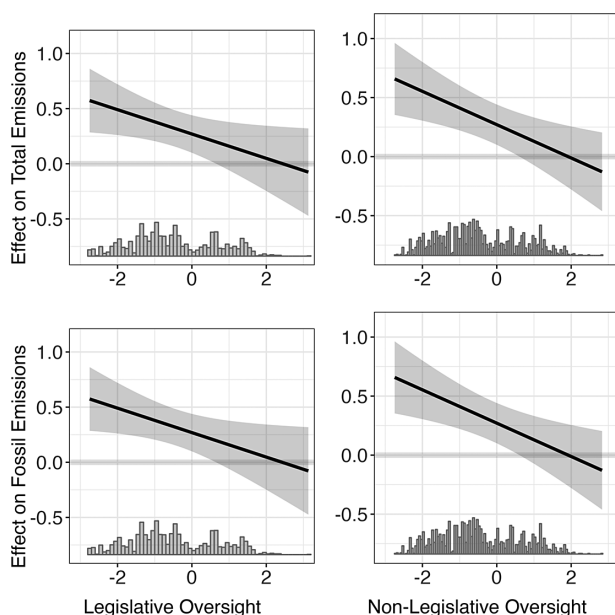


Figure 4
Conditional Marginal Effects and 95% CIs
(Oversight Rules)



excluding observations without elections. More generally, addressing competing explanations through statistical control relies on strong assumptions about the functional form

of treatment assignment, the underlying distribution of unobserved confounders, and other aspects of the data generating process.

Therefore, to address concerns about unobserved confounding more comprehensively and with fewer assumptions than are required for doing so through statistical control, I conduct a sensitivity analysis that uses unexplained variance in the least restrictive models specified in the main analysis to compute adjusted coefficient estimates for the explanatory variables of interest, given a hypothetical omitted variable that is k -times stronger a confounder as a given covariate in the model (Cinelli and Hazlett 2020).

In figures 5 and 6, I plot the partial R^2 values for the outcomes of interest (y -axis) against the partial R^2 values for the explanatory variables of interest (x -axis) in the least restrictive two-way fixed-effects models estimated in the main analysis. The adjusted coefficient estimates in these figures reveal that any hypothetical confounder would need to be more than four times more predictive of the outcomes and explanatory variables of interest than real per capita GDP to reduce the effects of either oil and gas income or the interaction between oil and gas income and executive constraints to zero. Given the strong, persistent relationship among GDP, emissions, and macroeconomic and institutional variables like oil and gas income and executive constraints throughout history, it is highly unlikely that the main results contain bias from unobserved confounding.

Discussion and Implications

The results support the two main findings of this article. First, oil and gas income led to higher levels of emissions in authoritarian regimes between 1990 and 2021, suggesting that fossil fuel wealth weakens autocratic regimes' efforts to combat climate change. Taking action on climate change means reducing oil and gas rents that autocratic leaders could use to maintain power by financing mechanisms of repression, co-optation, and rentierism, thereby creating incentives for them to obstruct climate action.

Second, however, oil and gas income produced a significantly lower rise in emissions in constrained compared with unconstrained autocracies during this period, suggesting that institutions that restrict unilateral executive action through oversight rules moderate the effects of fossil fuel wealth on climate inaction in nondemocracies. Effective climate action in nondemocracies demands restricting carbon-intensive rent-seeking behaviors. One way to do so may be through governing arrangements that limit autocratic leaders' ability to exploit fossil fuel wealth for their own political gain. Empirically, both legislative and non-legislative oversight rules may fulfill this role.

These findings both support and challenge existing research in interesting ways. First, they complement

Table 2
Oil and Gas Exports Results

	Dependent variable			
	Total emissions		Fossil emissions	
	(1)	(2)	(3)	(4)
Oil and gas	0.322*** (0.119)	0.391*** (0.130)	0.323*** (0.119)	0.392*** (0.130)
Executive constraints	0.293 (0.606)	−4.819*** (1.835)	0.275 (0.610)	−4.853*** (1.838)
Exports	0.272** (0.117)	0.246* (0.133)	0.271** (0.117)	0.245* (0.133)
Oil and gas × executive constraints		−0.398*** (0.144)		−0.400*** (0.144)
Country–year FEs	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Adjusted R^2 (within)	0.980	0.981	0.980	0.981
Observations	2,172	2,172	2,172	2,172

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Country-clustered standard errors are in parentheses.

Table 3
State Capacity Results

	Dependent variable			
	Total emissions		Fossil emissions	
	(1)	(2)	(3)	(4)
Oil and gas	0.523*** (0.143)	0.578*** (0.108)	0.523*** (0.143)	0.578*** (0.108)
Executive constraints	0.542 (0.777)	−6.472*** (2.326)	0.506 (0.780)	−6.556*** (2.332)
State capacity	0.450 (0.417)	0.510 (0.583)	0.457 (0.418)	0.518 (0.585)
Oil and gas × executive constraints		−0.718*** (0.163)		−0.720*** (0.163)
Country–year FEs	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Adjusted R^2 (within)	0.981	0.984	0.981	0.984
Observations	1,714	1,714	1,714	1,714

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Country-clustered standard errors are in parentheses.

recently proposed models of distributive climate politics in established democracies. Scholars of distributive climate politics tend to find that the unequal allocation of climate policy costs creates winners and losers that compete to influence the design, enactment, and implementation of emissions reduction measures (Aklin and Mildenberger 2020; Aklin and Urpelainen 2018; Mildenberger 2020). The findings in this article provide indirect support for these models to the extent they suggest that politicking over climate change occurs in authoritarian regimes as well. But they also suggest that, in authoritarian regimes, distributive climate politics reflects competition between executives who face

incentives to capture oil and gas rents and other elites in institutions that constrain (or do not constrain) carbon-intensive rent-seeking through oversight rules.

Second, these findings complicate the theory that environmental authoritarianism benefits from concentrating power in the hands of the executive. Indeed, my findings provide evidence of a more nuanced relationship between environmentalism and authoritarianism. Political institutions that decentralize power, spreading it more evenly between the executive branch and other institutions in authoritarian regimes significantly decrease the effects of fossil fuel wealth on emissions, suggesting they may also promote climate action. To be

Table 4
State-Owned Oil Companies Results

	Dependent variable			
	Total emissions		Fossil emissions	
	(1)	(2)	(3)	(4)
Oil and gas	0.522*** (0.145)	0.578*** (0.105)	0.522*** (0.145)	0.578*** (0.105)
Executive constraints	0.194 (0.721)	−5.887*** (2.050)	0.156 (0.724)	−5.976*** (2.065)
Nationalized oil company (NOC)	−1.230 (0.796)	−1.106 (1.085)	−1.235 (0.799)	−1.118 (1.090)
Oil and gas × executive constraints		−0.725*** (0.150)		−0.727*** (0.151)
Country–year FEs	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Adjusted R^2 (within)	0.981	0.984	0.981	0.984
Observations	1,773	1,773	1,773	1,773

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Country-clustered standard errors are in parentheses.

Table 5
Legislative Opposition Results

	Dependent variable			
	Total emissions		Fossil emissions	
	(1)	(2)	(3)	(4)
Oil and gas	0.242 (0.208)	0.567** (0.243)	0.239 (0.208)	0.566** (0.105)
Executive constraints	1.368 (0.955)	−2.109 (2.197)	1.430 (0.949)	−1.909 (2.200)
Opposition	0.007 (0.007)	0.027* (0.014)	0.007 (0.007)	0.027* (0.014)
Oil and gas × executive constraints		−0.795** (0.321)		−0.796** (0.319)
Country–year FEs	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Adjusted R^2 (within)	0.986	0.989	0.986	0.989
Observations	266	266	266	266

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Country-clustered standard errors are in parentheses.

clear, I do not advocate for “authoritarian climate governance” (Mittiga 2021, 1007). Recent evidence suggests that autocracies do not emit significantly less carbon pollution than democracies (Chesler et al. 2023), but my results suggest that emissions differ in predictable ways *among* autocracies.

Third, this article suggests that integrating existing work on the political economy of climate change, natural resource governance, and political institutions in authoritarian regimes helps explain why some autocracies contribute more than others to climate change. The disjointedness in these literatures stems largely from the fact that none of them ever intended to explain variation in

climate action among authoritarian regimes. Nevertheless, the explanation arising from a theoretical framework that incorporates diverse insights from scholars of climate politics (Javeline 2014), natural resource governance (Ross 2013), and executive constraints (Boix and Svolik 2013) has considerable analytical utility that warrants further investigation.

Finally, this article has ambiguous implications for ongoing policy debates about how to obtain credible climate policy commitments from oil-rich autocracies. There is substantial scholarly and popular debate about how to promote climate action in countries like Iran, Russia, Saudi Arabia, and Venezuela (Bordoff 2020;

Figure 5
Sensitivity Analysis Results

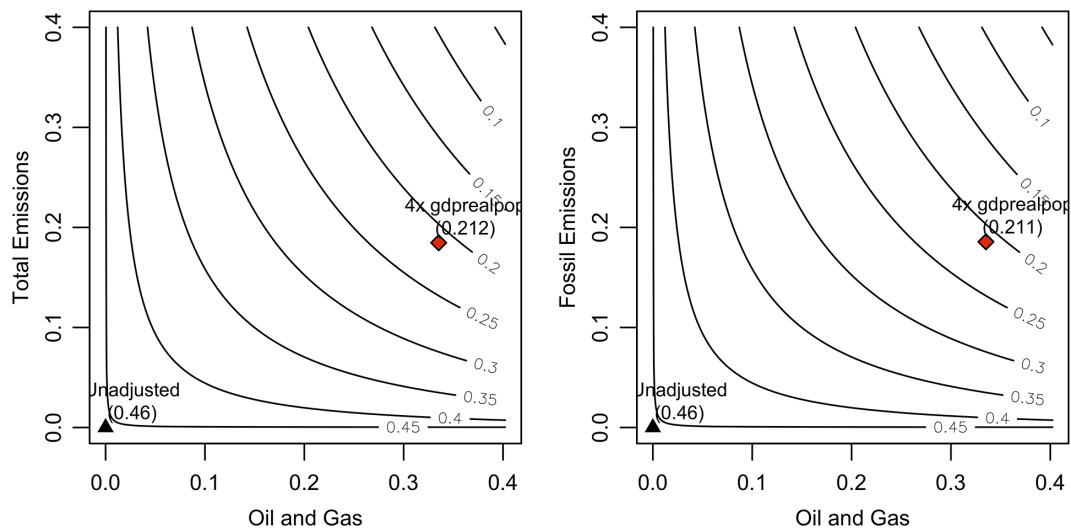
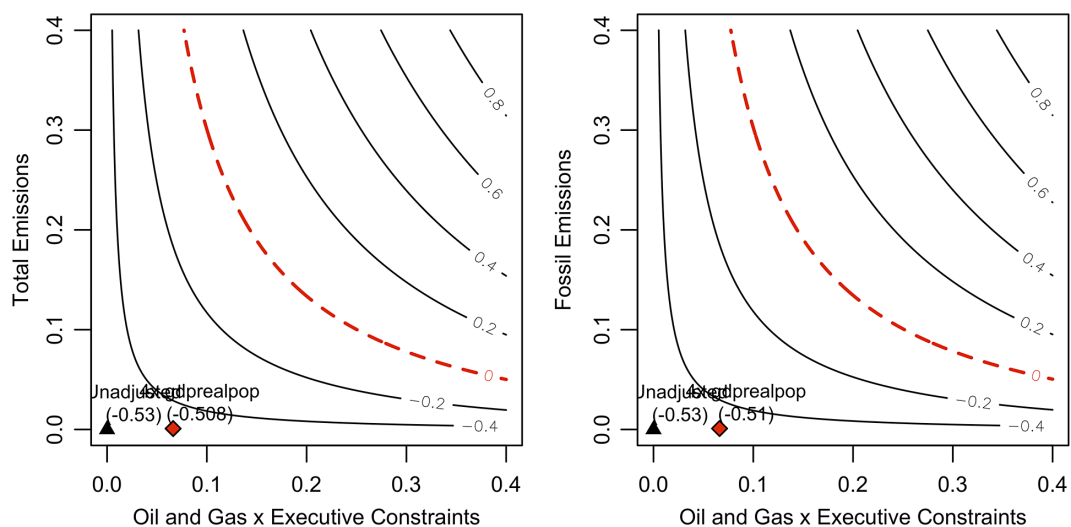


Figure 6
Sensitivity Analysis Results (continued)



Javeline et al. 2023; Zumbraegel 2022). My results point to an important but often overlooked factor that could motivate such commitments: domestic political reforms. When reforms create oversight rules that place fossil fuel wealth beyond the reach of autocrats, they may allow actors to chart a new course for pro-climate action even in countries rich in fossil fuels. However, such reforms may be extremely difficult to achieve and thus should not be regarded as a silver bullet for tackling

climate change. While climate policy makers should see executive constraints in authoritarian regimes as having greater importance, they should not consider executive constraints as the only, best, or even easiest way to support pro-climate action in autocracies. It is important for policy makers to remain clear-eyed about the likelihood of limiting global temperature rise to between 1.5 and 2°C above preindustrial levels within the brief time that remains available for doing so.

Conclusions

In this article, I consider why some nondemocracies contribute more to climate change than others. I argue that climate inaction in nondemocracies is shaped by a combination of fossil fuel wealth and executive constraints. Reducing emissions means reducing oil and gas rents that autocratic leaders could use to maintain power, providing them with incentives to obstruct climate action. Yet, executive constraints can limit opportunities for carbon-intensive rent-seeking through oversight rules and can thus moderate the effects of fossil fuel wealth on climate inaction in nondemocracies.

Evaluating this argument using panel data on greenhouse gas emissions, oil and gas income, and executive constraints in 108 countries governed by authoritarian regimes between 1990 and 2021, I find that fossil fuel wealth leads to weaker climate action, but that executive constraints moderate this relationship, producing significantly smaller effects in constrained compared with unconstrained autocracies. Oversight rules vested in both legislative and non-legislative institutions appear particularly effective forms of constraint. In developing this argument, I offer a novel explanation for climate inaction in authoritarian regimes: the lack of institutional constraints on autocratic leaders' use of fossil fuel wealth for political gain.

This theory, supported by the empirical results in this article, lends credence to distributive models of climate politics but complicates the argument that environmental authoritarianism benefits from centralized executive decision making. It also implies a greater need to incorporate insights from diverse literatures on the political economy of climate change, natural resource governance, and non-democratic political institutions to understand why some authoritarian regimes do more than others to combat climate change.

At first glance, the idea that fossil fuel wealth creates emissions in autocracies may seem obvious. In fact, 90% of the overall variance in emissions in my sample of autocracies since 1990 is cross-sectional, not within countries over time. However, the strong persistence of over-time trends in the data raises methodological challenges for studying the relationship between climate inaction and fossil fuel wealth in autocracies that this analysis addresses. The seemingly obvious findings ground conventional wisdom in rigorous, quantitative, empirical analysis that leverages within-case variation over time to estimate the causal effect of oil and gas income on emissions in authoritarian regimes. Future research may build on the evidence presented here by analyzing other important questions, such as the precise mechanisms by which fossil fuel wealth causes emissions to rise in authoritarian regimes.

Future research should identify the microfoundations of elite interactions in autocracies with relatively more or

less fossil fuel wealth and relatively stronger or weaker executive constraints, with a particular emphasis on analyzing their implications for climate change. It should also expand climate policy stringency data to include authoritarian regimes. Finally, it should also build on the arguments in this article with in-depth qualitative analysis to outline the concrete ways that fossil fuel wealth shapes climate inaction in different kinds of authoritarian regimes. Both theoretical and empirical advances are still needed to understand variation in climate action and inaction in authoritarian regimes. We still know too little about environmentalism and authoritarianism, but there is appreciable room to explore in the future.

Supplementary material

To view supplementary material for this article, please visit <https://doi.org/10.1017/S1537592724000793>.

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Data Replication

*Data replication sets are available in Harvard Dataverse at: <https://doi.org/10.7910/DVN/3Q6NST>

Notes

- 1 I use the terms “dictatorship,” “authoritarian regime,” “autocracy,” and “nondemocracy” interchangeably to refer to countries whose governments are not chosen through free and fair elections.
- 2 I refer to executive constraints as the degree to which political institutions restrict unilateral executive action. See Cox and Weingast (2018).
- 3 See Barma (2014); Yamada and Hertog (2020).
- 4 For a full list of cases included in the analysis, see [online appendix E](#). For more details about the data and

descriptive statistics, see the section “Data and Methodology” and online appendix B.

- 5 See online appendix B for all variable names, descriptions, measurements, and sources. See also Kakenmaster (2024) for data and replication materials.
- 6 See online appendix E for a discussion of alternative measurement and sampling choices.
- 7 See online appendices A and B for the full results, descriptive statistics, and other details.

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