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Too calm in the storm? Revisiting the Relationship Between Vulnerability and Climate Action

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Abstract

Most countries are expected to become more vulnerable to climate change over the coming decades. Existing literature suggests that increasing vulnerability might incentivize mitigation, as climate-induced disasters often act as "focusing events" that spur action. This viewpoint is somewhat optimistic, implying more action due to increases in damages. However, there is limited empirical support for this. Conversely, wealthy countries (which are generally less vulnerable) are expected to take greater action under the principle of *Common But Differentiated Responsibilities* due to their high incomes and historic responsibility for climate change. These two observations raise the research question of whether the negative relationship between vulnerability and climate action holds, even when controlling for countries' income per capita. Using relevant vulnerability data and controlling for output per capita, we find a strong negative association between vulnerability and three proxies of climate action (pledges, mitigation laws, and growth rate of emissions). Our findings challenge the "focusing events" argument, highlighting the importance of not relying on damages and vulnerability increases to foster action.

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1 Introduction

According to the IPPC, 2022 most countries across the world are in course to become more vulnerable to climate change over the coming decades due to “unavoidable increases in multiple climate hazards”. The recent deadly floods in Valencia are the latest example of this trend. The spectre of these events raise an unanswered but crucial question - to what extent does heightened vulnerability influence countries' decisions to mitigate climate action? Given that the frequency and intensity of climate disasters can only be prevented if future emissions are mitigated, understanding the relationship between vulnerability and climate mitigation is of the upmost importance.

The relationship between vulnerability and mitigation is not clear cut. Becoming more vulnerable to climate change is likely to lead to an increase in damages and deaths from extreme weather events. Such extreme phenomena can act as “focusing events” (Birkland, 1998) that shift public attitudes toward green policies (Andre et al., 2024; Zaval et al., 2014), voting behaviour for green parties (Hoffmann et al., 2022; Zelin et al., 2023) and mitigation policies (Rowan, 2022; Peterson et al., 2023; Tubi et al., 2012), however without always leading to parties' change in policy focus (Wappenhans et al., 2024).

Understanding the relationship by estimating associations using historical data presents challenges. The UNFCCC principle of Common But Differentiated Responsibilities (CBDR) requires rich countries to lead mitigation efforts, given their access to more economic resources and their historical responsibility for climate change related to the concept of just transition.[1] As rich countries are generally less vulnerable, due to the CBDR principle, a negative relationship between vulnerability and climate action can be expected. Thus, the research question becomes whether there is a negative relationship between vulnerability and climate action, even when controlling for countries' income per capita.

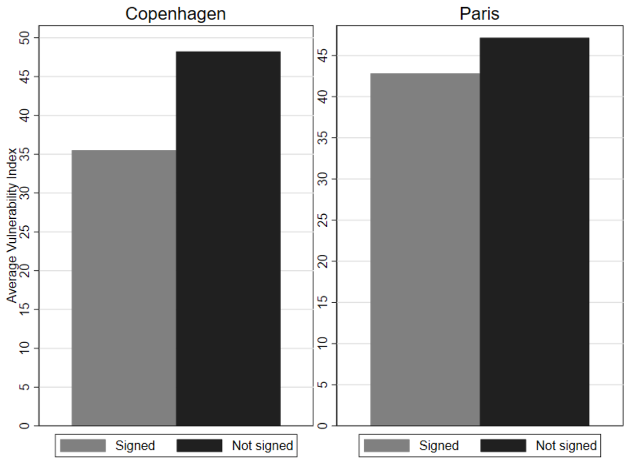
In order to test the previous hypothesis, we use vulnerability data from the Notre Dame Global Adaptation Initiative (ND-GAIN) and three dimensions of climate action highlighted by de Silva et al. (2021): pledges, laws and outcomes and control for GDP per capita and other effects discussed in relevant works (for example, see Tubi et al., 2012; Silva et al., 2024; Shepherd et al., 2022; Galanis et al., 2024). Contrary to the assumptions of the related literature, we find robust support that vulnerability is significantly negatively associated with climate action. Our finding has two main implications. Firstly, it indirectly questions the validity of the "focusing events" argument and provides empirical support of the fact that actually the inverse is true. Secondly, it emphasizes the need to enhance climate action in less vulnerable countries and to provide support to more vulnerable ones to reduce vulnerability levels.

2 Empirical Method and Data

We use an aggregate measure of vulnerability from the ND-GAIN data set, where higher values indicate higher vulnerability.[2] We measure international pledges as whether a country signed the 2008 Copen-

[1]For a discussion on Just Transition see Galanis et al. (2025).
[2]Table A1 in the appendix presents the summary statistics.

Figure 1: Vulnerability and pledges - whether signatories/non-signatories Copenhagen and Paris Accords



Notes: ND-GAIN Vulnerability index average 1995-2020 for groups of countries that did or did not sign the Copenhagen and Paris Accords with quantifiable targets.

hagen or 2015 Paris agreement, with quantifiable targets. Data for this is taken from de Silva et al. (2021), which shows that quantifiable targets in particular impact actual emissions. Figure 1 shows that countries which signed either the 2008 Copenhagen or the 2015 Paris Accords with quantifiable targets were on average less vulnerable than those that did not sign.

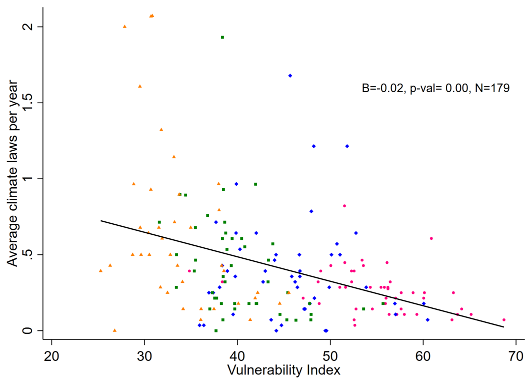
Laws are measured as the number of domestic mitigation laws passed in each country in any given year, from the Climate Change Laws of the World database. Outcomes refers to the log of GHG emissions per capita at the country level. Figure 2a shows a negative relationship between vulnerability and the average number of (mitigation) laws implemented in each country per year from 1995 to 2020.[3] Regarding outcomes, figure 2b shows that vulnerable countries are more likely to have higher growth rates of GHG emissions over the 1995-2020 period.[4]

We estimate three types of econometric models for each measure of climate action. For pledges, we estimate two cross-sectional logit regressions on pledging to sign the 2008 Copenhagen and the 2015 Paris Accord respectively. For laws, we estimate a fixed effect Poisson panel regression with maximum likelihood, given its robustness as an estimator for panel count data (Santos Silva et al., 2010). For outcomes, we estimate a fixed effect panel regression on the log of GHG emissions per capita. For all

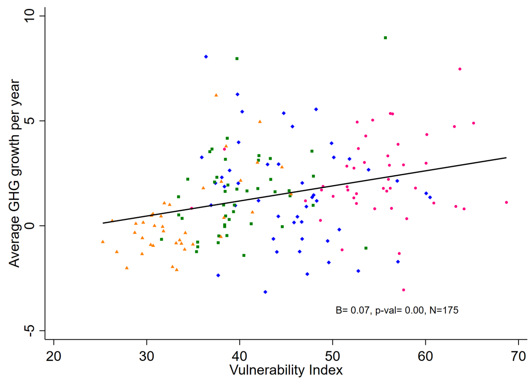
[3]Both vulnerability and climate laws have a panel data structure, but here we just present the between-country differences.

[4]Figures A1, A3 and A3 in the Online Appendix reproduce these figures for quartile groups based on average GDP per capita form 1995 to 2020, given that GDP per capita will be highly correlated to vulnerability. As can be seen, more vulnerable countries are still less likely to take action even within each income group.

Figure 2: Vulnerability vs Laws (left) and Outcomes (right)



(a) Vulnerability and Laws - average number of mitigation laws passed each year 1995-2020



(b) Vulnerability and outcomes - average GHG Growth per year 1995-2020

Notes: Averages of the average number of mitigation laws passed each year (left) and the average GHG growth per year (right) over the 1995-2020 period across 179/175 countries. We ignore Samoa, Kuwait and Saint Kitts and Nevis due to outliers growth rates in the figure 2b. A simple OLS regression is estimated with a coefficient (B) and p-value (p-val). The countries are split into four income quartiles. Yellow: Highest Income; Green: Middle Income; Blue: Lower-middle Income; Pink: Lower income.

estimations, we control for fossil fuel rents (the sum of coal, oil and gas rents as a share of GDP from the World Bank), population (millions people from World Bank), a measure of Democracy (University of Gothenburg's Varieties of Democracy database) and the left-right political orientation of the chief minister and GDP per capita a 2017 PPP dollars \$1000s from World Bank[5]. We consider the period from 1995 to 2017 due to data limitations. In the Poisson panel regression, we also control for the stock of domestic mitigation laws in the previous year, following Fankhauser et al., 2016.

3 Results

Table 1 shows the estimation results for the four baseline specifications. Across all regressions, vulnerability is strongly negatively associated with climate action. In column 1, a one unit increase in the vulnerability index reduces the odds ratio of signing the Copenhagen Accord by 0.731. The odds is the probability of signing the Copenhagen Accord relative to not signing it and the odds ratio is the relative change in odds for a one unit change in vulnerability. In other words, if vulnerability is increased by one unit, the odds of signing Copenhagen declines by 26.9% (i.e. they are reduced by 0.269) - a large effect. For example, reducing a country's vulnerability from the level of Paraguay (40) to the level of Canada (30) more than doubles the odds of signing the agreement (increase of 269%). Reducing the

[5]Note that the vulnerability index from ND-GAIN does not use GDP per capita in its construction (Chen et al., 2023)

vulnerability from the most vulnerable country (Niger) to the least vulnerable (Switzerland) increases the odds of signing the agreement by over a factor of 10 (by 1,154.5%). The coefficient is significant at the 5% level.

Column 2 shows the equivalent estimation with respect to the Paris Accord. Like Copenhagen, more vulnerable countries are less likely to sign the Paris Accord. A one unit increase in vulnerability reduces the odds ratio by 0.875, i.e. a one unit increase in vulnerability is associated with a 12.5% lower odds of signing Paris. While this effect is smaller than Copenhagen, it is still large and is significant at the 1% level.

Table 1: Estimation results: the relationship between vulnerability and climate action

	(1) Pledge: Cope	(2) Pledge: Paris	(3) Laws	(4) Outcomes
Vulnerability index	0.731**	0.875***	-0.258***	0.049***
	(0.106)	(0.038)	(0.056)	(0.016)
Log GDP per Capita	2.406	0.500*	2.309***	0.282***
	(0.579)	(0.380)	(0.292)	(0.071)
Fossil fuel rents / GDP	0.916*	0.955	-0.008	0.002**
	(0.042)	(0.033)	(0.010)	(0.001)
Democracy index	4.070	4.174	1.982***	-0.076
	(6.278)	(5.180)	(0.607)	(0.180)
Left-right index	0.921	0.645**	0.018	0.010
	(0.261)	(0.122)	(0.042)	(0.012)
Population	1.025**	1.003	0.003	0.000
	(0.011)	(0.004)	(0.003)	(0.001)
Stock Domestic Laws t-1			0.003	
			(0.009)	
R-squared	0.664	0.162	0.265	0.068
N	155	155	3414	3557

For two first two columns, we report exponentiated coefficients; Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Column 3 shows the results of the Poisson panel regression on the number of mitigation laws passed in each country in each year. A one unit increase in vulnerability is associated with a reduction in the number of climate laws by -0.258. This is significant at the 1% level. As the average number of laws implemented in each year is 0.358, this is a large effect.

Lastly column 4 presents the results of a fixed effect panel regression on log GHG per capita. A one unit increase in vulnerability is associated with a 0.049% increase in the log of GHG per capita. The magnitude of this effect is relatively small (average growth rate of GHG per capita over this period is 1.80%) but still significant at the 1% level.

We check the robustness of our results through the following tests. First, we estimate the effects without using controls (Table 2). Second, we use alternative measures for climate laws (Table 3). Third, we use alternative estimation techniques (Table 4). Finally, we use an alternative measure of vulnerability from Wheeler, 2024 (5). Across all robustness tests, vulnerability has a significant negative relationship with respect to climate action.

Table 2: Robustness 1: the relationship between vulnerability and climate action without controls

	(1) Pledges: Cope	(2) Pledges: Paris	(3) Laws	(4) Outcomes
Vulnerability index	0.771***	0.948***	-0.536***	0.009***
	(0.057)	(0.017)	(0.030)	(0.003)
R-squared	0.402	0.041	0.233	0.001
N	183	183	4860	4967

For two first two columns, we report exponentiated coefficients; Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In Table 2, columns 1 and 2 correspond to the relationship between vulnerability and pledges, column 3 corresponds to laws, and column 4 corresponds to outcomes. We note that in all cases the signs are the same and expected, and the results remain significant at 1% confidence level.

Column 1, in Table 3, uses a broader definition of laws from the Climate Laws Database of the World that does not just include passed laws but also all directives, decree, resolutions, strategies, acts, plans, programmes and policies implemented. As can be seen the relationship between vulnerability and this broader definition of mitigation action is still negative and significant. Column 2, in Table 3, uses an alternative measure of climate policy implementation, the Environmental Policy Stringency Index from the OECD. The index is only available for OECD countries, which is why the number of observations declines to 915. The relationship between this index (where positive numbers indicates more climate action) and vulnerability is still negative and significant.

Table 4 tests the robustness of the results to alternative econometric models. Columns 1 and 2 estimate the relationship on the Copenhagen and Paris Accord respectively using a probit model (comparaed to the logit regression used in the baseline). As can be seen, the relationship between vulnerability and pledging is still negative (i.e. the odd ratios are still below 1 and significant). Column 3 shows the estimations of a panel Poisson regression using the fixed effects estimator rather than the maximum likelihood estimator in the baseline. Column 4 estimates a random effects panel regression on the log of GHG emissions per capita (compared to the fixed effects estimator in the baseline). Across

Table 3: Robustness 2: alternative measure of law/policy

	(1)	(2)
Vulnerability index	-0.260***	-0.137***
	(0.055)	(0.039)
Fossil fuel rents / GDP	-0.008	-0.027
	(0.010)	(0.018)
Log GDP per Capita	2.348***	3.193***
	(0.265)	(0.149)
Democracy index	1.921***	1.200***
	(0.600)	(0.421)
Left-right index	0.011	-0.156***
	(0.042)	(0.022)
Population	0.003	-0.007***
	(0.003)	(0.001)
R-squared	0.269	0.554
N	3414	915

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Robustness 3: the relationship between vulnerability and climate action with alternative econometric models

	(1) Pledge: Cope	(2) Pledge: Paris	(3) Laws	(4) Outcomes
Vulnerability index	0.891*	0.919***	-0.258***	0.022*
	(0.060)	(0.027)	(0.066)	(0.012)
Fossil fuel rents / GDP	0.959**	0.973	-0.008	0.003***
	(0.021)	(0.022)	(0.010)	(0.001)
Log GDP per Capita	1.680*	0.647*	2.309***	0.281***
	(0.301)	(0.245)	(0.394)	(0.065)
Democracy index	2.965	2.064	1.982***	-0.075
	(0.926)	(0.715)	(0.760)	(0.173)
Left-right index	1.000	0.779**	0.018	0.010
	(0.155)	(0.107)	(0.048)	(0.012)
population	1.010**	1.002	0.003	-0.000
	(0.004)	(0.003)	(0.003)	(0.000)
Domestic stock laws t-1			0.003	
			(0.011)	
R-squared	0.635	0.173	NA	NA
N	155	155	3414	3557

For two first two columns, we report exponentiated coefficients; Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

all regressions the relationship between vulnerability and climate action is still negative and significant.

Table 5: Robustness 4: the relationship between vulnerability and climate action with alternative measure of vulnerability

	(1)	(2)	(3)
Vulnerability index 2	-1.497***	-0.673**	-0.415**
	(0.519)	(0.281)	(0.200)
Log GDP per Capita	-0.324	-0.967*	0.077
	(1.158)	(0.561)	(0.413)
Fossil fuel rents / GDP	-0.101	-0.045	-0.047**
	(0.062)	(0.043)	(0.021)
Democracy index	1.447	0.538	1.091
	(2.276)	(1.434)	(1.465)
Left-right index	-0.210	-0.340*	0.400**
	(0.365)	(0.190)	(0.164)
Population	0.022***	0.009	0.006***
	(0.007)	(0.010)	(0.002)
R-squared	0.68	0.15	0.336
N	149	149	150

Standard errors in parentheses

(1) Logit 2015 Copenhagen Accord; (2) Logit 2015 Paris Accord; (3) Laws

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5 tests the robustness of the results to an alternative measure of vulnerability from Wheeler (2024). This measure of vulnerability only has a cross sectional component measured in 2010 and so this robustness test only looks at the cross sectional regressions and we do not test the relation between outcomes and vulnerability (column 4 of the previous tables). Column 1 and 2 estimates the relationship on the Copenhagen and Paris Accord respectively using a probit model (compared to the logit regression used in the baseline). As can be seen, the relationship between vulnerability and pledging is still negative (i.e. the odd ratios are still below 1 and significant). Columns 3 estimates an OLS regression of the measure of vulnerability on the total number of laws implemented until 2010. Across all the regressions the relationship between vulnerability and climate action is still negative and significant.

4 Conclusion

Our commentary provides an empirical estimation of the relationship between vulnerability and three dimensions of climate action (pledges, laws, and outcomes). Contrary to the prevailing assumption that increased vulnerability drives heightened mitigation efforts through “focusing events”, our findings reveal a significant negative association between vulnerability and different measures of climate action. Furthermore, our findings are robust when controlling for income per capita and other factors. This shows that our results are not simply driven by the fact that richer countries pollute more, also related to the CBDR principle.

Our analysis emphasises the critical role that less vulnerable countries must play in enhancing climate action and leading global mitigation efforts. At the same time, it is essential to provide substantial support to more vulnerable countries to help them reduce their levels of vulnerability, enabling them to take more effective climate action. As such this commentary contends that just transition concerns hold significant importance not only from a normative standpoint but also from a practical one, as addressing these concerns is crucial for achieving equitable and sustainable climate outcomes worldwide.

Our work raises different questions for future research on the relationship between vulnerability and climate action. First, while our results are robust under various specifications, our analysis shows association between variables and is not a causal one. As such one future direction is to establish similar results, through a causal analysis if possible. Second, the focus of this commentary has been to show that existing insights do not hold. An interesting extension would be to provide an in-depth theoretical understanding of why this is not the case. Finally, the focus here has been international inequalities related to per capita income and vulnerability, the effects of within country inequalities on climate action remains an open question.

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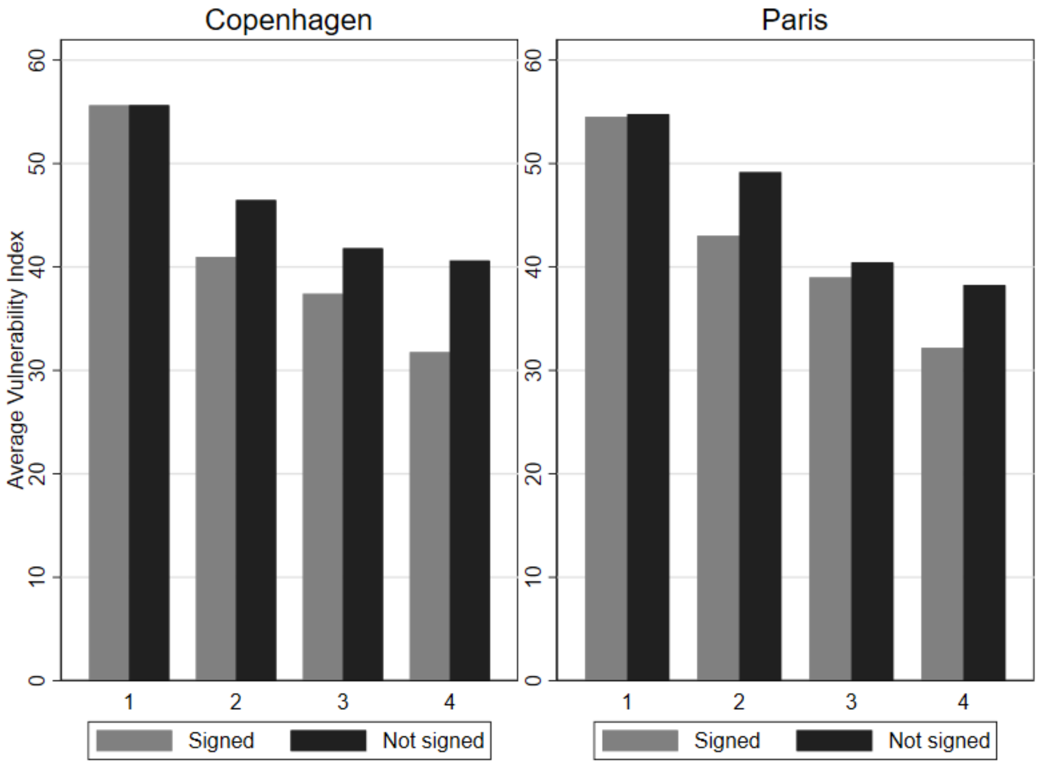
Online Appendix

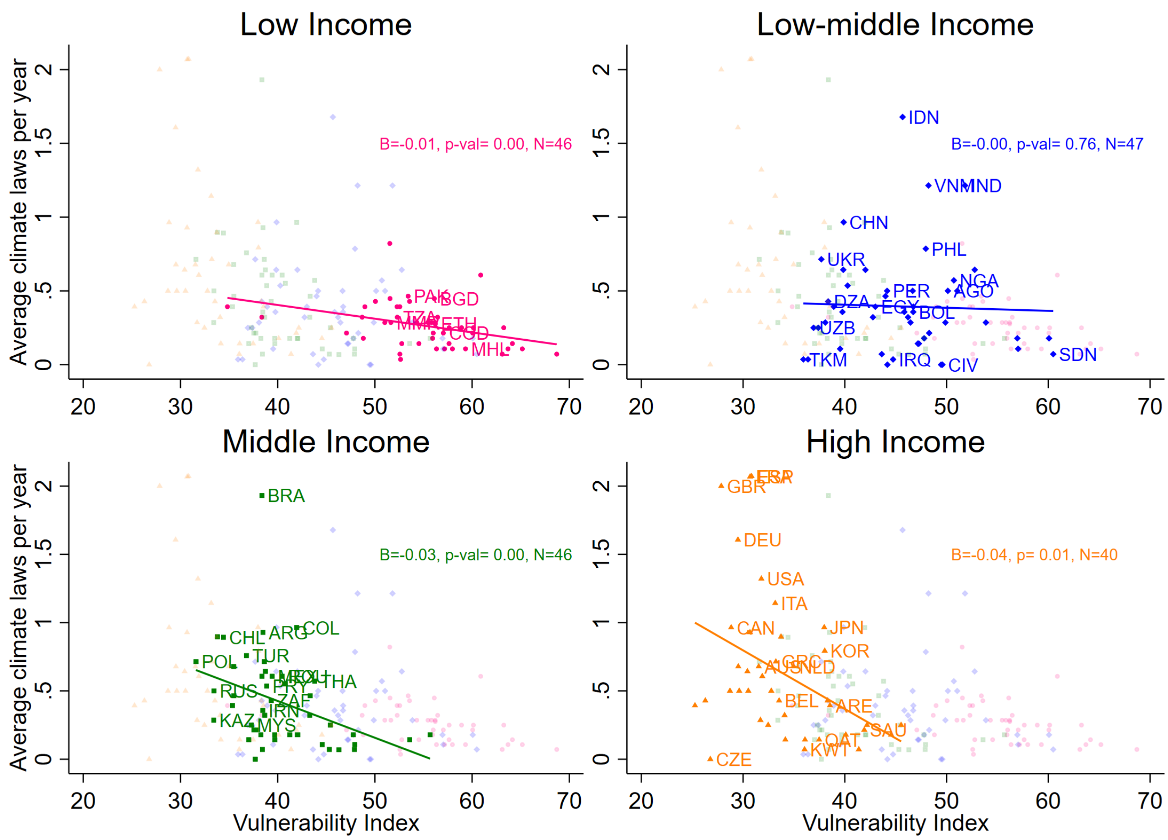
Figure A1: Vulnerability and pledges - whether signatories/non-signatories Copenhagen and Paris Accords



Notes:

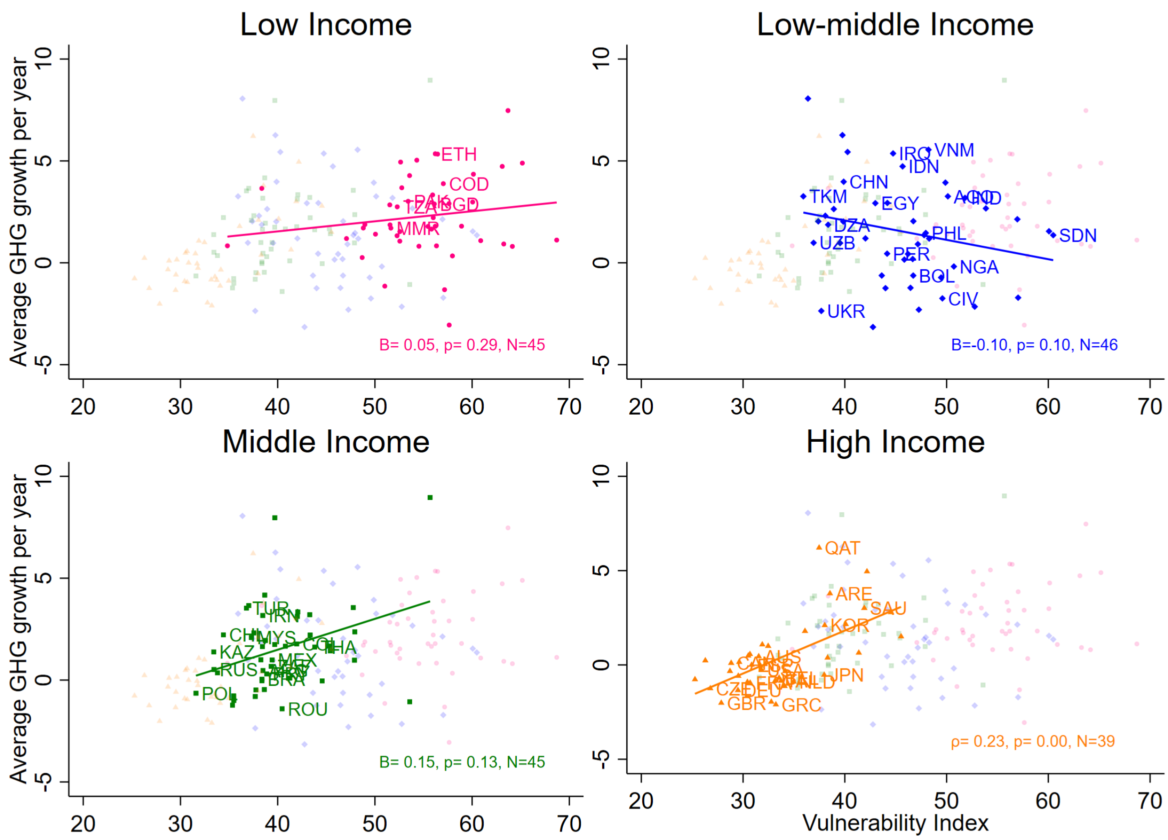
Averages of the vulnerability index from the ND-GAIN database, are taken for groups of countries that did or did not sign the Copenhagen and Paris Accords with quantifiable targets. The countries are split into four income quartiles based on their average GDP per capita from 1995 to 2020: highest income; middle income; lower-middle income; lower income

Figure A2: Vulnerability and laws: average number of mitigation laws passed each year 1995-2020 for each income group



Notes: Averages of the ND-GAIN Vulnerability index and the average number of mitigation laws passed each year are taken over the 1995-2020 period across 175 countries. A simple OLS regression is estimated with a given coefficient (B) and p-value (p-val). The countries are split into four income quartiles. Yellow: Highest Income; Green: Middle Income; Blue: Lower-middle Income; Pink: Lower income

Figure A3: Vulnerability and outcomes: average GHG Growth per year 1995-2020 for each income group



Notes: Averages of the ND-GAIN Vulnerability index and the average GHG growth per year are taken over the 1995-2020 period across 175 countries. A simple OLS regression is estimated with a given coefficient (B) and p-value (p-val). The countries are split into four income quartiles. Yellow: Highest Income; Green: Middle Income; Blue: Lower-middle Income; Pink: Lower income

Table A1: Summary Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Sign Copenhagen (1=sign)	155	.3419355	.4758957	0	1
Sign Paris (1=sign)	155	.8064516	.3963596	0	1
Yearly number of mitigation laws	3,557	.358167	.7555001	0	8
Log GHG per capita	3,557	1.809159	.8638681	-.4168989	4.710632
NG Gain Vulnerability Index	3,557	43.45464	9.517274	24.58329	68.53706
Log GDP per Capita	3,557	-4.689832	1.212857	-7.671683	-2.11488
Fossil fuel rents / GDP	3,557	4.915929	11.18361	0	87.57686
Democracy index	3,557	.535244	.2639153	.015	.924
Left-right index	3,557	1.213944	1.276264	0	3
Population	3,557	41.21697	144.4472	.170612	1396.215
Stock Domestic Laws t-1	3,557	2.542311	3.644528	0	31
Climate Policy OECD	915	1.882058	1.145673	0	4.222222
Yearly no. of mitigation policies	3,557	.3601349	.757725	0	8
Log Alternative Vulnerability Index	3,419	-.6301996	2.393338	-6.214608	4.60517 height