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Abstract

Stringent climate policy compatible with the targets of the 2015 Paris Agreement would pose a substantial scal challenge. Reducing carbon dioxide emissions by 95% or more by 2050 would raise 7% (1-17%) of GDP in carbon tax revenue, half of current, global tax revenue. Revenues are relatively larger in poorer regions. Subsidies for carbon dioxide sequestration would amount to 6.6% (0.3-7.1%) of GDP. These numbers are conservative as they were estimated using models that assume rst-best climate policy implementation and ignore the costs of raising revenue. The scal challenge rapidly shrinks if emission targets are relaxed.

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1. Introduction

Much has been written about how to reduce greenhouse gas emissions and how much that would cost (see Riahi et al., 2022, for a review of recent studies) but there is little about the implications for the public nances. This is an odd omission. Rapid emission reduction requires a major overhaul of the energy sector and energy-intensive activities (IEA, 2021). The energy transition will not just a ect energy but everything it touches, including tax revenue and government spending. IEA (2022), for instance, reports that investment in the energy sector needs to double between 2020 and 2030, from 2% to 4% of GDP. This paper uses results from commonly-used integrated assessment models to study the impact of stringent climate policy on tax revenue and public expenditure, revealing the potential size of the carbon industry in the process.

The climate economics literature has focused on how best to reduce emissions (Dubash et al., 2022) and what that would cost (Riahi et al., 2022). Much attention has been paid to the technical feasibility of rapid emission reduction (Clarke et al., 2009) and to the required transition of energy, agriculture, and transport. The accompanying cha Tdtransit]TJ 0 914 -14.4403

2‰target of the 2015 Paris Agreement. India's Leviathan tax (for 2019) is $95/tCO$_{2eq}$, China's $96/tCO$_{2eq}$, and Indonesia's $102/tCO$_{2eq}$. Stringent climate policy is therefore not just a technical and economic challenge, but a scal challenge too.

Fiscal problems would arise long before the Leviathan tax is reached. Besley and Persson (2013) show that scal capacity has grown slowly and that the structure of tax revenues has developed gradually. Rapid, massive change in tax collection is unprecedented and would be di cult, or so the historical record suggests. Climate policy would require two tax revolutions. First, taxes should shift to carbon from everything else to drive emissions to zero|and then taxes would have to shift back to maintain tax revenue.

Dowlatabadi (2000) was perhaps the rst to warn about possible tax revolts (Burg, 2004, Keen and Slemrod, 2021) in the context of climate policy. One example is the 2018 protests by les gilets jaunesin France in response to a modest carbon tax on transport fuels (Stoll and Mehling, 2021). The carbon taxes needed to meet the Paris targets are not modest|and they will need to apply in countries that are not as used to high taxes as France is.

Throughout the paper, I write about climate policy as if a carbon tax were the sole policy instrument. The reason for this is that the models I rely on make this assumption. Although the optimal climate policy is a carbon tax, a uniform carbon tax, and nothing but a carbon tax (Tol, 2023b), the bulk of past and present climate policies rely on other instruments. There is no reason to assume future climate policy will be any di erent.

Some of the insights carry over. Cap-and-trade with auctioned permits behaves much like a carbon tax, the key di erence being that permit prices uctuate and taxes do not. The revenue of permit auctions can be used to reduce taxes.

If permits are grandparented instead of auctioned, climate policy is like a carbon tax (at the margin) plus lump-sum capital subsidies for the recipients of free permits. These capital subsidies pose no burden on the scal budget as the government costlessly creates the permits before giving them away. In this case, taxes cannot be reduced. Instead, the public sector expands.

Subsidies, another popular policy instrument, are negative taxes. Other taxes would need to go up substantially if subsidies are used to reduce emissions at the required scale.

Any technical standard has an equivalent tax (Baumol and Oates, 1971). If standards are the policy instrument of choice|as they often are|the tax burden calculated below is a measure of the changes needed in the economy. Fiscal implications would be indirect.

More troublesome than the assumption of a carbon tax is the assumption, again taken from the models I rely on, that climate policy will be cost-e ective.[3] Current climate policy most de nitely is not (e.g., Grimm et al., 2022). However, this strengthens the argument below. If cost-e ective policy implies unrealistically large scal shocks, then sub-optimal policy (with

[3]This paper shies away from a discussion of optimal climate policy targets, which are treated extensively elsewhere (Nordhaus, 1992, Tol, 1999, 2012b, 2023a).

the same emissions target) implies even larger shocks. Admittedly, without a carbon tax, those shocks may not be to the public nances; they will be to the economy instead.

The paper proceeds as follows. Section 2 discusses the materials and methods used. Section 3 presents the results. Section 4 concludes.

2. Materials and methods

The IPCC AR6 scenario database contains projections of GDP, greenhouse gas emissions, carbon dioxide sequestration, and emission taxes for a range ex-ante models and a range of scenarios with and without emission reduction targets. The database contains a host of variables on the structure of energy demand and supply, agriculture, land use, and so on. I here only use GDP, gross carbon dioxide emissions, gross carbon uptake, and carbon taxes. For most models, results are reported for 10-year intervals until 2100.

While generally well-structured, the database, unfortunately, does not match baseline and policy scenarios; this was added, manually, based on scenario names. Missing rows were

gives the posterior estimate of the tax efficacy. Alternatively, I shrunk the five estimates to a single, combined one (Goldberger, 1986). In a second step, as a prior, I assumed that each IPCC model is equally likely. The posterior likelihood of the tax efficacy implies a probability that an ex-ante model is able to reproduce observed climate policy as measured by the ex-post models.

While the methods are well-established, this is their first application to the fiscal implications of stringent climate policy.

3. Results

3.1. Model skill

Before discussing the key results, I need to establish which model is most credible. This is because the range of model range is so large. Some models find that climate policy is too

3.2. The impact of stringent climate policy

Table 2 shows the main result. Twelve models in the IPCC AR6 database report scenarios

obvious like ill-health. If climate policy is successful, there is not much of a problem to solve anymore, making it harder to continue to justify spending large sums of money. In order to keep costs down, carbon capture will be done where land is cheap|that is, where few people live|and heavily mechanized. Paying 7% of your income in taxes to keep grandma alive and your nurse friend in work is one thing. Paying 7% to a multinational company to suck carbon dioxide out of the air in a faraway country is something else.

3.3. Regional results

The above results are for the world as a whole. The models in the IPCC database also report regional results. I restrict the attention to imaclim and one particular scenario which reduces emissions by 94% in 2050. The carbon tax is \$300/tCO_2 in 2030, rising to \$1,298/tCO_2 in 2040 and \$2,253/tCO_2 in 2050. Figure 2 shows carbon tax revenue and sequestration subsidy, as a percentage of GDP, for 2030, 2040, and 2050.

panel, continue to fall steadily. Sequestration, in the bottom right panel, similarly shows no profound non-linearity. The top right panel shows the drop in GDP, which accelerates around a 50% emission reduction. This accentuates carbon tax revenue and carbon sequestration expenditures relative to GDP.

4. Discussion and conclusion

Stringent climate policy would pose a substantial scal challenge. The global revenue of the

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Table 1: Carbon tax e cacy according to 24 *ex-ante* models and 5*ex-post* policy evaluations.

model	#	mean	st.err.	prob.
coffee	63	4.883%	0.584%	0.000
aim	123	1.103%	0.352%	0.000
image	81	0.802%	0.128%	0.000
remind	286	0.705%	0.045%	0.000
witch	142	0.646%	0.028%	0.000
gcam	47	0.612%	0.082%	0.000
gem-e3	49	0.604%	0.025%	0.000
message	258	0.566%	0.042%	0.000
poles	134	0.544%	0.046%	0.000
farm	12	0.529%	0.060%	0.000
prometheus	6	0.442%	0.065%	0.000
eppa	4	0.373%	0.040%	0.000

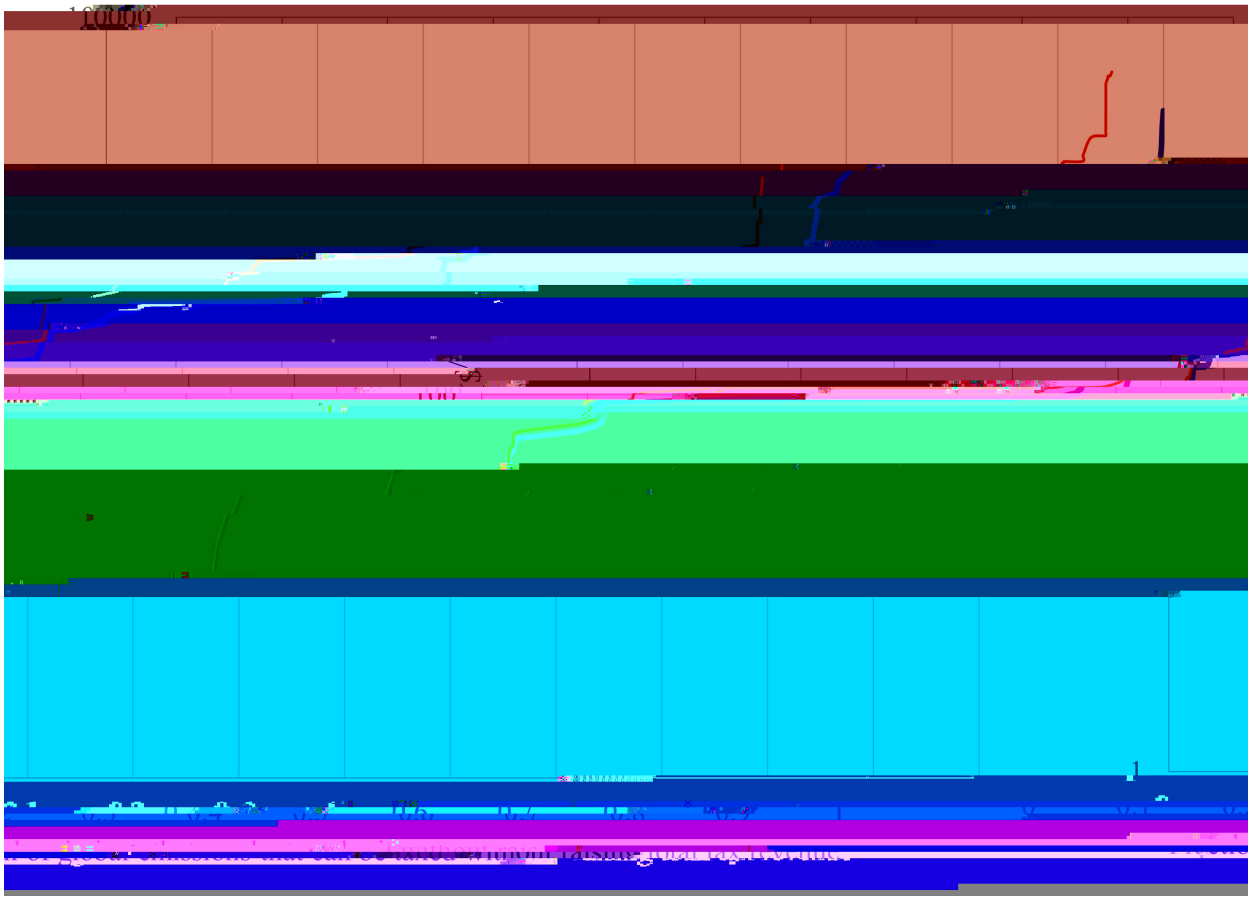

Figure 1: The Leviathan tax for 2019 without (thick blue line) and with emission reduction (thin orange line

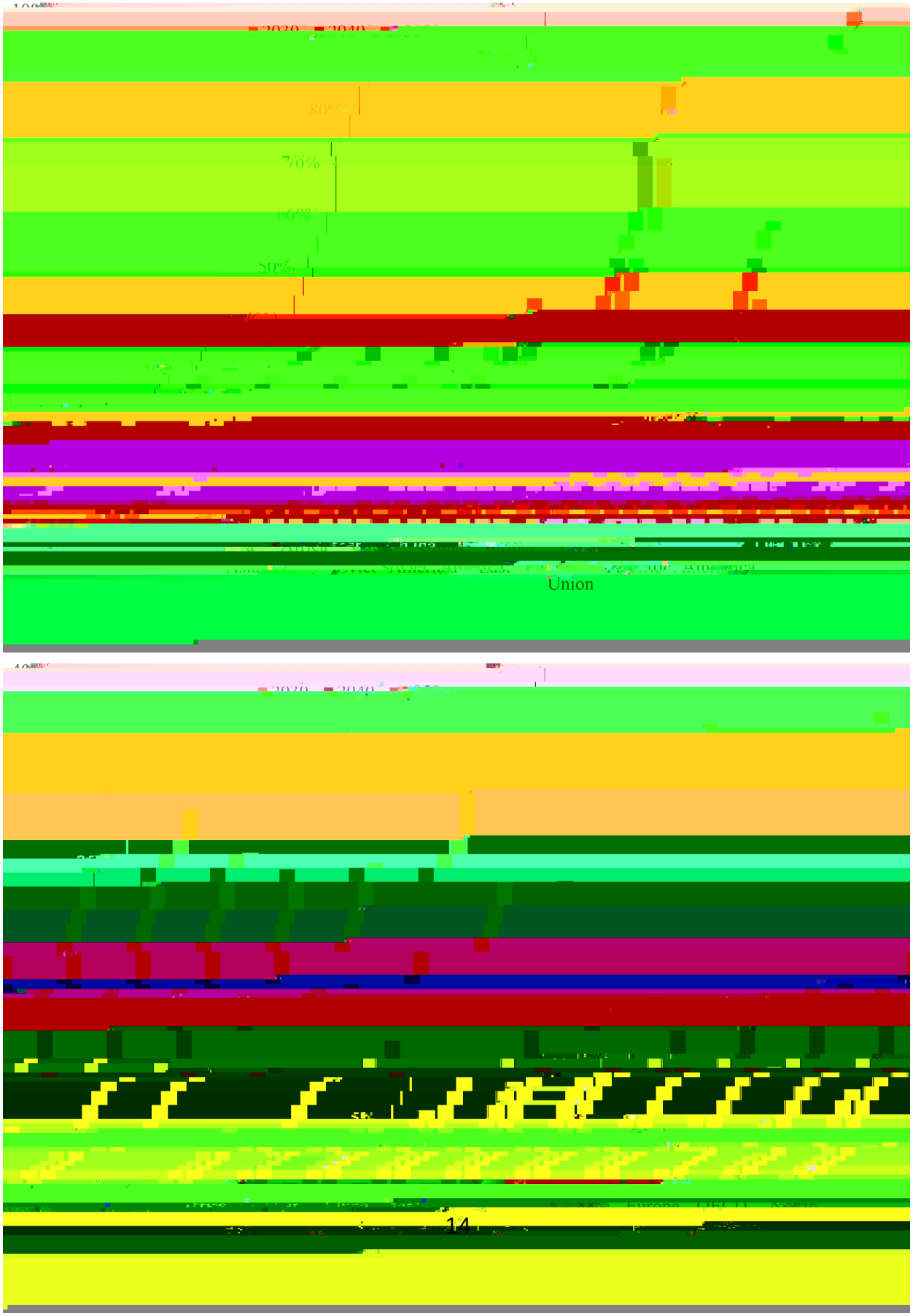

Figure 2: Carbon tax revenue (top panel) and carbon sequestration subsidy (bottom panel) as a share of GDP for 10 regions according to theimaclim model and its ADVANCE/2030/WB2C scenario.

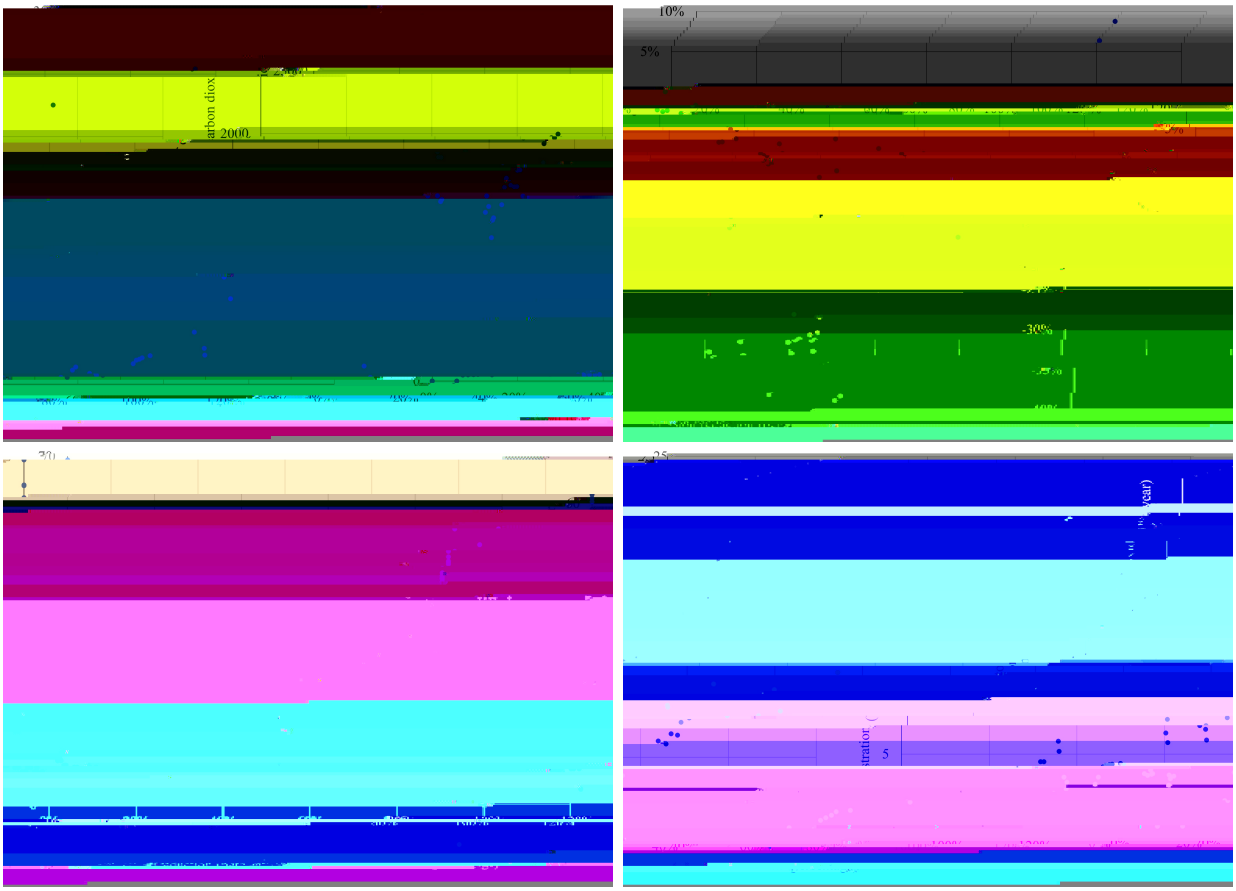

Figure 3: The carbon tax (top left), loss of GDP (top right), gross carbon dioxide emissions (bottom left) and carbon dioxide sequestration (bottom right) in 2050 as a function of carbon dioxide emission reduction from baseline according to theimaclim model.

Table 2: Value of carbon capture and emissions as share of GDP in 2050.

model	tax $/tCO$_2$	sequestration %GDP	emissions %GDP
coffee	3	-0.07	0.20
aim	119	-0.29	1.73
gem-e3	385	-0.30	1.07
gcam	1720	-0.31	-4.21
remind	537	-1.76	2.66
image	586	-2.26	3.35
message	823	-2.26	4.83
witch	1204	-3.08	5.84
poles	4601	-4.09	17.08
imaclim	913	-6.56	7.41
grape	1196	-7.09	20.58
dne21	977	-230.08	301.22

For the selected 10 IPCC models, the table shows the gross carbon tax revenue and the total subsidy for carbon dioxide