Manuscript Number: **ECOLEC-D-24-01797**   
  
Systematically evaluating all European climate policies: a reverse causal analysis  
  
Dear Mr Tebecis,

Thank you for submitting your manuscript to Ecological Economics. We have received reviews of your manuscript from two scholars who are experts on the topic.

I regret to inform you that one of the reviewers have advised against the publication of your manuscript in its current form. Consequently, I must reject it at this time. For your information and guidance, comments received from reviewers are listed below.

As your work – despite the significant concerns with the current version – shows potential, you can resubmit a substantially re-researched and re-written version of your paper, which would be considered a new submission. If you choose to do this, please indicate my name as the handling editor and the reference number of the current paper in the cover letter accompanying the new submission.  You should also explain in detail how the paper has been revised in response to comments from the editor and reviewers. To avoid misunderstandings: this rejection-plus-invitation-to-resubmit is not an invitation for a normal major revision, but we expect an essentially new paper.  
  
Thank you for giving us the opportunity to consider your work.

Kind Regards,  
Mikael Skou Andersen, Ph.D.   
Editor   
Ecological Economics  
  
Reviewer comments:  
  
Reviewer 1: The paper identifies effective climate policies in the European Union by first detecting structural breaks in two-way fixed effects models of greenhouse gas emissions, and subsequently attributing these breaks to potential policy interventions. The paper provides insights into effective policies, makes a valuable contribution to the novel literature on reverse-causal modelling, and is well-written and engaging. I recommend publication subject to some revisions outlined below.  
  
Main Comments:  
  
1. Estimation of Breaks and Sample Specifications  
  
i. Minimum Effect Size: it's perhaps worth discussing that there is a minimum detectable effect size of emissions reductions, and this minimum effect size increases the more conservative (i.e lower) the significance level of selection is. In other words, a break needs to be larger (relative to the standard error) to be detected at a 0.1% target compared to a 5% target level of significance of selection. The minimum effect size will depend on the sample size and could be simulated here, or at the least, mentioned. For example, Stechemesser et al. (2024) note this in their appendix.  
  
ii. Break Date Uncertainty: Uncertainty around the break dates can significantly impact policy attribution. As the paper mentions, there may be anticipation effects or lags until a policy becomes effective. The paper states that an interval around the break date is being used, but it's not clear what that interval is? I couldn't find the interval in the text. While precisely quantifying the break uncertainty isn't fully solved, you could consider using approximate intervals or the fixed interval approach (e.g. +- 2 years) applied by Stechemesser et al. (2024). Alternatively, the approximation method from Hendry and Pretis (2023) for simple time series step-functions could also be informative, though this is computationally more involved.  
  
iii. Country/Sector Samples and Structural Breaks:  
  
a. The paper lists 23 (or so) different greenhouse gases (GHGs) in its dataset, but the estimation results seem to be presented only as an aggregate. Table 1 states that coefficients are reported as averages? I don't fully understand how individual sectors are used here. Is a separate model run for each sector? Please clarify and consider perhaps reporting full results (in main text or the appendix).  
  
b. The methodology for analyzing EU-wide emissions and the case study of Austria require some clarification. Are there two distinct samples for these analyses? While the introduction mentions Austria as a case study, it is unclear how this is estimated differently from the EU specification. Please elaborate on the methodological differences between these two levels of analysis.  
  
c. Please clarify whether all countries in your analysis are considered potentially treated. If so, Table 1 should specify which countries the identified breaks refer to.  
iv. Austrian Case Study: Table 3 lists multiple Austrian structural breaks, yet the EU model reports only nine breaks. How are these Austrian-specific breaks derived? This distinction needs to be clarified. What is the model specification that is run for Austria?  
  
v. EU Structural Break Detection: Please provide additional details on the method used to detect structural breaks for the EU. How are the break indicators specified? Is the EU treated as a single unit in this analysis, with aggregated emissions levels, or are individual countries included in the model, with structural breaks assumed to affect all EU countries uniformly? Are the identified EU-wide structural breaks then used to infer policies for the EU15 group? This relationship requires further explanation.  
  
2. Attribution: Attributing treatment effects is a challenging step, particularly when dealing with smaller sectors. For example, the large treatment effect estimated for urea production stands out, yet this is a relatively small sector. Could the observed effect simply result from a small operation shutting down? This attribution could benefit from a more detailed discussion in the text.  
  
Minor Comments  
  
i. Background on the methods: The methods of detecting breaks in a TWFE panel and then interpreting them as treatment (as applied in this paper) were first introduced in Pretis (2022), followed by the application in Koch et al. (2022), and more recently by Stechemesser et al. (2024). A brief mention of these studies could help contextualize the methodological development.  
  
ii. Tables: The tables are very clear and well-organized. However, I suggest adding the standard errors alongside the break coefficients. It is, however, great to see the implied reductions in CO2 equivalent emissions.  
  
iii. Model Fit: It might be nice to show plots of model fit and structural breaks (at least for a subset of the results?).  
  
References:  
  
Hendry, D. F., & Pretis, F. (2023). Quantifying the uncertainty around break dates in step-indicator saturation. Working Paper. https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=4416619  
Pretis, F. (2022). Does a carbon tax reduce CO2 emissions? Evidence from British Columbia. Environmental and Resource Economics, 83(1), 115-144.  
Stechemesser, A., Koch, N., Mark, E., Dilger, E., Klösel, P., Menicacci, L., Nachtigall, D., Pretis, F., Ritter, N., Schwarz, M. and Vossen, H., 2024. Climate policies that achieved major emission reductions: Global evidence from two decades. Science, 385(6711), pp.884-892.  
  
  
  
Reviewer 2: My recommendation is to reject the submitted article, as it does not align closely with the objectives of the journal Ecological Economics. The journal aims, among others, to integrate elements of ecological science, economics, and the analysis of values, behaviors, cultural practices, insti-tutional structures, and societal dynamics.  
The submitted article focuses primarily on a climate policy analysis, specifically evaluating the effectiveness of various EU climate instruments in reducing greenhouse gas emissions using the reverse causal approach to structural breaks in greenhouse gas emissions. It would be more appropriate to submit this work to journals that specialize in policy issues, such as Climate Policy or Energy Policy.  
That said, the subject of the paper is highly interesting and policy relevant. However, there are several aspects that require attention to enhance the paper's quality, improve the analysis, and ensure more robust and plausible results.  
Some general comments:  
The author claims to be conducting an analysis of the effectiveness of all climate policies and policy mixes in Europe from 1995 to 2022, covering 23 greenhouse gases across 37 sectors. However, there is no comprehensive overview of the policies and policy mixes being investigated. It is merely mentioned that the International Energy Agency's Policies and Measures Database was used to link structural breaks to associated policies (last paragraph of Section 3.3). Furthermore, in the "lessons for climate policymakers" section, it is stated: "…with 14 regulations out of the total 27 policies associated with structural breaks at the national and regional levels…". However, the analysis does not clarify which 27 policies are addressed. This lack of clarity makes it impossible to determine which of the investigated policies are irrelevant to the structural breaks and why, as no comprehensive overview is provided.  
Among the climate policies associated with structural breaks in the EU15, as presented in Table 2, both EU Directives and EU Regulations are categorized under the policy type "regulation." However, EU Directives are legislative acts that establish a goal or standard that all EU Member States must achieve, while allowing individual member states the flexibility to determine how to implement the goal. Consequently, member states may employ other policy instruments, such as subsidies, funding, or alternative mechanisms, to achieve the set target. Given this flexibility, the conclusion that regulations have been the most effective in reducing CO₂e emissions is not entirely convincing, as other instruments at the national level may have contributed significantly to meeting the goals. The interplay between policies at different regional levels needs to be examined more closely to fully understand their relative contributions.  
It is unclear why the author investigates emissions reductions at such a highly disaggregated level, specifically "(GHGs, 32 gases), and across all 37 sectors in the Intergovernmental Panel on Climate Change (IPCC) guidelines for national greenhouse gas inventories" (p. 2, l. 36 ff). A more reasonable approach would be to use the greenhouse gas emissions by sector as outlined in Austria's Annual Greenhouse Gas Inventory (submitted under Regulation (EU) No 2018/1999). This inventory categorizes emissions into broader sectors such as energy, industrial processes and product use, agriculture, waste, and land use and land use change, which would provide a more suitable starting point for the reverse causal analysis. The rationale for this suggestion is that often EU-level policy instruments target more broadly defined sectors. Using these sectoral aggregations could also highlight more significant reductions in GHG emissions. Furthermore, it is unclear what the 32 GHGs mentioned in the analysis represent. These should be clearly listed, and the choice of this aggregation level needs to be justified. It would be more understandable to focus on the well-recognized GHGs: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and fluorinated gases (F-gases), as defined under the Kyoto Protocol.  
Finally, Figures 3 and 4 need to be thoroughly explained and analyzed. For example, it is important to address why GHG emissions from road transport have evolved so differently in Austria compared to the European level. Additionally, specific categories such as "substitutes for ODS," "urea application," "indirect N₂O - nitrogen," "indirect N₂O - managed soils," and "liming" should be clearly explained. These categories are highly specific and may not be immediately understandable to readers without further clarification.  
Regarding Table 3, which highlights significant structural breaks for Austria between 1995 and 2022, the break in biomass burning in 2019 warrants further explanation. This break may not solely result from effective climate policy, as the author suggests (p. 15, l. 13/14), but could also be attributed to changes in reporting methodologies. Additional analysis is required to clarify this point.  
Moreover, the analysis of policy mixes (p. 16, l. 34 ff) appears superficial. There is no systematic evaluation of the combinations of individual instruments that may have been effective in reducing GHG emissions. A more structured and in-depth approach is necessary to assess these in-teractions and their potential success.  
  
  
   
  
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