The manuscript you provided explores the nonlinear effects of information and communication technology (ICT) on carbon emission intensity (CEI) in China using a spatial panel smooth transition threshold model. Here are some key points to focus on when commenting on the manuscript:

**1. Research Gap and Significance**

* Gap: the nonlinear relationship between ICT and CEI, which many existing studies have failed to analyze comprehensively. The inverted U-shaped relationship proposed is significant because it highlights that ICT’s impact on carbon emissions changes over time and across development stages.
* The paper also introduces the spatial spillover effect of ICT on nearby regions, furthering our understanding of regional cooperation in carbon reduction.

**2. Modeling Approach**

* The use of a **spatial panel smooth transition threshold model** is appropriate given the focus on nonlinearity and spatial effects. The choice of this model allows for a dynamic analysis, capturing how ICT’s impact on CEI shifts over time and space.
* The study effectively combines multiple econometric techniques, ensuring robustness. However, additional clarity could be provided on the testing process for nonlinearity, particularly regarding the **LM tests** mentioned, which assess nonlinearity and spatial dependencies. Presenting this with greater detail in the methods section would strengthen the study’s validity.

**3. Key Findings**

* **Nonlinear Impact of ICT:** The inverted U-shaped finding, where ICT initially increases CEI before reducing it after passing a threshold, is well-supported by both theoretical and empirical arguments. However, further explanation could be offered on why this transition point occurs and how policymakers can influence this shift earlier.
* **Spatial Spillover Effects:** The positive spatial spillovers (reduced emissions in neighboring cities with high ICT development) are crucial for policy implications. These findings encourage regional cooperation but could benefit from more discussion on real-world applications.
* **Moderating Factors:** The analysis that government competition, environmental regulations, and urban innovation moderate ICT’s impact on CEI is insightful. Still, more specifics on how these moderating effects operate, especially in diverse city clusters, would enrich the analysis.

**4. Clarity and Structure**

* The manuscript is well-structured with a logical flow from theory to empirical analysis. However, the **theoretical framework** could benefit from more detail, particularly in explaining the connection between ICT, carbon reduction, and economic development.
* Some technical terms, such as "threshold value," "low/high regimes," and "Metcalfe’s Law," could be explained in simpler terms for readers unfamiliar with econometrics and technology diffusion theories.

**5. Policy Implications**

* The policy recommendations are a strong part of the paper. The focus on promoting ICT to reduce CEI, combined with a call for differentiated strategies based on urban connections and resource endowments, provides actionable insights.
* However, the suggestion to accelerate ICT development needs to be more grounded in specific steps governments or industries can take, such as infrastructure investment or specific technological innovations.

**6. Further Improvements**

* The manuscript would benefit from expanding the **literature review** to include more diverse perspectives, especially regarding ICT’s impact on sustainability in various contexts (e.g., outside China or in different industries).
* The **limitations** of the study should be discussed in more detail, particularly the reliance on available data from 2003–2017 and potential biases from omitted variables or endogeneity, even though instrumental variables were employed.

In conclusion, the manuscript offers a valuable contribution to the field by exploring ICT’s nonlinear and spatial spillover effects on carbon emission intensity. Strengthening some sections for clarity, expanding on certain key findings, and discussing limitations in more detail will improve its overall impact.

**Strengths**

1. **Timely and Relevant Topic**: The paper addresses a critical issue—how ICT can influence carbon emissions in China, which is vital given the global focus on achieving carbon neutrality. The study’s exploration of both direct and spillover effects of ICT on CEI is a novel contribution, especially in the context of China’s urban development.
2. **Innovative Methodology**:
   * The use of the **spatial panel smooth transition threshold model (STAR)** is well-suited for capturing both the nonlinearity in ICT’s impact on CEI and the spatial spillovers between cities. This methodology is innovative and adds depth to the analysis.
   * The consideration of moderating factors such as government competition, environmental regulations, and urban innovation enhances the robustness of the results.
3. **Clear Hypotheses**:
   * The hypotheses are well-formulated and relevant, particularly the one proposing an inverted U-shaped relationship between ICT and CEI. This adds an important dimension to understanding how ICT’s role evolves over time and stages of development.
4. **Policy Implications**:
   * The policy suggestions are actionable and pragmatic, especially the emphasis on accelerating ICT infrastructure development and fostering regional collaboration to reduce emissions. The study provides meaningful recommendations for differentiated strategies based on the specific characteristics of cities.

**Areas for Improvement**

1. **Clarity in Theoretical Framework**:
   * The theoretical foundation is sound, but more detailed explanation of key concepts like **Metcalfe’s Law** and **technology diffusion lifecycle** would help readers unfamiliar with these ideas. Simplifying the presentation of the model for non-expert readers would also enhance accessibility.
2. **More Details on Data**:
   * The data section could benefit from further elaboration. For instance, the choice of ICT indicators is logical, but more explanation on why these particular indicators were selected (e.g., the importance of telecom services, mobile users, etc.) would provide better context.
   * While panel data from 271 cities is impressive, a discussion on **potential data limitations** (e.g., missing values or the interpolation methods used) would make the analysis more transparent.
3. **Clarifying Nonlinear Thresholds**:
   * The discussion of the inverted U-shaped relationship (threshold effects) is central to the paper but could use more elaboration. Explaining **why the threshold appears at certain points** and how different cities may accelerate reaching it would deepen the analysis.
   * Additionally, the shift from ICT increasing CEI to reducing it is pivotal. Including practical examples or case studies (e.g., a city that has successfully passed the threshold) would enrich the discussion.
4. **Expanding on Spatial Spillovers**:
   * The spatial spillover effects are interesting and relevant for regional policy-making, but the mechanisms behind these effects could be explored in more detail. For example, how exactly does ICT development in one city lead to carbon reductions in neighboring cities? More real-world examples or illustrations of such spillover effects would be helpful.
5. **Moderating Effects**:
   * While the paper discusses the moderating effects of government competition, environmental regulation, and innovation capabilities, this section could be expanded. Specifically, more detailed policy examples that explain how **government competition and environmental regulation** have influenced ICT development and carbon emissions in practice would add depth to this argument.
6. **Discussion on Limitations**:
   * The manuscript would benefit from a dedicated section on **limitations**. For example, while the study uses data from 2003–2017, there’s no discussion on whether these findings are likely to hold in the current post-2017 context, especially given rapid changes in ICT.
   * There should also be a more explicit discussion on **endogeneity** beyond just mentioning instrumental variables (IV). How were potential biases addressed, and what challenges remain?
7. **Visuals and Tables**:
   * The use of tables and figures is effective but could be better integrated into the narrative. For instance, the **transition diagram** for the spatial threshold could be more explicitly linked to key findings in the text. A more detailed explanation of the figures would make the results easier to interpret.

**Additional Suggestions**

* **Broader Literature Review**

The literature review could include more discussion of ICT’s environmental impacts outside of China. Comparisons with studies from other countries or regions would provide more global relevance and context to the findings.

* **Future Research Directions**:

Consider adding a brief section discussing future research possibilities. For instance, how could emerging technologies (e.g., AI, 5G) influence ICT’s role in carbon reduction? How might future policies or international agreements shape these dynamics?

**Conclusion**

Overall, this is a strong paper with novel insights into the nonlinear and spatial effects of ICT on carbon emissions. By addressing some of the clarity and depth issues around the theoretical framework, data, and findings, the paper can be made even stronger. It contributes meaningfully to the literature and provides valuable policy recommendations for reducing carbon emissions through ICT development in China.