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Export diversification, \( \text{CO}_2 \) Emissions, and the Environmental Kuznets Curve

A Country Panel Approach

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*All perspectives of this academic paper is solely of the authors. All findings were done in a personal capacity and does not necessarily represent the views of the United States Department of Agriculture.
Introduction
Motivation: Economic Development and Pollutant Emission

- Growing interest in environmental changes
  - Besides being a natural phenomenon, climate change has been closely intertwined with human activity and economic development
- Finding the relationship between economic development and pollutant emission
  - Income and pollution are both endogenous variables, and the effect of growth on pollution depends on what causes the growth
- Literature suggests a Kuznets Curve type outcome of pollutant emission (inverted U)
- Environmental deterioration increases as a country develops, but environment improves as economy grows
- Theoretical references include Copeland and Taylor (2013) and Stern, (2004)
Trade Diversification and Pollutant Emission

- Does int’l trade have any impact on country level pollutant emission? (Yes.)
- Does the trade “structure” have an impact on pollutant emission, especially trade diversity?
  - Trade Diversity in markets may hedge trade risk
  - Trade Diversity in products may indicate wider range of technology
  - Trade Diversity is related to Economic Development
- Trade diversification adds a new dimension in understanding the relationship between economic development and pollutant emission
EKC “hypothesis”:

• “Dirty” industries set up in economic infancy, leading to increased CO₂ emissions within country (Selden and Song, 1994; Shafik and Bandyopadhyay, 1992; Song et al., 2008; Jayanthakumaran et al., 2012)

• No meaningful global relationship can be found between income and emissions in OECD countries (Dijkgraaf and Vollebergh, 2001)
Key Questions

• What impact does trade diversification have on pollutant emission?
  • If so, does it also have an inverted-U shaped relationship?

• Are there heterogeneous effects between product and partner diversification?

• Are there any differences based on country income levels?
Methodology and Data
Trade Diversity and Pollutant Emission

\[ \text{Pollutant}_{i,t} = \beta \cdot \text{HHI}_{i,t} + \epsilon_{i,t} \]  
\[ \text{Pollutant}_{i,t} = \beta_1 \cdot \text{HHI}_{i,t} + \beta_2 \cdot \text{HHI}_{i,t}^2 + \epsilon_{i,t} \]  
\[ \text{Pollutant}_{i,t} = \beta_1 \cdot \text{HHI}_{i,t} + \beta_2 \cdot \text{HHI}_{i,t}^2 + \theta_1 \cdot \text{GDP}_{i,t} + \theta_2 \cdot \text{GDP}_{i,t}^2 + \gamma_i + \epsilon_t + \epsilon_{i,t} \]

- Panel Analysis using fixed effects
- Robustness checks used (Driscoll/Kraay estimators, CADR, etc.)
World Bank and WITS data

- Numbers of Countries: 125
- Income: GDP per capita, adjusted for inflation
- Pollutant: CO$_2$ Emissions, metric tons per capita
- Trade Diversity: Herfindahl Index for int’l trade, for product (HS4 level) and partner country
- Timeframe: Years 2000 - 2014

**Table 1: Summary Statistics**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO$_2$</td>
<td>1867</td>
<td>.2636</td>
<td>.1729</td>
<td>.0152</td>
<td>1.360</td>
</tr>
<tr>
<td>GDP</td>
<td>1873</td>
<td>1763</td>
<td>18709</td>
<td>440.4</td>
<td>141947</td>
</tr>
<tr>
<td>$HHI_{product}$</td>
<td>1823</td>
<td>.1161</td>
<td>.1607</td>
<td>.003</td>
<td>.987</td>
</tr>
<tr>
<td>$HHI_{partner}$</td>
<td>1822</td>
<td>.1541</td>
<td>.1418</td>
<td>.004</td>
<td>.921</td>
</tr>
</tbody>
</table>
Preliminary Results
### Table 2: All Countries

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>1.419</td>
<td>1.416</td>
<td>1.439</td>
</tr>
<tr>
<td>$GDP^2$</td>
<td>-0.096</td>
<td>-0.096</td>
<td>-0.097</td>
</tr>
<tr>
<td>$HHI_{product}$</td>
<td></td>
<td>-0.012</td>
<td></td>
</tr>
<tr>
<td>$HHI_{partner}$</td>
<td></td>
<td></td>
<td>-0.01</td>
</tr>
</tbody>
</table>

Income shows quadratic relationship between CO$_2$ output Limited impact of Trade Diversity Index on CO$_2$ emissions
Select Results

Table 3: Results by Income Level using $HHI_{product}$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low-income</th>
<th>Low-mid</th>
<th>Upper-mid</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>-5.434</td>
<td>4.259</td>
<td>1.016</td>
<td>3.202</td>
</tr>
<tr>
<td>$GDP^2$</td>
<td>0.398</td>
<td>-0.271</td>
<td>-0.071</td>
<td>-0.182</td>
</tr>
<tr>
<td>$HHI_{product}$</td>
<td>0.193</td>
<td>0.188</td>
<td>0.242</td>
<td>-0.107</td>
</tr>
<tr>
<td>$HHI_{product}^2$</td>
<td>0.046</td>
<td>-0.026</td>
<td>0.041</td>
<td>-0.013</td>
</tr>
</tbody>
</table>

Countries are group by income, following Gozgor and Can (2016a). Low Middle Income countries show a significant EKC relationship but Upper-Mid income country have a U shaped relationship - results largely driven by China.
### Table 4: Results by Income Level using $HHI_{partner}$

<table>
<thead>
<tr>
<th>Variable</th>
<th>non-OECD Upper Income</th>
<th>OECD Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>4.652</td>
<td>1.599</td>
</tr>
<tr>
<td>$GDP^2$</td>
<td>-0.249</td>
<td>-0.105</td>
</tr>
<tr>
<td>$HHI_{partner}$</td>
<td>-0.140</td>
<td>0.392</td>
</tr>
<tr>
<td>$HHI_{partner}^2$</td>
<td>-0.048</td>
<td>0.059</td>
</tr>
</tbody>
</table>

Partner Diversity measures have little impact on $CO_2$ emissions. Heterogeneous impact exists between non-OECD and OECD members.
Conclusion and Discussion
Summary

• The impact of trade diversification on pollutant emission shows an inverted-U shaped relationship
  • Economic growth vs. Trade Diversification

• Differences in Product vs. Partner Diversification Effects
  • Product diversification and the “mix” of sectors
  • Partner diversification, trade agreements, and int’l compliance

• Heterogeneous effect exist between low, mid, and high income countries
Future Extensions

- Trade “Intensity”
- Country Specific Studies: Chinese firms
- Preferential Trade Agreements Information
- Ag-centric Study:
  - Different measure of environmental impact: Land Conversion?
  - Agricultural Products
Thank you.