A Multi-phases Analysis of China's Energy Consumption and Economic Growth Nexus

Xiaoqi Sun, Haizhong An, Xiaoliang Jia, Lijun Wang
China University of Geosciences, Beijing

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I. An Overview

Understanding the relationship between energy consumption and economic growth (E-E relationship) is one of the central questions in energy economics.

Four hypotheses have been proposed. (Ozturk, 2010)
1.1 Four Hypotheses

- Growth Hypothesis
- Conservation Hypothesis
- Feedback Hypothesis
- Neutrality Hypothesis
1.2 Our question

What causes this difference?

The data?

The methods?

 ...... 

The time period?
Further, what can we obtain from the analysis of this difference?
2. How we did it?

Embodied data vs Direct data

- Embodied data includes direct data and the data used in the intermediate process.
- We made use of embodied data concept to investigate the relationship between energy consumption and economic growth in another way.
- This poses one methodological question: how to calculate the embodied data?
## Input-Output (I-O) Table

<table>
<thead>
<tr>
<th>OUTPUT</th>
<th>Inter-Use</th>
<th>Final-Use</th>
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<tbody>
<tr>
<td>AG</td>
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<td>SER.</td>
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<td>Direct Input</td>
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The basic principle of Input-Output analysis: Gross input = Gross output

For sector i,

\[ d_i + \sum_{j=1}^{n} \varepsilon_j \times x_{j,i} = \varepsilon_i \times \left( \sum_{j=1}^{n} x_{i,j} + f_i \right) \quad (i, j = 1, 2, \ldots, n) \]

For the whole I-O table, that is,

\[ D^T + X^T Z^T = YZ^T \]
Based on the embodied data, we can construct an analysis model to the relationship. We use the following coefficients from classical I-O analysis to build our analysis model.

- Impact coefficient (IC)
- Response coefficient (RC)
• **RC** = \( \frac{\sum_{j=1}^{n} b_{i,j}}{\sum_{i=1}^{n} \sum_{j=1}^{n} b_{i,j}} \)

• **IC** = \( \frac{\sum_{i=1}^{n} b_{i,j}}{\sum_{i=1}^{n} \sum_{j=1}^{n} b_{i,j}} \)

where \( b_{i,j} \) is the Leontief inverse coefficient of sector j to sector i.
The Dynamics Mechanism of E-E Relationship

IC—Pull Effect

ECONOMIC GROWTH

ENERGY CONSUMPTION

RC---Push Effect
The un-weighted effect sector $j$ is
$$E_j = IC_j - RC_j, \ (j = 1,2, \ldots, 8)$$

The weighted effect of sector $j$ is
$$f_j = \gamma_j \ast E_j, \ (j = 1,2,\ldots, 8)$$

So, the total effect is
$$F_j = \sum f_j, \ (j = 1,2,\ldots, 8)$$
The dynamic property of every sector

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<tbody>
<tr>
<td>1997 RC</td>
<td>0.584</td>
<td>0.782</td>
<td>0.812</td>
<td>3.391</td>
<td>0.691</td>
<td>0.391</td>
<td>0.572</td>
<td>0.778</td>
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<tr>
<td>IC</td>
<td>1.102</td>
<td>0.756</td>
<td>1.200</td>
<td>0.975</td>
<td>0.680</td>
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<td>IC–RC</td>
<td>0.518</td>
<td>-0.026</td>
<td>0.388</td>
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<td>0.895</td>
<td>0.216</td>
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<tr>
<td>2002 RC</td>
<td>0.595</td>
<td>0.722</td>
<td>0.795</td>
<td>3.298</td>
<td>0.709</td>
<td>0.399</td>
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<tr>
<td>IC</td>
<td>1.054</td>
<td>0.732</td>
<td>1.171</td>
<td>0.990</td>
<td>0.683</td>
<td>1.282</td>
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<td>0.459</td>
<td>0.011</td>
<td>0.376</td>
<td>-2.308</td>
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<td>0.434</td>
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<td>2007 RC</td>
<td>0.478</td>
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<td>0.804</td>
<td>3.591</td>
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<td>IC</td>
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<td>IC–RC</td>
<td>0.587</td>
<td>0.121</td>
<td>0.336</td>
<td>-2.598</td>
<td>-0.047</td>
<td>0.907</td>
<td>0.198</td>
<td>0.496</td>
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Note: (1) AG denotes Agriculture sector; MIN. denotes Mining sector; LI denotes Light Industry sector; HI denotes Heavy industry & Chemical industry; EGW denotes Electric Power, Gas and Water Production and Supply sector; CON. denotes Construction sector; TSP denotes Transport, Storage, and Post sector; SER. denotes services sector.
(2) IC–RC denotes the dynamic property of sector i (i=1,2,..8).
The results of weighted effect and that of total effect

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<td>γ 1997</td>
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<td>0.080</td>
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<td></td>
<td>-0.287</td>
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<td>0.883</td>
<td>0.169</td>
<td>0.434</td>
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<td>-0.0023</td>
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Note: (1) r denotes the proportion of sector i (i=1,2,…,8) in the GDP share; (2) f_j denotes the un-weighted effect in the year of j (j=1997, 2002, 2007); (3) F_j denotes the total weighted effect in the year of j (j=1997, 2002, 2007).
4. The Conclusion

- The relationship is unstable.
- In the year of 1997 and 2007, it is energy consumption that pushes economic growth.
- In the year of 2002, it is economic growth that causes energy consumption.
- The economic structure and the dynamic property of one sector determine the unstable E-E relationship.
So, the completeness of data (embodied energy) does matter in the research on E-E relationship. One implication of this conclusion is that we should base our energy stock policy on the embodied energy, not the direct energy requirement.

Our results complement the uni-direction relationship studies. Both growth hypothesis and conservation hypothesis exist, but only one exists in a specific period.

We should pay much attention to the economic structure evolution when we make energy policies.
Summary

Q1: What we did?
A1: We investigated the impact of data completeness on the results of the E-E relationship research.

Q2: How we did?
A2: Input-Output Analysis

Q3: What we got?
A3: The data completeness does matter; The unstable relationship.

Q4: Why is that?
A4: economic structure + the dynamic property of sector
Thank you!