Industrialization and the Demand for Mineral Commodities

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The views expressed here are those of the authors and do not represent the views of the Federal Reserve Bank of Dallas or the Federal Reserve System.
Question: How does industrialization affect the derived demand for mineral commodities in the long run?

New dataset: Al, Co, Le, Ti, Zi, 12 countries, 1840-2010.

Methodology: Heterogeneous dynamic panel model.

Results:

- Manufacturing output affects demand very differently across minerals.
- Price elasticities are relatively small.
- Adjustment to equilibrium takes 7 to 15 years.
Motivation

- China’s boom and recent slowdown key driver of commodity prices.

- “Income elasticities of demand” versus “intensity of use.”

- Potential demand drivers:
  - Sectoral shifts.
  - Intra-sectoral shifts due to development-specific consumer preferences and/or production technology.
  - Time depending technological change.
  - Price.
  - Population growth.
A new dataset

- 12 major industrialized countries.
- 1840-2010, annual.
- Per capita consumption of aluminum, copper, lead, tin, and zinc (in metric tons).
- Per capita real value added of the manufacturing sector (IGK-$).
- Real prices (Inflation adjusted by PPIs)
Econometric model

- Heterogeneous dynamic panel model.

\[ c_{i,t} = \sum_{j=1}^{p} \lambda_{i,j} c_{i,t-j} + \sum_{l=0}^{q} \delta_{i,l} y_{i,t-l} + \sum_{m=0}^{r} \gamma_{i,m} p_{i,t-m} + \mu_{i} + \epsilon_{it} \]

- Error Correction Form

- Different extensions to account for technological change.
  - Linear time trend
  - Time fixed effects

- Pooled mean group estimator (Pesaran et al 1999).
Identification

- Reverse causality from the demand variable to price.

- Assumptions:
  - National prices follow international price in the long-run.
  - Long-run supply elastic, no single country causes long-term price changes.
**Regression Results: Benchmark**

<table>
<thead>
<tr>
<th></th>
<th>Al</th>
<th>Co</th>
<th>Le</th>
<th>Ti</th>
<th>Zi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufact. (log)</td>
<td>1.551***</td>
<td>0.914***</td>
<td>0.435***</td>
<td>0.616***</td>
<td>0.734***</td>
</tr>
<tr>
<td></td>
<td>(0.092)</td>
<td>(0.061)</td>
<td>(0.057)</td>
<td>(0.035)</td>
<td>(0.033)</td>
</tr>
<tr>
<td>Price (log)</td>
<td>-0.706***</td>
<td>-0.400***</td>
<td>-0.220**</td>
<td>0.169**</td>
<td>-0.064</td>
</tr>
<tr>
<td></td>
<td>(0.184)</td>
<td>(0.093)</td>
<td>(0.093)</td>
<td>(0.085)</td>
<td>(0.088)</td>
</tr>
<tr>
<td>Adj. Coeff.</td>
<td>-0.117***</td>
<td>-0.132***</td>
<td>-0.094***</td>
<td>-0.095**</td>
<td>-0.113***</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.028)</td>
<td>(0.021)</td>
<td>(0.040)</td>
<td>(0.055)</td>
</tr>
<tr>
<td>No. obs.</td>
<td>973</td>
<td>1,206</td>
<td>1,059</td>
<td>1,142</td>
<td>1,216</td>
</tr>
</tbody>
</table>

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Regression Results: Time Fixed Effects

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</tr>
</thead>
<tbody>
<tr>
<td>Manufact. (log)</td>
<td>1.581***</td>
<td>1.128***</td>
<td>0.745***</td>
<td>0.295**</td>
<td>0.834***</td>
</tr>
<tr>
<td>(0.073)</td>
<td>(0.067)</td>
<td>(0.112)</td>
<td>(0.141)</td>
<td>(0.132)</td>
<td></td>
</tr>
<tr>
<td>Price (log)</td>
<td>-0.836***</td>
<td>-0.009</td>
<td>-0.014</td>
<td>-0.384***</td>
<td>0.207**</td>
</tr>
<tr>
<td>(0.236)</td>
<td>(0.049)</td>
<td>(0.204)</td>
<td>(0.046)</td>
<td>(0.083)</td>
<td></td>
</tr>
<tr>
<td>Adj. coeff.</td>
<td>-0.142***</td>
<td>-0.180***</td>
<td>-0.148***</td>
<td>-0.096***</td>
<td>-0.085***</td>
</tr>
<tr>
<td>(0.031)</td>
<td>(0.057)</td>
<td>(0.033)</td>
<td>(0.030)</td>
<td>(0.022)</td>
<td></td>
</tr>
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<td>No. obs.</td>
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Conclusion

- Industrialization affects demand very differently across minerals in the long run.

- China’s slowdown: strong effect on aluminum and copper demand, less so on lead, tin, and zinc.

- But intensity of aluminum use will continue to increase; copper: stable; lead, tin and zinc: down.

- Prices have a small effect on long-run demand.

- Adjustment to equilibrium: 7-12 years.
Thank for your attention and your comments!
\[ \Delta c_{i,t} = \Phi_i(c_{i,t-1} - \theta_{0,i} - \theta_{1,i}y_{i,t} - \theta_{2,i}p_{i,t}) \]

\[ + \sum_{j=1}^{p-1} \lambda^{*\ast}_{i,j} \Delta c_{i,t-j} + \sum_{l=0}^{q-1} \delta^{*\ast}_{i,l} \Delta y_{i,t-l} + \sum_{m=0}^{r-1} \gamma^{*\ast}_{i,m} \Delta p_{i,t-m} + \epsilon_{it} . \]