Federal Reserve Bank of Dallas

# Industrialization and the Demand for Mineral Commodities

Martin Stuermer, Federal Reserve Bank of Dallas

Published in: *Journal of International Money and Finance*, 76 (2017) pp. 16-27.

## Abstract

This paper uses a new data set that begins in 1840 to investigate how industrialization affects the derived demand for mineral commodities. I establish that there is substantial heterogeneity in the long-run effect of manufacturing output on demand across five commodities. A one percent increase in per capita manufacturing output leads to an 1.5 percent increase in aluminum demand and a one percent rise in copper demand. Estimated elasticities for lead, tin, and zinc are below unity.

Results suggest that the experience of Japan's industrialization, for example, may be used to infer the impact of China's industrialization on future demand for metals. The results imply substantial differences across commodities with regard to future demand. Equilibrium adjustment takes 7-13 years, which helps explain the long duration of commodity price fluctuations.

## Introduction

Kilian (2009) and Stuermer (2018) show that the booms and busts in commodity prices are primarily driven by global demand shocks. For example, China's rapid industrialization and its recent slowdown strongly affect world commodity prices. Thus, understanding how industrialization affects the derived demand for mineral commodities is important for macroeconomic and fiscal policy making in commodity exporting countries.

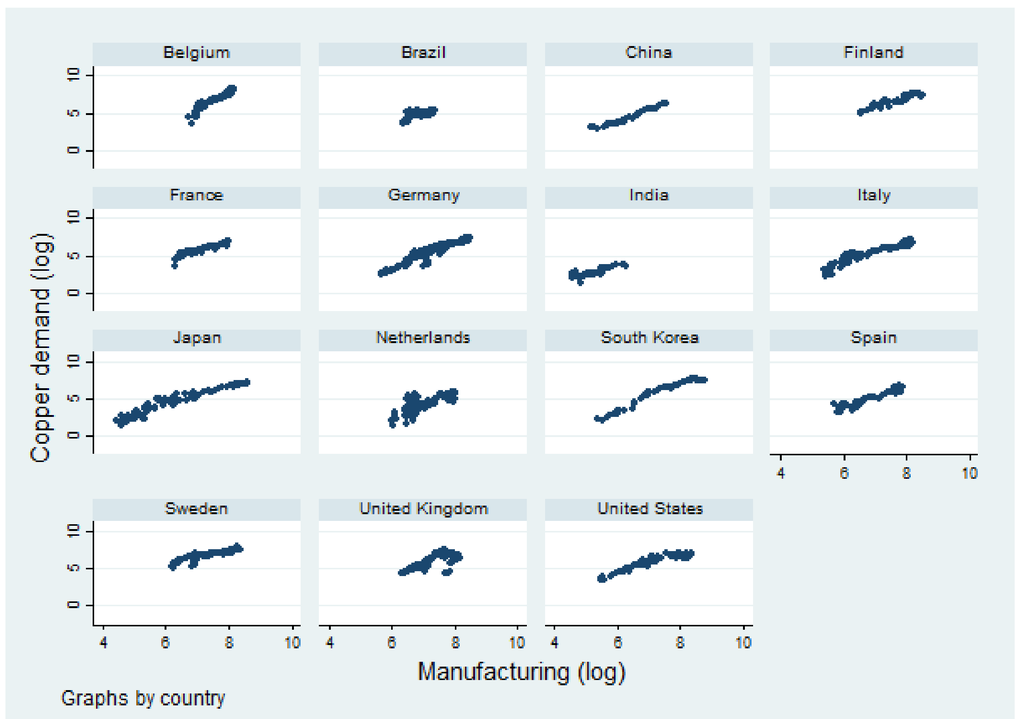
Main questions: how does a change in manufacturing output affect the demand for commodities? What is the response of demand to a price change? Can we use experience from past periods of industrialization to infer the impact of China's industrialization on the future demand for metals?

## A New Data Set

I assemble a new data-set on per capita usage and real prices of aluminum, copper, lead, tin and zinc, and per capital manufacturing output for the period 1840 to 2010. The five metals have characteristics, such as a substantial track record of industrial use and integrated world markets, which make a long-run analysis possible.

The data set is a sample of 12 industrialized countries: Belgium, Finland, France, Germany, Italy, Japan, South Korea, the Netherlands, Spain, Sweden, the United Kingdom, and the United States, and three currently industrializing countries—China, India, and Brazil.

**Scatter plot of log per capita value added by manufacturing (horizontal axis) and log per capita copper consumption (vertical axis)**




## Empirical Strategy

I employ an extension of the partial adjustment model, in which I introduce homogeneity of parameters in a stepwise manner following Pesaran et al (1999). I stay a priori agnostic about the commonality of coefficients for the short term and long term relationships. I control for common trends and time fixed effects in a stepwise manner. This allows me to take advantage of the panel structure of the data and to control for a variety of omitted common factors such as technological change in resource efficiency or world wars, which might affect the demand in all countries at the same time. The baseline specification for the pooled mean group estimator is:

$$\Delta c_{i,t} = \Phi(c_{t-1} - \theta_0 - \theta_1 y_t - \theta_2 p_t) + \sum_{j=1}^{p-1} \lambda^*_{i,j} \Delta c_{i,t-j} + \sum_{l=0}^{q-1} \delta^*_{i,l} \Delta y_{i,t-l} + \sum_{m=0}^{r-1} \gamma^*_{i,m} \Delta p_{i,t-m} + \epsilon_{i,t}$$

## Result 1: Similar Long-Run Elasticities Across Countries

The long-run elasticity of metal demand to manufacturing output is similar across countries, while there is substantial heterogeneity in the short term coefficients, according to evidence from Hausman tests. This suggests that one can use past experiences of industrialization to infer the impact of China's industrialization on the demand for metals.

**Estimates of the Long-Run Manufacturing Output and Price Elasticities (Baseline Specification)**

| | Aluminum | Copper | Lead | Tin | Zinc |
|---|---|---|---|---|---|
| Country fixed effects | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | No | No | No | No | No |
| Manufacturing (log)($\theta_1$) | 1.495*** | 0.933*** | 0.428*** | 0.580*** | 0.745*** |
| | (0.087) | (0.057) | (0.058) | 0.044) | (0.033) |
| Real price (log)($\theta_2$) | -0.691*** | -0.403*** | -0.227** | -0.104 | -0.035 |
| | (0.177) | (0.082) | (0.093) | (0.063) | (0.083) |
| Adjustment coefficient ($\Phi$) | -0.106*** | -0.130*** | -0.079*** | -0.147*** | -0.104*** |
| | (0.021) | (0.033) | (0.020) | (0.045) | (0.032) |
| Constant ($\theta_0$) | 0.038 | 0.171** | 0.051** | 0.127*** | 0.036 |
| | (0.062) | (0.072) | (0.022) | (0.048) | (0.024) |
| Observations | 1091 | 1322 | 1178 | 1260 | 1334 |
| Joint Hausman test-stat. | 2.072 | 3.256 | 0.960 | 0.960 | 1.283 |
| *p*-value | 0.355 | 0.196 | 0.619 | 0.619 | 0.527 |
| Log likelihood | 521.5 | 577.1 | 540.3 | 396.0 | 690.2 |

*Notes*: The table shows results from the pooled mean group (PMG) estimations of the preferred ARDL(4,4,2) model. Standard errors in parentheses. * p < 0.1 ** p < 0.05 *** p < 0.01

## Result 2: Heterogeneity Across Commodities

I find substantial heterogeneity in the long-run effect of a change in per capita manufacturing output on the per capita demand across the five commodities (Table 1). A one percent increase in per capita manufacturing output leads to a 1.5 percent increase in aluminum demand and a one percent rise in copper demand in the long run. Estimated elasticities for lead, tin, and zinc are far below unity. This heterogeneity implies large differences in the amplitude of demand shocks on the prices across the examined commodities. Holding all other factors constant, the intensity of use of aluminum in the manufacturing sector increases over the course of industrialization, while the intensity of use of copper is constant, and the intensities of use of lead, tin, and zinc decrease.

## Result 3: Price Inelastic Demand

The estimated long-run price elasticities of demand are rather inelastic for the examined mineral commodities. While price elasticity is about -0.7 in the case of aluminum, it is about -0.4 for copper demand, and below or equal to about -0.2 for tin and zinc demand. This shows that these mineral commodities are rather essential to manufacturing output, as the processing industry changes its use slowly in response to price.

*References*:
Kilian, L. (2009) , "Not All Oil Price Shocks are Alike" *American Economic Review* 99(3): 1053–69.
Pesaran, M, Shin, Y. and R. Smith (1999), "Pooled Mean Group Estimation of Dynamic Heterogeneous Panels." *J. Am. Stat. Assoc.* 294 (446): 621-634.
Stuermer, M. (forthcoming), "150 Years of Boom and Bust: What Drives Mineral Commodity Prices?" *Macroeconomic Dynamics*.

*Contact*:
Martin Stuermer
Federal Reserve Bank of Dallas
Email: martin.stuermer@dal.frb.org
Website: https://sites.google.com/site/mstuermer1/
Phone: +1 69 682 6524