

# NCCC-134

APPLIED COMMODITY PRICE ANALYSIS, FORECASTING AND MARKET RISK MANAGEMENT

## **Formation of Industrial Metal Markets: Fundamental Theory, Co-movement and Time-varying Dependencies**

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Suggested citation format:

Schischke, A. and A. Rathgeber. 2023. "Formation of Industrial Metal Markets: Fundamental Theory, Co-movement and Time-varying Dependencies." Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. [<http://www.farmdoc.illinois.edu/nccc134>].

# **Formation of industrial metal markets: fundamental theory, co-movement and time-varying dependencies<sup>†</sup>**

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*Paper presented at the NCCC-134 Conference on Applied Commodity Price Analysis,  
Forecasting, and Market Risk Management  
St. Louis, Missouri, April 24-25, 2023*

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<sup>†</sup>Due to publisher limitations on pre-prints, this online proceedings only contain an extended abstract of the study.

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The classical fundamental theory states a good's price is the result of its supply and demand equilibrium, see Hotelling (1931) and Deaton and Laroque (2003). In particular, commodity prices, especially industrial metals as industrial goods, are influenced by their fundamentals, see Cudington and Zellou (2013) as well as Stuermer (2018) and Chen et al. (2019). However, several empirical studies detect similar patterns in commodity prices, characterized first as (excess) co-movement by Pindyck and Rotemberg (1990). In the previous decades, many studies attempted to characterize the determinants and the magnitude of this co-movement, see Byrne et al. (2013) and West and Wong (2014), while more recent studies detect the co-movement varies over time and, especially, increased during the financialization, starting in 2004, see Le Pen and Sévi (2017), Ohashi and Okimoto (2016), Peersman et al. (2021) and Yin and Han (2015).

An initial, bi-variate and time-varying correlation analysis of industrial metal prices reveals the correlations between metal prices fluctuate around their correlation mean, over the entire sample period from 1995 to 2020, indicating the relations between commodities vary over time. Hereby, the metal prices do not follow a trend over time, but simultaneously show periods of decreasing, followed by increasing correlations. In general, the periods of higher correlation, starting in 2004 and 2009 reflect the higher co-movement in metal prices due to the financialization as well as the financial crisis, respectively. On the basis of this brief, bi-variate co-movement analysis, we claim a time-independent analysis of the relationship between commodity prices or even a trend analysis, can not fully display the interaction between commodity markets.

In this context, the question arises how the constitution of commodity markets, especially the impact of fundamentals as well as the co-movement, change over time. Therefore, we aim to analyze the following hypothesis:

*Fundamentals have a stronger influence on commodity markets in calm periods, while the effect of co-movement between prices increases during more volatile periods.*

For this reason, we examine the impact of fundamentals on prices, the co-movement, and the time-varying spillovers in individual commodity markets, as well as in the cross-commodity dimension. Hereby, we model the industrial metal markets in the period 1995 to 2020, represented by the monthly commodity-specific supply, demand and price variables, in a global vector autoregressive (GVAR) framework, first introduced by Pesaran et al. (2004) for economies and by Schischke et al. (2023) for commodity markets, extended by a Markov-Switching component, similar to Binder and Gross (2013), which allows for regime-switches, enabling time-varying relations in commodity markets. Subsequently, we analyze the regime inferences as well as the dynamic properties of the commodity markets via regime-dependent generalized impulse response functions (GIRFs) in calm and volatile regimes, to disentangle the differences in the spillover effects at different points in time.

Analyzing the regime inference of each commodity market, we observe the aluminum, copper, lead, tin and zinc markets are stable, as they show long periods in the calm regime with only few (brief) periods in the volatile regime, which correspond to periods at the end of the last century, during the beginning of the financialization of commodity markets around the year 2003, the financial crisis 2009, as well as several times within the last decade. In contrast, the nickel market shows numerous fluctuations between the regimes.

Subsequently, we aim to disentangle the differences in the spillover effects between commodity markets in calm and volatile periods. An analysis of impulse response functions, under the assumption that the commodity markets are either in their calm or volatile regime, will provide insights in the constitution of commodity markets, and in particular, will reveal whether the impact of fundamentals or the co-movement, is stronger in calm and/or volatile periods.

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