Extreme Price Co-movement of Commodity Futures and Industrial Production Growth: An Empirical Evaluation

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This article studies whether the extreme price co-movement of commodity futures can be exploited to anticipate future industrial production (IP) growth. For this purpose, an empirical model is estimated to derive a measure that characterizes upside and downside price extremes. The derived price extremes are shown to be positively associated with IP growth over the next quarter. The findings further suggest the presence of an asymmetry: the association corresponding to downside extremes is robust whereas that of upside extremes is weaker. The findings reinforce the informational friction theory as well as those financial studies that emphasize downside risk in financial markets.

Introduction

Economists have long recognized that commodity futures prices serve as valuable indicators for goods production as they convey insightful information about the future movement of the real economy. The net economic impact of commodity futures prices is still unclear because, as the informational friction theory of Sockin and Xiong (2015) contends, many different types of shocks (such as in supply, demand, and financial markets) are indeed non-observable to commodity market participants.

Goods producers may perceive an increase in commodity futures prices as signaling a booming economy, that is, revealing an increase in commodity consumption. However, increasing commodity futures prices could lower commodity demand simply because of the standard cost effect. Little is known, however, about the direction and degree to which the especially large ups and downs of commodity futures prices signal subsequent production levels. Understanding this will not only be helpful for goods production planning, financial investment, but is also highly important for regulators wishing to stabilize excessive turbulence from the supply side.

Relevance of the Research Question

The authors empirically examine how *extreme price co-movement* affects industrial production (IP) growth combining the *synchronized* movements and the *large* price changes into one indicator. Assessing these two aspects simultaneously grants this research with two main advantages. First, despite a growing body

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of literature with renewed interest in commodity futures markets, the analyses are limited within the scope of individual commodity futures (*e.g.*, Singleton, 2014)[1] or pairwise correlations (*e.g.*, Tang and Xiong, 2012). However, the ability to model a high-dimensional space is essential for understanding the growing integration of commodity futures markets. Second, though widespread co-movement in commodity futures prices can indicate a rising risk in the real economy, only characterizing this phenomenon may be not enough, as it is natural that commodity futures prices tend to move together due to some common fundamentals as well as financial trading factors (Pindyck and Rotemberg, 1990). In contrast, the co-moving tendency of large price changes, particularly over a longer period (such as one year), are generally thought to indicate big shifts in the underlying macro fundamentals or an accumulation of extreme risks that would further transmit to spot markets (Cheng and Xiong, 2014; Sockin and Xiong, 2015). In this regard, modeling synchronized large price changes appears to be a more promising representation of commodity price risks that indicate the direction of the real economy.

Technical Motivation in Modeling the Extreme Price Co-Movement of Commodity Futures

To measure the extreme price co-movement of commodity futures, not only the univariate distributions of each commodity futures return must be accurately modeled but also their joint distribution. The objective is to capture the dependence structure among different commodity futures returns, *i.e.*, how one commodity futures return depends on the others. The copula framework offers a great deal of flexibility for modeling multivariate distributions, as marginal distributions can be characterized separately from the dependence structure (copula) that links them and forms a joint distribution. Thus, copula-based models can capture rich patterns of tail dependence or extreme price co-movement (see *e.g.*, Oh and Patton, 2018; Fei *et al.*, 2017). The generalized autoregressive score (GAS) Factor copula model, in particular, is very feasible for modeling high-dimensional dependence because by setting a latent variable driven by common and idiosyncratic factors, it notably reduces the number of variables.

Main Results

The main data are weekly futures *excess return* indices of eleven major commodities, including corn, wheat, soybean, West Texas Intermediate (WTI) oil, Brent oil, natural gas, gold, silver, copper, aluminum, and sugar from the Bloomberg Commodity (BCOM) Index Family. The exact methodology for calculating each of the eleven excess return series is in Bloomberg (2021), but briefly, "[t]o avoid the delivery process and maintain a long futures position, nearby contracts must be sold and contracts that have not yet reached the delivery period must be purchased. This process is known as 'rolling' a futures position." Each of the study's eleven BCOM indices are "rolling indices" in that they simulate the return impact of successively going long and rolling individual commodity futures contracts over the duration of the study's time horizon.

The sample period is from January 1991 to June 2019 as dictated by the availability of IP growth data for a broad panel of 35 countries from the Trading Economics Database.

The authors identify the extreme price co-movement by aggregating multiple price sets of commodity futures. The scales of extreme price co-movement can be defined in two dimensions. On the one hand, a parameter *k* represents how many commodities futures are expected to move together. On the other hand, upside or downside co-movement is estimated separately based on returns over a yearly horizon lying above or below some specific thresholds. For example, the baseline investigation starts by setting *k* = 7, then *SU*_90% denotes the expected probability that 7 out of 11 commodity futures returns will go beyond their 90th percentile while *SD*_10% denotes the expected probability that 7 out of 11 commodity future returns will go below their 10th percentile.

The probability of observing a large return fall (*SD*_10%) is significantly higher than the probability of observing a large return increase (*SU*_90%). On the other hand, since 2000, both *SD*_10% and *SU*_90% experience more significant peaks and troughs, and their volatilities both significantly increase, with *p*-values of 0.000 for *SU*_90% and 0.008 for *SD*_10%. Moreover, the probability of observing large return increases (*SU*_90%) also increases significantly. In contrast, no significant increase in *SD*_10% is found. This implicitly confirms the relevance of a growing literature concerned with high volatilities and large increases in commodity futures prices over the last two decades (*e.g.*, Cheng and Xiong, 2014).

Using ordinary least squares (OLS) regression analysis, this research paper documents a significant association between the extreme price co-movement of commodity futures and the subsequent IP growth rate. In general, one standard deviation increase in *SU*_90% (*SD*_10%) is associated with an average 0.339% (0.575%) increase (decrease) in IP growth rate over the following quarter. Moreover, the paper finds an asymmetric effect: the negative effect of downside return extremes is of a larger magnitude and more significant than the positive effect of upside return extremes. Notably, this result is obtained by controlling many prevalent uncertainty variables that can affect economic activities, such as the volatility of oil and stock markets and macroeconomic uncertainty; thus it adds a new source of risk for the real economy as compared to previous studies.

The authors carefully examine the robustness of the measures by loosening the degree of synchronized movement and the magnitude of the price changes. Besides, because not every country has the same industrial structure, different countries may have a different reliance on commodities. Thus, from country to country, the IP growth rate could be clustered together with regard to *SU* and *SD* and this violates the independence assumption of the OLS regression. To mitigate this issue, the authors conduct additional regressions using a hierarchical linear model. Across all cases the paper observes a significant concurrent reaction from goods producers; that is, extreme price co-movements do matter to their later production and, specifically, downside uncertainties appear to have a priority in their decision making.

Conclusions

In this paper, the authors measure synchronized downside and upside extreme co-movements of commodity futures returns in diverse markets by estimating copula models with weekly prices of 11 major commodity futures indices. Further, through dynamic regressions, they further investigate their quarter-ahead predictive content using IP growth rate for a broad panel of 35 countries.

Overall, the paper finds that the upside (downside) extreme price co-movement is positively (negatively) associated with IP growth over the following quarter. Furthermore, the relationship is *not* symmetric: the net impact of downside extremes is very robust whereas that of upside extremes is weaker.

These results have implications for recent work on reconciling two seemingly contrary strands of the literature between the standard cost effect and informational effect (Sockin and Xiong, 2015). On the one hand, the paper's analysis provides a coherent illustration that goods producers are more sensitive to downside risks. When faced with a sharp increase in commodity prices, cost concerns appear to offset the expectation of an economic boom led by informational theory. On the other hand, the fear of an economic bust dominates the benefits of cost savings when an extreme negative price co-movement is present.

Endnote

1 Among the literature, most work focuses on the pricing impact of financial investors on individual commodity futures, with little study on the economic impact of the resulting prices.

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Extreme price co-movement, commodity futures, industrial production growth, GAS-factor copula, panel regressions.

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