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Commodities' common factor: An empirical assessment of the markets' drivers

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Using a generalized dynamic factor model, we identify a latent common factor in a broad sample of thirty-one commodity futures' returns between 1996 and 2015. An investigation of sub-periods reveals an increasing correlation between the common factor and changes in gold and oil prices during the financial crisis. We also consider whether the common factors of commodity subsectors give an advantage to the pricing of commodity futures' returns. In the cross-section of individual futures' returns we suggest that two- or three-factor models that include energy's or agriculture's common factors can explain commodity returns. Thus, our results indicate an increasing homogeneity of the commodity markets in recent years.

1. Introduction

On a global scale, commodities will gain even more importance in the future, as demand for agricultural and construction materials will grow with a growing world population, and global demand for fossil fuels will at least remain constant until 2040, even with increasing renewable-energy production (EIA, 2016). Thus, the development of commodity markets will play an important role in both economics and politics. Despite these trends, market movements in individual commodities are increasingly volatile, movements that market participants often claim are caused by idiosyncratic shocks. However, if there are fundamental or technical relationships between commodities, the question arises concerning whether this apparent co-movement can explain the cross-sectional variation of individual commodity prices. Since no factors have yet been proposed that can explain the cross-section of individual futures' returns (Daskalaki et al. 2014), we seek to fill this gap based on the co-movement of commodity returns determined by the data itself.

Factor models allow the joint driver of commodities' returns to be extract. In this paper we apply a one-sided representation of the generalized dynamic factor model (GDFM hereafter) originally proposed by Forni et al. (2000) and modified by Forni et al. (2015) to decompose the commodities' returns into a common market factor that influences all commodities and an idiosyncratic (or commodity-specific) factor that is individual to each commodity. We assume that the common market factor is related to undefined but fundamental macroeconomic values like the US dollar's exchange rate, global inventory levels, and demand and supply. Based on the GDFM, we investigate whether the common market factor can price the cross-section of individual commodity futures' returns for various periods of time. During the 2008 global financial crisis, commodity markets' correlations with other markets changed dramatically, so we emphasize this structural change by investigating sub-periods before, during, and after the crisis.

Our contribution to the literature is twofold. We add a methodological tool to the analysis of commodity markets and find that 12% of the variation in commodity returns can be explained by a common market factor during the period from 1996 to 2015, but

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16% was explained by the common market factor during the financial crisis, when it was increasingly correlated with changes in gold and oil prices. Since oil and gold prices are closely linked to the financial markets during times of financial crises, this increased correlation indicates the influence of financialization on commodity prices. We also identify common factors for the subgroups of agriculture, metals, precious metals, energy, and livestock. The explanatory power of their common factors is significantly higher than that of the whole commodity sector, varying between 52% (energy) and 23% (agriculture) for the period from 1996 to 2015. These groups' explained variation shows the idiosyncratic difference between groups of commodities, but we find that the common market factor of our whole sample is highly correlated with the common factor of the agriculture sector only. Assuming that the common factor of the whole commodity sector represents global macroeconomic developments of the commodity markets and thus also of the global economy, we may see the common movement of the agriculture sector as a representation of these developments.

Our second contribution is to show the explanatory power of the common factor in explaining the cross-sectional returns. Based on the approach from Fama and MacBeth (1973), our common factor of the whole commodity sector cannot explain the cross-sectional returns of our set of individual commodities. Even during periods of financial crisis or at the beginning of the financialization of the commodity market in the early 2000s, we find no evidence for a commodity pricing model based on only one factor determined by the data itself. In line with Daskalaki et al. (2014), we consider commodities to be a heterogeneous class of assets until 2011, but from 2011 to 2015 two- or three-factor models that include at least energy's and agriculture's common factors may price individual commodity returns. These results support the importance of these two sectors and indicate a recent weakening of the heterogeneity assumption of commodities. We illustrate that a dynamic factor model may be superior to factor models that are based on static principle components when estimating asset pricing models.

In the remainder of this paper, we continue with a literature review, followed by an overview of the data used in the model. The penultimate section examines the cross-sectional commonality, while the final section concludes.

2. Literature review

Researchers have used factor models to understand commodity markets as early as Pindyck and Rotemberg (1988), who show that prices of unrelated raw commodities have a persistent tendency to move together, even in excess of macroeconomic variables like inflation, industrial production, interest rates, and exchange rates. Some following investigations confirm this finding, while others reject it. Deb et al. (1996) and Karstanje et al. (2013) examine the co-movement of factors that drive commodity futures curves in price levels and in futures curve shapes and conclude, based on the dynamic Nelson-Siegel model, that individual futures' curves are driven by common components, whereas the commonality mostly is sector-specific. Vansteenkiste (2009) and Byrne et al. (2013) extract common unobserved factors from individual non-fuel commodity prices using principal component techniques. Vansteenkiste (2009) finds periods of changing co-movement, suggesting that supply, global demand, exchange rate, and real interest rate are important factors when describing the co-movement. This finding is in line with Frankel (2006), Calvo (2008), and Wolf (2008), who find that real interest rates, excess liquidity, and shifts in global supply and demand drive commodity prices. Based on returns, Christoffersen et al. (2014) and Yin and Han (2015) find evidence of a factor structure in daily and monthly commodity futures' returns and volatilities. Comparing commodity and equity markets, Christoffersen et al. (2014) conclude that commodity market returns have been detached from those of equity markets since 2010, whereas commodity volatility shows a nontrivial degree of integration with the volatility of equity markets.

The asset pricing literature seeks to identify observable factors that can explain the cross-section of commodity futures' returns. The two seminal theories on this subject are motivated by hedging pressure and the theory of storage. According to Dusak (1973), commodity futures risk premiums are related to systemic risk and to net positions of hedgers in futures markets, the latter of which is also known as hedging pressure. De Roon et al. (2000) argue that futures prices deviate from expected future spot prices because of the risk premiums that investors expect to earn or pay when investing in futures markets. Gorton et al. (2013) show that low inventory levels for individual commodities is associated with high risk premiums for their respective futures, seen as rewards for taking the risk of stock outs. Among others, Szymanowska et al. (2014) identify two additional types of risk premiums for commodity futures portfolios: spot premiums that are related to the risk in the underlying commodity and term premiums that are related to changes in the basis. Erb and Harvey (2006), Gorton and Rouwenhorst (2006), and Liu and Tang (2011) relate futures risk premiums to the basis or carry, and Bakshi et al. (2013) extend this framework to include an average commodity factor, a commodity carry factor, and a commodity momentum factor to explain both the cross-sectional and the time-series variation of commodity returns. Roache (2008), Shang (2011), Etula (2013), and Basu and Miffre (2013) find that macro factors like the real interest rate, foreign exchange variables, and hedging pressure affect the pricing of commodities. Daskalaki et al. (2014) deviate from the standard procedure in the asset pricing literature by using individual commodity futures instead of portfolios. They argue that the small cross-section of commodities means that only a small number of portfolios can be created and that their formation may conceal the heterogeneous structure of individual commodities. Based on macro-factor models, equity-motivated models, and standard principal components, their results reveal no asset pricing model that prices the cross-section of individual commodity futures' returns.

We take a fresh approach by introducing Forni et al.'s (2000) generalized dynamic factor model to the pricing of individual commodity futures' returns. Researchers traditionally use dynamic factor models to construct economic indicators like the coincident indicator of the Euro area business cycle (EuroCOIN) (cf. Hallin and Liška (2007)). They also apply the GDFM, among others, to provide a data-driven definition of the unobservable market liquidity for the S & P 500 (Hallin et al. 2011) and a volatility decomposition of the S & P 100 (Barigozzi and Hallin, 2015). Stock and Watson (1989) use factor models to study economic issues like the determination of a reference cycle in macroeconomic data and the finance literature uses factor models