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Are there common factors in individual commodity futures returns?

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ABSTRACT

We explore whether there are common factors in the cross-section of individual commodity futures returns. We test various asset pricing models which have been employed for the equities market as well as models motivated by commodity pricing theories. The use of these families of models allows us also to test whether the commodities and equities market are integrated. In addition, we employ principal components factor models which do not require à priori specification of factors. We find that none of the models is successful. Our results imply that commodity markets are segmented from the equities market and they are considerably heterogeneous per se.

1. Introduction

The primary goal of the asset pricing literature is to develop a model which explains (i.e. prices) the *cross-section* of the assets returns by means of a small set of common factors. There is an extensive research which addresses this task for traditional asset classes like equities. The empirical evidence is universal in that there are at least three well-accepted factors (size, value, and momentum) which price the cross-section of equities. However, there is no consensus on whether there is an asset pricing model which may explain the cross-section of individual commodity futures returns. We contribute to this debate by conducting a comprehensive study.

The answer to the asset pricing question in the case of commodities is challenging from an academic standpoint given that commodities are alleged to form an alternative asset class (Gorton and Rouwenhorst, 2006). Therefore, the factors which price the traditional asset classes may not price commodities. In addition, commodities are notorious for their heterogeneous structure (Erb and Harvey, 2006; Kat and Oomen, 2007). This makes harder the identification of a set of systematic factors which may price the common variation of commodity returns. The detection of an appropriate asset pricing model for commodities is also of particular importance to practitioners. Institutional investors have increased their portfolio allocations to commodities over the last years (Daskalaki and Skiadopoulos, 2011; Skiadopoulos, 2013). Therefore, commodity investors need to have reliable asset pricing models to evaluate their risk-adjusted performance.

The literature on the validity of asset pricing models to price the *cross-section* of commodities has been developing only recently. In the earlier literature, the vast majority of papers tests only the *time series* pricing properties of asset pricing models for each commodity individually rather than evaluating their performance within a cross-sectional setting. These studies employ either models that are designed to price *any* asset (stochastic discount factor, SDF, paradigm, Dusak, 1973; Bodie and Rosansky, 1980; Breeden, 1980) or commodity-specific factors (Stoll, 1979; Carter et al., 1983; Hirshleifer, 1988, 1989; Bessembinder, 1992; de Roon et al., 2000; Gorton et al., 2012; Acharya et al., 2013; Gospodinov and Ng, 2013) as determinants of the time series of each commodity futures premium. The latter family of models is motivated by the hedging pressure hypothesis (Keynes, 1930; Cootner, 1960) and the theory of storage (Working, 1949; Brennan, 1958).

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The prior literature that examines the existence of common factors in the cross-section of individual commodity futures finds mixed results. Jagannathan (1985) rejects the Consumption Capital Asset Pricing model (CCAPM) over monthly horizons whereas de Roon and Szymanowska (2010) find that CCAPM explains commodity futures returns (only) at quarterly horizons. Roache (2008), Shang (2011) and Etula (2013) find that the real interest rate, a foreign exchange variable and a quantity related to the broker dealers' leverage price commodity futures, respectively. Miffre et al. (2012) find that the idiosyncratic volatility of the commodity futures is not priced once one controls for commodity-specific factors. Basu and Miffre (2013) find that the hedging pressure is priced by constructing 16 different versions of the hedging pressure factor. However, their cross-sectional pricing evidence is based on pooling the 16 risk premium estimates from the different hedging pressure factors. This evidence though does not necessarily imply that any of these 16 different factors can individually explain the cross-section of commodities futures returns. In sum, the existing evidence suggests that further research should be conducted within a unified setting.

Building on the previously discussed literature, we comprehensively investigate whether there are any factors which explain the *cross-sectional* variation in individual commodity futures returns. We use a cross-section of 22 individual commodity futures contracts over the period January 1989–December 2010. The employed contracts represent the five main commodity categories (grains and oilseeds, softs, livestock, energy and metals). This cross-section is similar to the one employed by the previous cross-sectional studies on individual commodity futures. Moreover, this time period incorporates the 2003–2008 commodity boom period and the recent 2007–2009 financial crisis.

We begin our research by testing a number of macro-factor (aggregate variables) models. These models are designed to price *any* asset class including commodity futures if the markets are integrated (market integration is defined to be the case where the same SDF prices all markets, as in Bessembinder, 1992). We choose macro-factor models which use factors that play an important role in commodity futures markets, and hence they are appealing candidates for pricing purposes.

We find that no macro-factor model prices commodity futures. Next, we examine popular equity-motivated tradable factor models which have been shown to price the cross-section of equity returns (Fama–French, 1993; Carhart, 1997; Pastor and Stambaugh, 2003). The rationale lies in Cochrane's (2005, p. 64) theorem: under the law of one price, free portfolio formation, and provided that markets are not segmented, if a certain factor prices a given market, then it should also price the other markets. Hence, if the theorem's conditions hold, then these empirically successful factors for the equity market should price the cross-section of commodity futures too. Notice that our research approach does not assume in advance that the equity markets are integrated with the commodity futures ones.[1] In fact, testing whether macro-models or equity-motivated tradable factors price the cross-section of commodity futures provides a clean test for the markets integration hypothesis given Cochrane's (2005) theorem (for a similar approach, see also Bessembinder, 1992).

We find that the equity-motivated tradable factors models do not price commodity futures either. This finding implies that commodity futures markets are segmented from equity markets corroborating the results of Bessembinder (1992) and Bessembinder and Chan (1992). Consequently, we then focus on commodity-specific factors. We construct theoretically sound commodity-specific factors by relying on the two main theories for the determination of commodity futures returns; hedging pressure and the theory of storage. We also construct a commodity-specific liquidity risk factor and a commodity futures open interest factor motivated by Marshall et al. (2012, 2013) and Hong and Yogo (2012), respectively. We find that commodity-specific factors fail in pricing commodity futures too. This finding implies that there is no common risk factor structure in the cross-section of commodity futures risk premiums. We verify the heterogeneous structure of the commodity futures markets by showing that there is no single factor from our factors' menu which can explain the *time series* of returns of *every* single commodity futures.

As a final step, we implement principal components (PCs) factor models in the spirit of Cochrane (2011). In contrast to the previously employed models, these models do not require à priori specification of factors and they enable detecting the presence of *any* factor that may be used as a candidate for pricing commodity returns. We find that the PC models also perform poorly. Moreover, the results from the PC models confirm that there is a significant degree of segmentation in commodities futures markets. This finding also explains the failure of all previously employed factors.

We conclude this introduction by discussing the choice of our universe of test assets. Szymanowska et al. (forthcoming), Bakshi et al. (2013) and Yang (forthcoming) use commodity futures portfolios as test assets in line with the practice in the equities pricing literature.[2] Instead, we use individual commodity futures as test assets because the latter approach has a number of shortcomings in the case of commodities. First, the cross-section of commodity futures is small. Hence, only a small number of portfolios can be formed and this poses econometric challenges for model testing purposes. Second, the formation of commodity portfolios may mask the heterogeneous characteristics of individual commodities. This may also lead to large efficiency losses, potentially distorting the estimated factor risk premiums (Ang et al., 2010). Finally, the portfolio formation process is subject to data snooping criticism (Lo and MacKinlay, 1990). Nevertheless, we conduct a robustness analysis by using commodity futures portfolios formed by the type of the underlying commodity. The results from the portfolio test assets are in line with these obtained from the individual test assets.

Finally, a word is in order regarding the fact that we employ individual commodity futures asset class in a stand-alone fashion rather than augmenting our test assets universe with other asset classes. Dhume (2011) and Asness et al. (2013) use an augmented test asset universe and they find that certain factors are priced (consumption growth of durable goods and value/ momentum factors, respectively). However, the fact that these factors price multiple asset classes when they are jointly examined does not imply that they also price any given asset class separately. This will only be true in the case where these markets are integrated because in

[1] The empirical evidence on the integration of commodity and equity markets is mixed. Bessembinder (1992) and Bessembinder and Chan (1992) find that certain commodity markets are segmented from other asset markets. The evidence in Erb and Harvey (2006) also indicates that the Fama–French (1993), term spread, default spread, and foreign exchange factors do not drive the time-series variation of the returns of individual commodity futures. Gorton and Rouwenhorst (2006) regard the low correlations of commodities with other asset classes as evidence for market segmentation. On the other hand, Tang and Xiong (2012) argue that the increase of investments in commodities via commodity indexes (financialization of commodities) tends to integrate the equity with the commodity markets (see also Basak and Pavlova, 2012; Henderson et al., 2012; Singleton, 2012). Bakshi et al. (2011) and Hong and Yogo (2012) find that there are common variables which predict commodity futures and equity returns. However, this is a necessary but not a sufficient condition for market integration (Bessembinder and Chan, 1992).

[2] These portfolios are formed by using as sorting criterion variables that are found to predict commodity futures returns (e.g., basis, momentum, volatility). They find that the futures basis and momentum factors are priced. However, this is not an entirely unexpected result because these factors are identical/highly related to some of the sorting criteria employed to form the test portfolios (e.g., the basis is correlated with the momentum and volatility criteria, see Gorton et al., 2012). This may lead to a tautology and hence these factors ought to price the basis/momentum-sorted portfolios by construction.