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Portfolio diversification in energy markets☆

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ABSTRACT

This paper's results indicate that futures for crude oil, natural gas and unleaded gasoline fail to enhance the performance of representative energy stocks in terms of return to risk, but do decrease the overall level of risk exposure borne by passive equity investors. Our findings suggest that futures contracts on energy commodities are valuable to market participants with an interest in hedging against price fluctuations in energy markets by buy-and-hold strategies. However, this conclusion is reversed when one takes the perspective of traders whose core interests can be better approximated through the return to risk-bearing. In fact, this paper documents that return-to-risk maximizing agents are unlikely to profit from trading energy futures in addition to energy stocks. Moreover, futures for energy commodities fail to offer significant diversification gains with respect to energy stocks once investors adopt simple dynamic trading strategies that rely on readily available pricing information.

1. Introduction

What could investors in North American energy stocks potentially gain by diversifying their portfolios with investments on energy commodities markets? This is the key question addressed by this paper. Textbook portfolio theory teaches us that investors can improve portfolio performance by diversifying across different classes of assets. The argument is that allocating funds to imperfectly correlated securities decreases portfolio risk without necessarily affecting the level of expected return. However, utility-based portfolio selection models do not provide a consensus regarding the advantages of expanding the collection of tradable assets.[1] This is especially true if the additional investment opportunities are dominated by the securities that are already in investors' portfolios.[2]

The systematic evaluation of the benefits from exposure to alternative markets has attracted enormous attention from individuals and institutional investors. The main line of study in this field concerns the assessment of the advantages that are associated with expanding the set of tradable assets from the domestic to the international equity market (among others, Bekaert and Urias, 1996; Errunza et al., 1999; De Roon et al., 2001). Other works have investigated the gains from portfolio diversification across different classes or sets of assets (e.g., Eun et al., 2008). Ours is the first paper that applies these methodologies to assess the value of portfolio diversification within energy asset and commodity markets.

This study addresses the question of whether energy futures improve the investment possibilities offered by a representative selection of crude oil and natural gas producers, refiners, and integrated firms. Our empirical findings indicate that futures for crude oil, natural gas, and unleaded gasoline are effective in decreasing the overall level of risk borne by passive investors. That is, trading energy futures is a valuable strategy for investors that have an interest in hedging against energy commodities' price fluctuations by means of buy-and-hold portfolios. This might be the perspective of an agent who regards futures contracts as insurance policies rather than as profitable investments.

The opposite conclusion can be reached when one takes the perspective of market participants whose core interest lays in maximizing their compensation for risk-bearing. Our analysis clearly indicates that no additional reward to risk-taking is entailed by including energy futures in an efficient portfolio of energy stocks.

This paper also documents that the returns to energy futures contracts can be replicated–up to some zero-mean error term–by simple dynamic strategies of stock holdings. In fact, a dynamic portfolio of energy stocks that mimics the net positions of commercial traders (i.e., large hedgers) is shown to exhaust all the diversification gains offered by the futures contracts considered.

Hence, this paper's findings document the existence of simple trading strategies, that rely on readily accessible information and

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[1] For example, Willig (1978), Elul (1995), Bowman and Faust (1997), Kajii (1997), and Cass and Citanna (1998).

[2] In this paper the terms investments, securities, and assets are used interchangeably.

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require infrequent portfolio rebalancing, for which the selected energy futures fail to offer significant diversification benefits over a representative pool of energy stocks.

Our empirical results are in line with some known stylized facts on commodities markets. Erb and Harvey (2006) documented that for most commodities the average return on futures contracts is indistinguishable from zero, a fact that finds support in our sample. Gorton and Rouwenhorst (2006) noted that the returns on commodity futures are negatively correlated with those on equities. Standard portfolio management principles therefore suggest that futures might decrease the level of risk-bearing entailed by stocks. In contrast to Gorton and Rouwenhorst's study, however, our analysis relies on utility-based measures of diversification benefits which disentangle gains that come in terms of improved return to investment from those entailed by a lowered risk exposure.

The remainder of the paper is structured as follows. The next section provides an analytical framework and the econometric approach that we adopt. The data library utilized for our empirical analysis is described in Section 3, which is followed in Section 4 by our first set of results. Section 5 refines the analysis of the diversification benefits associated with energy futures by introducing dynamic trading. A short statement of conclusions follows in Section 6. Finally, three appendices provide additional description of the data used, some robustness checks of our empirical analysis, and the mathematical derivation of some of the tests for spanning.

2. Background

The purpose of this section is to outline this paper's approach to the evaluation of the benefits from portfolio diversification. In the first part we introduce the adopted analytical framework, namely mean-variance analysis, and discuss our take on the selection of assets representing energy stock and commodity markets. Next we illustrate the intuition underlying the measures of diversification benefits considered. A description of the testing techniques that we use concludes the section.

2.1. Analytical framework

A meaningful assessment of the effects of a change in agents' investment opportunities set requires that traders identify which strategies are to be adopted in each scenario. Mean-variance (MV) analysis (Markowitz, 1952) offers a suitable framework for this comparison because it identifies the collection of optimal portfolios associated with a given set of investments.

MV analysis maintains that risk-averse individuals design their portfolios to minimize risk-bearing, as measured by portfolio variance, while meeting a targeted level of expected return. The solution of the associated optimization problem bears a convenient graphical representation in the standard deviation and expected return plane. Once each asset return is identified with a point in this plane, the returns of the variance-minimizing portfolios span a characteristic hyperbolic curve, called the MV frontier of asset returns. Portfolios whose returns are on the MV frontier are called efficient. Standard economic theory casts the MV paradigm in the expected utility maximization framework, and, under some distributional assumptions, links it to second degree stochastic dominance.[3]

Diversification benefits can be gauged by the relative distance between the MV frontiers generated by the investments that are already represented in agents' portfolios and those associated with the broadened opportunities set. Whenever these efficient frontiers are not significantly different, then the benchmark investments are said to span the additional trading opportunities, that is there is spanning. These concepts were discussed by Huberman and Kandel (1987), who developed a regression-based test for spanning. De Roon and Nijman (2001) offer an excellent survey on the MV spanning tests.

In the MV framework, the risk reward of a portfolio is gauged by its Sharpe ratio (i.e., the ratio between its excess return and standard deviation). Jobson and Korkie (1982, 1984, 1989) measured benefits from the exposure to new markets in terms of changes in the optimal Sharpe ratio. Because return to investment lays at the core of investors' objectives, this paper complements Huberman and Kandel's test for spanning with the evaluation of the change in the risk-bearing compensation that is entailed by the expansion of the collection of tradable assets.

In this article we consider futures contracts on West Texas Intermediate (WTI) and Brent blend crude oils, unleaded gasoline, and natural gas. In our sample, covering daily trades starting from the beginning of 1990 to the winter of 2007–2008, the selected futures contracts are traded on the New York Mercantile Exchange (NYMEX) with the exception of the futures contracts on Brent, which are traded on Intercontinental Exchange (ICE, formerly the International Petroleum Exchange). Brent blend is used as benchmark price for oil produced in many areas of the world (including Russia and Africa and many parts of the Middle East) and is therefore included to proxy for investments in futures other than the NYMEX contracts.

Diversification gains are always defined with respect to a set of benchmark securities that acts as a term of comparison. Stated differently, the benefits of expanding the investment opportunities set depend on the characteristics of the assets initially held. In this paper energy futures are matched against a collection of U.S.-based energy stocks. The selected equities are issued by well-known large U.S. crude oil and gas producers, refiners, and integrated firms and provide a suitable, but parsimonious, representation of the investment opportunities available to participants on North American energy stock markets.

Several previous studies have examined the performance of futures with respect to alternative assets.[4] The pervasive approach in this body of literature is to compare the returns generated by managed futures portfolios or commodity futures indexes with broad equity indexes or other indexes representing separate classes of assets. Erb and Harvey (2006) argued that time variations in the composition, and differences in the way the weights are selected, make broad market indexes rather unsuitable to represent the complex reality of futures markets. In support of this claim, they documented that commodity futures contracts display an average cross correlation as low as 0.01 across commodities. In addition, the average return correlation of individual futures with popular commodity futures indexes, like for example the Goldman Sachs Commodity Index, is a mere 0.2. In short, lumping dissimilar assets together into broad indexes negates the existence of significant differences that might be essential from the perspective of investors.

From a modeling perspective, considering individual assets rather than broad indexes offers the advantage of not limiting traders' investment activities to predetermined strategies that are implicitly dictated by the definition of the indexes. Therefore, in this work, we anchor the diversification benefits offered by individual energy futures contracts to the performance of a collection of individual stocks.

Another reason on the basis of which we decided to rely upon individual energy assets rather than indexes is linked to our econometric approach. Simulations show that the reliability of MV tests of diversification benefits improves whenever there are

[3] Because experimental evidence has shown that individuals violate the assumptions underlying expected utility theory when taking decisions under uncertainty, MV analysis might seem inappropriate to model actual investment selection procedures. Nevertheless, a growing area of research investigating the relation between the MV framework and behavioral portfolio selection techniques (Shefrin and Statman, 2000; Levy and Levy, 2004) reveals a (perhaps) surprising robustness of the MV paradigm.

[4] Papers in which commodity futures are considered include, among others, Elton et al. (1987), Irwin et al. (1993), Edwards and Park (1996), and Jensen et al. (2000).