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Estimating the commodity market price of risk for energy prices

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Abstract

The purpose of this paper is to estimate the "market price of risk" (MPR) for energy commodities, the ratio of expected return to standard deviation. The MPR sign determines whether energy forward prices are upward- or downward-biased predictors of expected spot prices. We estimate MPRs using spot and futures prices, while accounting for the Samuelson effect. We find long-term MPRs generally positive and short-term negative, consistent with positive energy betas and hedging, respectively. In spot electricity markets, MPRs in Day-Ahead Prices agree with short-dated futures. Our results relate risk premia to informed hedging decisions, and futures prices to forecast/expected prices.

Keywords: Future prices; Market price of risk; Energy

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1. Introduction

The purpose of this paper is to determine the magnitude and sign of the commodity "market price of risk" (MPR) in energy markets. Defining the commodity market price of risk as compensation per unit standard deviation,[1]

$$\lambda_F \equiv \frac{\mu}{\sigma}, \tag{1}$$

permits us to determine whether forward prices are upward- or downward-biased predictors of future spot prices. Whereas the market price of risk is assumed positive in financial markets (participants require a premium for bearing risk), its sign in commodity markets could be negative.

The examination of the market price of risk has been performed in both financial (equity/bond) and commodity markets:

1. In equity markets, the estimation of the market price of risk — there denoted also the "Sharpe ratio" — is an enduring empirical and practical phenomenon. Researchers have addressed both the magnitude as well as the possible time variation in that variable. More recent estimates were provided in the AFA Presidential Address of George Constantinides (2002). As is well-known, in (positive "beta") equity markets, no-arbitrage future prices are downward-biased.[2]
2. There is a significant debate on the question of whether forward prices in energy markets are biased or unbiased predictors of future expected prices. The empirical work dating back to Houthakker (1957) and Chang (1985), and more recently Fama and French (1987) and Bessembinder (1992), showed that in financial and mature commodity futures markets risk premia in general satisfy the integrated-market model, which predicts that risk premia are proportional to the covariance of the futures return with the return on the market portfolio. On the theoretical side, the model by Hirshleifer (1988) assumed a cost for speculators to participate in the market, related the risk premium to the number of speculators, and found that risk premia possess an additional positive component due to cost. More recently, Routledge et al. (2001) and Bessembinder and Lemmon (2002) have related risk premia to volatility of price changes, risk of price spikes and uncertainty in quantity demanded. Empirical work has been performed by Dincerler and Ronn (2001), who use mean-reverting spot prices to obtain a −2.73 estimate of the MPR, and Doran and Ronn (2003), who consider the commodity market price of risk in the context of the market price of volatility risk.

[1] The market price of risk in equity markets is defined as the *excess* return per unit standard deviation,

$$\lambda_S \equiv \frac{\mu - r}{\sigma}.$$

Whereas equities require a costly investment, and return the risk-free rate under the risk-neutral distribution, the distinct definition for commodities arises from the recognition that futures contracts are costless to enter into, and thus have a *zero* drift under the risk-neutral measure. Note also that we focus our attention on the market price of risk, as distinct from the absolute risk-premia, μ in the case of futures and $\mu - r$ for equities.

[2] For a zero dividend-yielding stock, the no-arbitrage cash-and-carry model implies $F = S_0(1+r)^T$. For a positive-beta asset, the expected return exceeds the risk-free rate, $E(S_T) > S_0(1+r)^T = F$, and thus $F < E(S_T)$.