ELSEVIER

Energy Economics 24 (2002) 539–556

Energy Economics

www.elsevier.com/locate/eneco

Time-varying risk premiums in petroleum futures prices

Perry Sadorsky

Schulich School of Business, York University, 4700 Keele Street, Toronto, Ontario, Canada M3J 1P3

Abstract

This paper uses an ARMAX-ARCH model to estimate the conditional expected returns of petroleum futures prices under time-varying risk. Empirical results suggest that macroeconomic risk factors have significant forecast power in petroleum futures markets. The conditional expected returns for petroleum futures prices are quite large. Results from a small forecasting experiment indicate that the out-of-sample forecasts from an ARMAX-ARCH model generally outperform a random walk for all forecast horizons. Regression-based tests for market timing indicate that the model captures both the correct sign and the correct magnitude. Net trading profits are positive in all cases.

JEL classifications: G13; Q43

Keywords: Forecasting; Petroleum futures prices; Risk premium

1. Introduction

The trade-off between risk and return is one of the central issues faced by individuals who trade commodity futures contracts. Recently, there has been much interest in estimating risk premiums in petroleum futures prices. Serletis (1991), Deaves and Krinsky (1992) and Moosa and Al-Loughani (1994) have found evidence of risk premiums in petroleum futures prices, while Peroni and McNown (1998) found evidence to the contrary. Serletis (1991) and Moosa and Al-Loughani (1994) used futures prices and spot market prices to investigate market efficiency, and attributed market inefficiency to risk premium. Serletis (1991) used a variance

E-mail address: psadorsk@schulich.yorku.ca (P. Sadorsky).

0140-9883/02/$ - see front matter
PII: S0140-9883(02)00062-2

decomposition method to study the relationship between energy futures prices and energy spot prices. He found that the premium and expected future spot price components of energy futures prices are negatively correlated and that most of the variation in futures prices is due to variation in expected premiums. Moosa and Al-Loughani (1994) found that oil futures prices are neither unbiased nor efficient forecasters of spot oil prices. They employed a generalized autoregressive conditional heteroskedastic (GARCH) model and found that a GARCH-M (1,1) model reveals the existence of a time-varying risk premium in crude oil futures prices. Deaves and Krinsky (1992) used an autoregressive conditional heteroskedastic (ARCH) model to show that there is some evidence that short-term unconditional risk premiums in crude oil futures prices are positive. Peroni and McNown (1998) used cointegration tests of market efficiency to find support for weak and semi-strong efficiency in three energy futures markets.

There is considerable evidence that excess returns in equity and bond markets can be forecast using dividend yields, short-term interest rates, default premiums and the term structure of interest rates (Keim and Stambaugh, 1986; Fama and French, 1988, 1989, 1993; Fama, 1991; Chen, 1991). These macroeconomic risk factors are negatively related to business conditions and positively related to expected returns in the equity and bond markets. The counter business cycle variation of expected returns can be explained by consumption smoothing (Baum and Barkoulas (1996)). When business conditions are poor, income is low and expected returns on stocks and bonds must be high to induce substitution from consumption to investment. When business conditions are good, income is high and the stock and bond markets clear at lower levels of expected returns.

The idea that macroeconomic variables can help to explain excess returns in equity and bond markets has recently been extended to commodity futures markets. For example, Bessembinder and Chan (1992), Bailey and Chan (1993), Baum and Barkoulas (1996), and Bjornson and Carter (1997) used dividend yields, default premiums and the term structure of interest rates to model risk premiums in commodity futures markets. Bessembinder and Chan (1992) showed that the changes in prices in 12 futures, including currencies, metals and agricultural commodities, can be forecast using three common macroeconomic risk factors (dividend yields, short-term interest rates and junk bond yields). Bailey and Chan (1993) showed that stock and bond market risk factors in the commodity futures basis are mostly due to the presence of risk premiums. Baum and Barkoulas (1996) showed that dividend yields, short-term interest rates and junk bond yields can explain the risk premiums in the currency futures basis of five currencies. Bjornson and Carter (1997) showed that the changes in prices of eight agricultural commodities can be forecast using a common set of six macroeconomic risk factors (the most important instruments being dividend yields, short-term interest rates and junk bond yields). These results suggest that it might be possible to use a common set of macroeconomic risk factors to model time-varying risk premiums in petroleum futures prices.

In this paper I model time-varying risk premiums in three petroleum futures prices using an ARMAX-ARCH model. The three petroleum futures prices are crude oil, heating oil #2, and unleaded gasoline. These three futures trade on the