***ENERGY COMMODITY BASIS, RETURNS AND THE BUSINESS CYCLES***

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## Overview

This study examines the variation of spot and futures prices for energy commodities in the United States over the business cycle. The interest-adjusted basis (the difference between futures and spot prices net of the interest rate) and expected returns for crude oil, natural gas, heating oil, gasoline and propane are estimated in relation to proxies for the state of economy and economic determinants predicted by the theory of storage and the theory of normal backwardation using daily and weekly data over the period 1987-2011. Understanding the relationship between energy spot and futures prices in relation to economic determinants is crucial to economic agents in energy market.

## Methods

We take two complementary approaches to analyse the variation in energy prices. First, we apply the indirect test proposed by Fama and French (1988) by looking at the relative variation of daily and weekly spot and futures prices for energy commodities in periods of positive and negative interest-adjusted bases as proxies for high and low inventories. Alternatively, we directly verify weekly spot and futures price variation for energy commodities in periods of low and high stocks by using long-term averages of physical stocks from 1987 to 2011.

We then investigate evidence of energy spot and futures price variation around the U.S. business-cycle peaks, using the same approach proposed by Fama and French (1988). Second, we directly test the variation of the interest-adjusted basis and expected returns in relation to economic conditions and major economic determinants, such as the detrended petroleum and natural gas inventories, return volatility, monthly seasonals, etc.

For calculation of energy interest-adjusted basis, we use daily and weekly spot and three-month futures prices and treasury constant maturity rate. For the direct test, we use energy inventory data, which comprise weekly coverage and sufficient availability in the U.S. since 1982. For empirical test, we compute log normalised, detrended inventories (Gorton et. al., 2012) using weekly physical stocks for crude oil, distillate fuel oil, total gasoline, propane and propylene and natural gas. Following Pindyck (2001), we compute spot price volatility, measured as the conditional standard deviation of spot returns estimated with a GARCH (1,1) model.

We use several proxies for the state of economy. The first proxy is Aruoba-Diebold-Scotti (ADS) Business Conditions Index, designed by Aruoba et al. (2009) to track the real business conditions at high frequency. An alternative business cycle measure is the Chicago Fed National Activity Index, constructed as a principal component of 85 economic indicators. We also use a recession dummy constructed using the NBER business-cycle turning points and the real time probability of recession index constructed at monthly intervals using the Markov switching model by [Chauvet and Piger (2008](#_ENREF_4)) to indicate the probability that the U.S. economy is in recession.

## Results

Using the indirect test of Fama and French (1988) and the direct approach we find that when the stock is low the daily and weekly interest-adjusted bases for heating oil, propane and gasoline but not for natural gas and crude oil are mostly negative and more variable. We also find that spot returns are more variable than 3-month futures returns when the stock is low but its variability and conditional correlations are only slightly larger than that when the stock is high. Possible explanation is that demand and supply shocks affect the energy bases under low and high stocks with slightly larger impact when the stock is low.

Consistent with theory of storage, the energy interest-adjusted bases tend to be negative and expected returns are positive around business-cycle peaks when the stock is low. The signs of the energy interest-adjusted bases and expected returns reverse during recession when inventory increase. In addition, energy interest-adjusted bases and expected returns become more volatile around business cycle peaks and during recessions, suggesting that the commodity futures and spot prices strongly respond to demand and supply shocks.

Our preliminary empirical results show that business conditions play a role in the price variation for major energy commodities. The energy interest-adjusted bases tend to decrease while the expected returns increase when economic conditions are strong. Conversely, the energy bases increase and the expected returns fall in contractions. As theory of storage predicts, we find large positive and significant impact of the inventory on petroleum interest-adjusted bases when the stock is low but small and insignificant when the stock is high. In addition, we find that energy spot return volatility negatively affects the basis when the stock is low. Consistent with the theory of storage, the energy commodity bases positively predict expected returns, suggesting that the bases contain information about future spot price changes.

## Conclusions

This study focuses on energy interest-adjusted bases and expected returns in relation to the state of the economy and major economic determinants predicted by the theory of storage and the theory of normal backwardation. Our study confirms that the behaviour of spot and futures prices for energy commodities have a business-cycle pattern: the energy interest-adjusted bases tend to be negative and expected returns are positive around business-cycle peaks; while their signs are reverse during recessions. We find a statistically significant relationship between economic conditions and spot and futures price variation for petroleum commodities in the United States for 1987–2011. We also confirm a strong relationship between the inventory and the interest-adjusted basis for major energy commodities when the stock is low over the sample period, implying that the storage is a crucial determinant for the interest-adjusted bases. In turn, energy bases and economic conditions are informative about expected returns over three-month horizon, and they can be used to predict energy future spot prices.

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