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A comparison of the convenience yield and interest-adjusted basis

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A B S T R A C T

The convenience yield is a major notion in commodity markets but this variable is unobservable. Consequently, two methods are generally used to test stylized facts regarding commodity convenience yields: the first method relies on a convenience yield filtered from derivative prices while the second one directly uses an observable proxy, the interest-adjusted basis. We believe that our study is the first to theoretically prove that these two methods do not provide the same results. We confirm this finding by analyzing the copper and oil markets.

1. Introduction

Empirical validation of the theory of storage[2] is ongoing, as shown by the recent work of Gorton et al. (2013). The convenience yield[3] is the central element of the theory of storage and is not observable

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[2] The theory of storage explains the term structure of (storable) commodity futures prices thanks to inventory management. Brennan (1958) is an early example of empirical validation of this theory. More generally, the study of commodity markets is not only interesting per se but also because of its links with other markets such as equity markets (Nguyen et al., 2015).

[3] Brennan (1991) defines the convenience yield "as the flow of services that accrue to the owner of a physical inventory and not to the owner of contracts for future delivery." In this paper, we consider the net convenience yield, i.e. the convenience yield net of storage cost. This variable is of practical relevance as it is the key element of the shape of the term structure of commodity futures prices. Kim and Kang (2014) show the importance of the dynamics of the term structure of commodity futures prices as far as commodity risk management is concerned.

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(Schwartz, 1997; Mellios and Six, 2011). Consequently, researchers rely on an observable proxy such as the interest-adjusted basis[4] or resort to a model to filter the convenience yield from commodity derivatives. Our paper aims, for the first time to the best of our knowledge, to compare the two methods.

Articles that rely on the interest-adjusted basis to study the predictive power of the theory of storage include that by Fama and French (1987). More recently, Geman and Ohana (2009) use the interest-adjusted basis to test the Working–Kaldor curve for energy prices. The Working–Kaldor curve consists of a (convex) decreasing relationship between the convenience yield and the level of inventory. Carbonez et al. (2012) compare competing models of the convenience yield, using the interest-adjusted basis, for agricultural products. Symeonidis et al. (2012) analyze the residual maturity of interest-adjusted basis regarding various stylized facts of the theory of storage.

The filtered convenience yield is used less often than the interest-adjusted basis to test the theory of storage. Nielsen and Schwartz (2004) use a filtered convenience yield to plot the Working–Kaldor curve in the case of copper. Prokopczuk and Wu (2013) rely on Schwartz's (1997) model adjusted for seasonality to study the determinants of the filtered convenience yield. Kremser and Rammerstorfer (2014) use Heaney's (2006) filtering technique to study the convenience yield: Heaney (2006) uses the spread of two Asian options to infer the convenience yield.

This technique may suffer from a lack of liquid derivative prices for some commodities. Moreover, Heaney (2006) assumes very restrictive dynamics as far as spot and future prices are concerned. In particular, he expects that futures and spot prices will follow the dynamics of a Brownian motion. In this paper, we use the futures contract to infer the convenience yield as in Prokopczuk and Wu (2013). The futures contract is a very liquid instrument for most commodities. Moreover, the use of futures contracts enables us to compare the filtered convenience yield directly with the interest-adjusted basis. Our theoretical section relies on general dynamics for the spot price and the convenience yield.

We prove in our general setting that the interest-adjusted basis is the expectation of the average future values of the convenience yield. However, this expectation must be computed under a probability that takes into account the risk of the spot commodity price, the market price of risk of the convenience yield and the correlation between the convenience yield and the spot price. The interest-adjusted basis is then a bias estimate of the convenience yield. In addition, this bias is in general impacted by the level of inventory, as the risks of the commodity spot price and the convenience yield and the correlation between these two variables depends on inventory (Routledge et al., 2000). Consequently, validation of the theory of storage might depend on the method used to study the convenience yield.

We provide a short empirical comparison of the two methods for the copper market as in Nielsen and Schwartz (2004) and for the oil market. We choose these commodities because copper and oil are frequently used to test derivative pricing models (e.g. Casassus and Collin-Dufresne, 2005) and are used in empirical analyses (e.g. Symeonidis et al., 2012). Our sample covers the recent post-financial crisis period. We provide a descriptive analysis of the filtered convenience yield and the interest-adjusted bases. The first two moments of the filtered convenience yield and the interest-adjusted bases differ in both sign and magnitude. In addition, their correlation is positive but imperfect for bases with short-term residual maturities. Therefore, both the filtered convenience yield and the interest-adjusted basis should be used to validate the theory of storage for robustness purpose.

The remainder of the paper is organized as follows. Section two presents the settings and the results of our theoretical comparison. Section three focuses on an empirical test of this comparison using the copper and oil markets. Section four concludes and suggests avenues for future research. Proofs of our main theoretical results appear in Appendix A.

2. The filtered convenience yield and the interest-adjusted basis

(Ω, H, Θ, P) designates a complete probability space endowed with a continuous non-decreasing filtration $\Theta \equiv \{H_t : t \in [0, T]\}$. T is a positive constant that stands for the maturity of the futures contract

[4] The interest-adjusted basis is defined as the difference between the futures price and the spot price adjusted for the cost of time.

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