Relative Basis and Risk Premia in Commodity Futures Markets

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Motivation

- **Define the cost of carry as the storage cost plus the interest that is paid to finance the asset less the income earned on the asset. For an investment (financial) asset, the futures price is**

$$F_0 = S_0 e^{cT}.$$

For a consumption asset, it is

$$F_0 = S_0 e^{(c-y)T},$$

where, y is the <u>convenience yield</u>.

- **Question:** *How should one estimate convenience yield and cost of carry when one observes the price of a futures contract and its corresponding spot price?*

Contributions

- This paper proposes the relative basis measure as a more precise measure of the convenience yield on commodity markets.
- The relative basis exhibits significant return predictability on commodity futures markets.
- The empirical findings are robust to various robustness tests.
- The relative basis does not predict returns on financial futures markets.
- The paper claims that the relative basis is a better proxy for the convenience yield because it excludes components in the traditional basis that are related to storage cost and financing costs (cost of carry).

Merits

- A measure that is simple and easy to compute.
- A measure that does predict returns in commodity futures market.
- Thorough empirical tests with extensive robustness tests.
- Well written and clearly structured.
- An attempt to find an estimate of convenience yield.

Is the Relative Basis a Proxy of Convenience Yield?

According to classical cost-of-carry (expression 6)

$$F_{i,t}(T) = S_{i,t} exp[r_{i,t}(t, T) - \delta_{i,t}(t, T) + w_{i,t}(t, T)],$$

Thus,

$$F_{i,t}(T_1) = S_{i,t} exp[r_{i,t}(t, T_1) - \delta_{i,t}(t, T_1) + w_{i,t}(t, T_1)]$$

$$F_{i,t}(T_2) = S_{i,t} exp[r_{i,t}(t, T_2) - \delta_{i,t}(t, T_2) + w_{i,t}(t, T_2)]$$

Therefore,

$$
\begin{aligned}
& TradtBasis_{i,t}(T_1, T_2) \\
&= \frac{ln(F_{i,t}(T_1)) - ln(F_{i,t}(T2))}{T_2 - T_1} \\
&= \frac{[r_{i,t}(t, T_1) - \delta_{i,t}(t, T_1) + w_{i,t}(t, T_1)] - [r_{i,t}(t, T_2) - \delta_{i,t}(t, T_2) + w_{i,t}(t, T_2)]}{T_2 - T_1} \\
&= \frac{[\delta_{i,t}(t, T_2) - \delta_{i,t}(t, T_1)] - [r_{i,t}(t, T_2) - r_{i,t}(t, T_1)] - [w_{i,t}(t, T_2) - w_{i,t}(t, T_1)]}{T_2 - T_1}
\end{aligned}
$$

The above expression can only equal expression (8) in the paper:

$$TradtBasis_{i,t}(T_1, T_2) = \frac{1}{T_2 - T_1}[\delta_{i,t}(T_1, T_2) - r_{i,t}(T_1, T_2) - w_{i,t}(T_1, T_2)]$$

If we define:

$$
\begin{aligned}
\delta_{i,t}(T_1, T_2) &= \delta_{i,t}(t, T_2) - \delta_{i,t}(t, T_1), \\
r_{i,t}(T_1, T_2) &= r_{i,t}(t, T_2) - r_{i,t}(t, T_1), \\
w_{i,t}(T_1, T_2) &= w_{i,t}(t, T_2) - w_{i,t}(t, T_1).
\end{aligned}
$$

- What does $\delta_{i,t}(T_1, T_2)$ mean?
- A convenience yield is the benefit or premium of holding an underlying product (physical goods), rather than the associated derivative security.
- $\delta_{i,t}(t, T_1)$ can be interpret as the premium (benefit) of holding a physical good i at time t over holding the futures contract on i with time to expiration T_1. $\delta_{i,t}(t, T_2)$ has a similar interpretation.
- Does $\delta_{i,t}(T_1, T_2)$ mean the premium of holding one futures contract with shorter expiration (T_1) over holding another futures contract with longer expiration (T_2).
- If there is "benefit" holding one futures contract over the other, is it the traditional "convenient yield"? Should we call it "relative convenience yield" instead?

Further more, the paper defines $TradtBasis_{i,t}(T_2, T_3)$ similarly as:

$$TradtBasis_{i,t}(T_2, T_3) = \frac{1}{T_3 - T_1}[\delta_{i,t}(T_2, T_3) - r_i, t(T_2, T_3) - w_{i,t}(T_2, T_3)]$$

Following the above calculation, here we should have defined:

$$\delta_{i,t}(T_2, T_3) = \delta_{i,t}(t, T_3) - \delta_{i,t}(t, T_2),$$

$$r_{i,t}(T_2, T_3) = r_{i,t}(t, T_3) - r_{i,t}(t, T_2),$$

$$w_{i,t}(T_2, T_3) = w_{i,t}(t, T_3) - w_{i,t}(t, T_2)$$

- If we take the difference between the two basis measures and *assuming T_1, T_2, and T_3 are not too far away from each other, the two storage costs $w_{i,t}(T_1, T_2)$ and $w_{i,t}(T_2, T_3)$ should be similar to each other and the financial costs $r_{i,t}(T_1, T_2)$, and $r_{i,t}(T_2, T_3)$ cancel each other*, we have

$$\begin{aligned}
& RelatBasis_{i,t} \\
&= TradtBasis_{i,t}(T_1, T_2) - TradtBasis_{i,t}(T_2, T_3) \\
&= \frac{1}{T_2 - T_1}\delta_{i,t}(T_1, T_2) - \frac{1}{T_3 - T_2}\delta_{i,t}(T_2, T_3) \\
&= \frac{\delta_{i,t}(t, T_2) - \delta_{i,t}(t, T_1)}{T_2 - T_1} - \frac{\delta_{i,t}(t, T_3) - \delta_{i,t}(t, T_2)}{T_3 - T_2}
\end{aligned}$$

- This seems to be a "relative relative convenience yield".

- Is the assumption (see footnote 10) "as long as T_1, T_2, and T_3 are not too far away from each other, the expected physical storage costs and the expected commodity prices between these time points (i.e., from T_1 to T_2 and T_2 to T_3) should be close to each other." too strong? – On April 20, 2020, the front-month May 2020 WTI crude contract dropped 306%, or $55.90, for the session, to settle at negative $37.63 a barrel on the New York Mercantile Exchange partially (mainly?) due to "storage risk".
- If one can argue that the terms related to storage and financial costs can cancel each other, why not the convenience yield?