Relative Basis and the Expected Returns of Commodity Futures

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Motivation: Theory of Storage

- **Theory of Storage**: A long-standing and important theory for the commodity futures markets.
  - It can be traced back to as early as Kaldor (1939), Working (1949), and Brenann (1958), and are then followed by a large number of studies, such as Wright and Williams (1982), Scheinkman and Schechtman (1983), Gibson and Schwartz (1990), Brennan (1991), Deaton and Laroque (1992, 1996), Ng and Pirrong (1994), Routledge, Seppi, and Spatt (2000), Geman and Nguyen (2005), Dewally, Ederington, and Fernando (2013), Gorton, Hayashi, and Rouwenhorst (2013), Basak and Pavlova (2016).

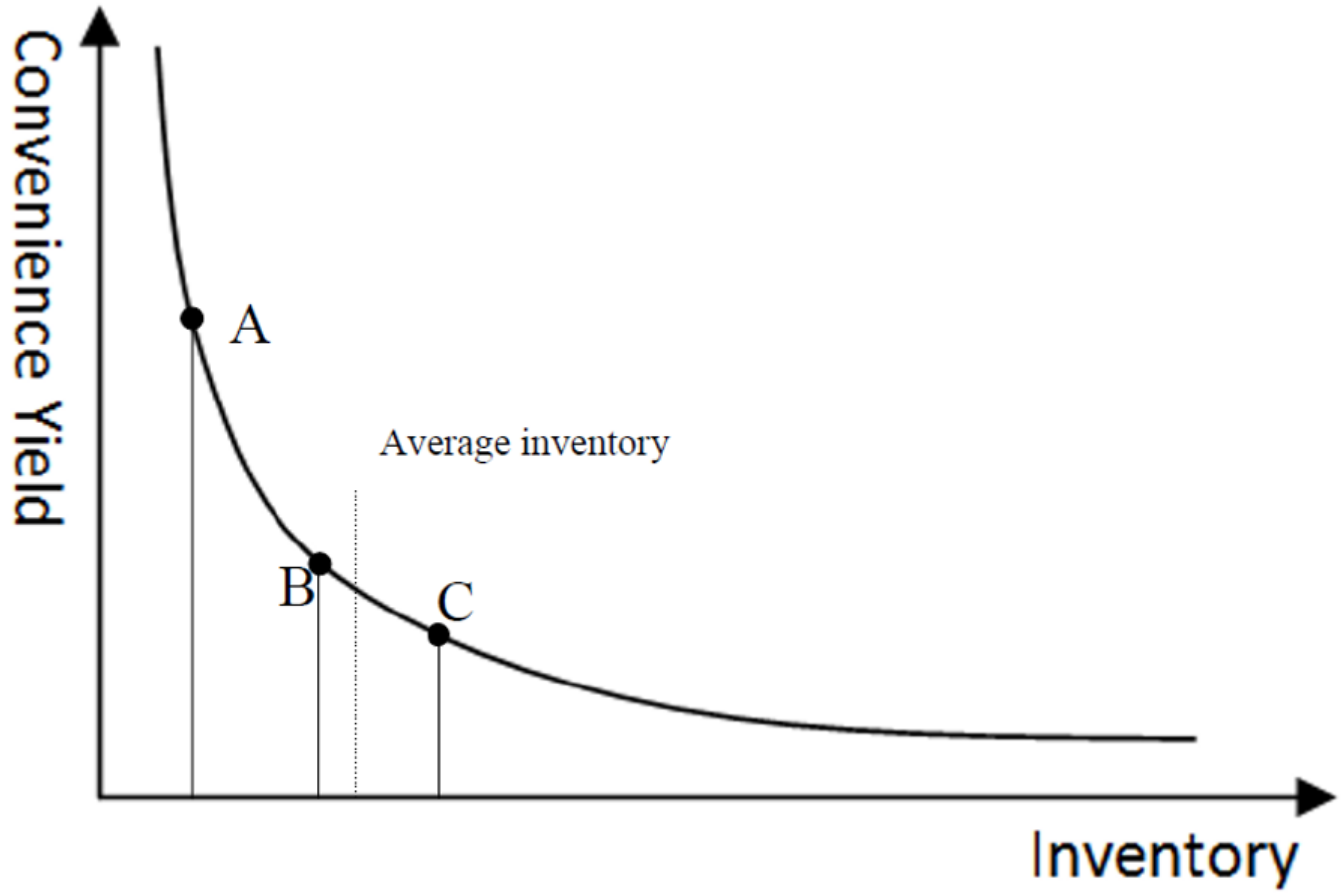
- In the Theory of Storage, we compare the benefits of holding spot commodities vs. futures contracts.
  - There is an implicit but important benefit, dubbed the "**convenience yield**", that accrues to the owners of the physical commodity, but not to the owners of the commodity futures contracts.

Motivation: Theory of Storage

- Convenience yield is closely related to inventory.
  - Convenience yield increases when inventory decreases.
  - When the inventory is particularly low, it may have "stock-out" risk, as suggested by Deaton and Laroque (1992) and Routledge, Seppi, and Spatt (2000), and therefore extra convenience yield.

- Convenience yield also predicts commodity futures returns.
  - No consensus on why this is the case
  - One possibility is convenience yield's close relation to inventory.

A negative, convex relation between convenience yields and inventories



Motivation: Theory of Storage

- The literature uses the basis (the slope of futures term structure) as a proxy for the convenience yield.
  - We call it the "traditional basis"

- The (traditional) basis is a noisy measure of convenience yield, because it is determined not only by convenience yield, but also other commodity-specific characteristics.
  - Most notably the cost to carry the commodity, which includes both the physical storage cost and financing cost.
  - Financing costs may vary because some commodities (e.g., gold) can be more readily used as collaterals for borrowing than other commodities (e.g., soybeans).

Motivation: Theory of Storage

- The traditional basis (*TradtBasis*) measure has the following empirical features:

  - The traditional basis is persistent over the time, yet inventory shocks (or even level) are highly time-varying.

  - In a simple univariate regression setting, the traditional basis predicts next-month futures returns. However, its return prediction power diminishes when adding other commodity characteristics.

  - The traditional basis measure has strong return predictability for financial futures, unlikely to be related to convenience yield.

Our Relative Basis Measure

- We introduce a new **Relative basis** (*RelatBasis*) measure, which is defined as the difference between the short-term basis (based on the first- and second-nearby futures contracts) and a similarly defined long-term basis (based on the second- and third-nearby futures contracts).
  - It reflects the curvature of the futures term structure.
  - Relative basis has more time-series variation and is more closely linked to physical inventories (particularly inventory decreases).

- Relative basis outperforms the traditional basis in return predictability.
  - It dominates the traditional basis measure in both the Fama-MacBeth regression and factor portfolio return test.
  - It does not predict financial futures returns, as suggested by the Theory of Storage.

Our Relative Basis Measure

$$F_{i,t}(T) = S_{i,t}\exp\left[r_t^f(t,T) \times (T-t) - \delta_{i,t}(t,T) \times (T-t) + w_{i,t}(t,T2) \times (T-t)\right]$$

$$TradtBasis_{i,t}(T1,T2) = \delta_{i,t}(T1,T2) - r_t^f(T1,T2) - w_{i,t}(T1,T2)$$

$$TradtBasis_{i,t}(T2,T3) = \delta_{i,t}(T2,T3) - r_t^f(T2,T3) - w_{i,t}(T2,T3)$$

$$RelatBasis_{i,t} = TradtBasis_{i,t}(T1,T2) - TradtBasis_{i,t}(T2,T3)$$
$$\cong \delta_t(T1,T2) - \delta_t(T2,T3)$$

Data and Methodology

- We obtain monthly pricing/return data from the Commodity Systems Inc. (CSI) for commodities traded on NYMEX, CBOT, and CME.
  - Our sample covers 24 commodities from Jan 1979 to Dec 2019.

- We obtain **position** information for different participants in commodity futures markets by using the Commitment of Trader (COT) data provided by the commodity futures trading commission (CFTC).

- We also follow Gorton, Hayashi, and Rouwenhorst (2013) and collect **inventory** data from a variety of sources, for a limited sample period though.

Data and Methodology

- Futures excess return

$$R_{i,t} = \frac{F_{i,t}(T) - F_{i,t-1}(T)}{F_{i,t-1}(T)}$$

- Traditional Basis

$$TradtBasis_{i,t} = \frac{\ln(F_{i,t}(T1)) - ln(F_{i,t}(T2))}{T2 - T1}$$

- Relative Basis

$$RelatBasis_{i,t} = \frac{ln(F_{i,t}(T1)) - ln(F_{i,t}(T2))}{T2 - T1} - \frac{ln(F_{i,t}(T2)) - ln(F_{i,t}(T3))}{T3 - T2}$$

Data and Methodology

- We run a cross-sectional regression of the Traditional Basis measure on the Relative Basis measure, with the intercept plus the residual item named as the Residual Basis (*ResidBasis*).
  - The relative basis and the residual basis are orthogonal to each other.

	RelatBasis	TradtBasis	ResidBasis	Momentum	BasisMom
RelatBasis	1.00	0.52	0.00	0.04	0.20
TradtBasis		1.00	0.76	0.39	0.36
ResidBasis			1.00	0.44	0.29
Momentum				1.00	0.36
BasisMom					1.00

Data and Methodology

- We present the time-series autocorrelation structure for the Traditional Basis, the Relative Basis, and the Residual Basis measures as below.

	TradtBasis	RelatBasis	ResidBasis
Lag 1 month	**0.68**	**0.34**	**0.71**
Lag 2 month	**0.51**	0.08	**0.56**
Lag 3 month	**0.40**	-0.02	**0.45**
Lag 4 month	**0.34**	-0.03	**0.38**
Lag 5 month	**0.31**	-0.03	**0.34**
Lag 6 month	**0.30**	0.00	**0.31**

Relative Basis and Inventory Changes

	$RelatBasis_{i,t+1}$				$ResidBasis_{i,t+1}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$InventChg_{i,t}$	**-0.024**	**-0.029**			0.002	0.001		
	(-4.76)	*(-5.55)*			*(0.48)*	*(0.27)*		
$InventIncrs_{i,t}$			-0.016	-0.016			0.000	0.000
			(-1.23)	*(-1.17)*			*(-0.01)*	*(-0.04)*
$InventDecrs_{i,t}$			**-0.032**	**-0.038**			-0.002	-0.005
			(-3.10)	*(-3.51)*			*(-0.19)*	*(-0.59)*
$InventLvl_{i,t-1}$		-0.009		-0.008		0.000		-0.001
		(-3.87)		*(-3.26)*		*(-0.01)*		*(-0.55)*
Adj R^2	32.2%	31.5%	33.9%	33.4%	46.3%	46.2%	46.8%	46.7%

Futures Return Predictability

- We examine which basis measure can better predict futures return on **commodity markets**, the Relative Basis, the Traditional Basis, or the Residual Basis
  - Our sample of commodities includes the following categories: Energy, Metals, Soft, Agriculture, and Live Stocks.

- As a comparison, we also conduct the same return-prediction regression on the financial futures markets.
  - We includes 19 financial futures that include stock index futures, interest rate futures, and forex futures.
  - Remember that there is no inventory concern for financial futures.

Futures Return Predictability

Return Predictability of Relative Basis on **Commodity Futures** Markets: Fama-MacBeth Regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$RelatBasis_{i,t}$	**0.019**			**0.018**			**0.017**	**0.024**
	(3.44)			***(2.65)***			***(2.53)***	***(2.85)***
$ResidBasis_{i,t}$		0.010			-0.008		-0.011	
		(1.43)			*(-1.06)*		*(-1.44)*	
$TradtBasis_{i,t}$			0.011			-0.002		-0.011
			(2.16)			*(-0.30)*		*(-1.44)*
$Momentum_{i,t}$				0.013	0.012	0.012	0.016	0.016
				(2.68)	*(2.19)*	*(2.25)*	*(2.95)*	*(2.95)*
$BasisMom_{i,t}$				0.035	0.050	0.048	0.042	0.042
				(1.87)	*(2.54)*	*(2.54)*	*(2.05)*	*(2.05)*
Adj R^2	2.3%	3.2%	3.3%	9.7%	10.7%	10.4%	12.7%	12.7%

Return Predictability of Relative Basis on **Financial Futures** Markets: Fama-MacBeth Regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$RelatBasis_{i,t}$	0.013			0.067			0.099	0.013
	(0.11)			*(0.65)*			*(1.00)*	*(0.12)*
$ResidBasis_{i,t}$		0.120			0.082		0.083	
		(4.55)			*(2.78)*		*(2.92)*	
$TradtBasis_{i,t}$			0.100			0.078		0.083
			(3.41)			*(2.60)*		*(2.92)*
$Momentum_{i,t}$				0.030	0.024	0.023	0.027	0.027
				(3.85)	*(2.50)*	*(2.48)*	*(3.11)*	*(3.11)*
$BasisMom_{i,t}$				0.667	0.433	0.367	0.466	0.466
				(2.40)	*(1.96)*	*(1.52)*	*(1.78)*	*(1.78)*
Adj R^2	2.1%	3.8%	4.0%	23.0%	27.1%	28.4%	27.8%	27.8%

Futures Return Predictability

- To sum up, for commodity futures, the relative basis dominates the traditional basis.
  - Assume that the relative basis increases from the average minus one standard deviation to plus one standard deviation for commodity futures, its return impact will be 2*17.3%*0.018 = 0.62% per month, or 7.5% in annualized rates.

- For financial futures, there is no significant return predictability based on the relative basis. It is the residual basis that determines next-month futures returns.
  - Assume that the relative basis increases from the average minus one standard deviation to plus one standard deviation for financial futures, its return impact will be at most 2*0.88%*0.067 = 0.12% per month.

Portfolio Sorting Analysis

- We also conduct portfolio sorting analysis based on these three basis measures.
  - At the end of each month, we construct three equally-weighted commodity futures portfolios based on the relative basis.
  - We then observe these three portfolio returns, as well as the return difference between the portfolios with the highest and lowest relative basis measure, in the post one month and one quarter horizon.
- Again, as a “control group” test, we repeat the portfolio sorting analysis above on financial futures markets.

Portfolio Sorting Analysis

Portfolio Sorting Based on Different Basis Measures on **Commodity Futures** Markets

	P1	P2	P3	P3-P1	
	mean	mean	mean	mean	*t*-stat
Sorted by RelatBasis					
next month	-0.22%	-0.10%	0.59%	**0.81%**	***(3.99)***
next quarter	-0.89%	-0.19%	1.82%	**2.71%**	***(6.64)***
Sorted by TradtBasis					
next month	-0.22%	-0.06%	0.54%	**0.75%**	***(3.30)***
next quarter	-1.03%	-0.11%	1.86%	**2.89%**	***(5.07)***
Sorted by ResidBasis					
next month	-0.24%	0.08%	0.41%	**0.65%**	***(2.97)***
next quarter	-0.66%	-0.07%	1.46%	**2.12%**	***(3.60)***

Portfolio Spanning Tests

Risk-adjusted Returns of the Relative Strategy Portfolio Based on **RelatBasis** on Commodity Futures Markets

	RelatBasisRet	RelatBasisRet	RelatBasisRet
Intercept	**0.685**	**0.686**	**0.633**
	(3.48)	***(3.48)***	***(3.35)***
ResidBasisRet		-0.012	
		(-0.25)	
TradtBasisRet			0.303
			(6.74)
MKTRet	0.132	0.131	0.146
	(2.32)	*(2.31)*	*(2.69)*
MomRet	-0.105	-0.105	-0.196
	(-2.69)	*(-2.43)*	*(-4.97)*
BasisMomRet	0.185	0.185	0.099
	(4.35)	*(4.21)*	*(2.34)*
Adj.R^2	5.1%	4.9%	13.6%

Portfolio Spanning Test

Risk-adjusted Returns of the Relative Strategy Portfolio Based on **TradtBasis** and **ResidBasis** on Commodity Futures Markets

	ResidBasisRet	ResidBasisRet	TradtBasisRet	TradtBasisRet
Intercept	0.056	0.063	0.172	-0.021
	(0.31)	*(0.35)*	*(0.90)*	*(-0.12)*
RelatBasisRet		-0.010		0.282
		(-0.25)		*(6.74)*
MKTRet	-0.031	-0.030	-0.017	-0.045
	(-0.59	*(-0.57)*	*(-0.32)*	*(-0.86)*
MomRet	0.388	0.387	0.294	0.319
	(11.25)	*(11.15)*	*(8.07)*	*(9.10)*
BasisMomRet	0.279	0.282	0.346	0.290
	(7.08)	*(6.98)*	*(8.28)*	*(7.12)*
Adj.R^2	29.0%	29.0%	23.8%	30.2%

Portfolio Sorting Based on Different Basis Measures on Financial Futures Markets

	P1	P2	P3	P3-P1	
	mean	mean	mean	mean	*t*-stat
Sorted by RelatBasis					
next month	0.17%	0.10%	0.24%	0.07%	*(0.55)*
next quarter	0.51%	0.32%	0.68%	0.17%	*(0.63)*
Sorted by TradtBasis					
next month	-0.06%	0.19%	0.38%	**0.44%**	***(3.11)***
next quarter	-0.26%	0.58%	1.16%	**1.42%**	***(3.78)***
Sorted by ResidBasis					
next month	-0.11%	0.18%	0.40%	**0.51%**	***(4.70)***
next quarter	-0.29%	0.59%	1.12%	**1.41%**	***(4.64)***

Return Predictability of Positive and Negative Relative Basis on Commodity Futures Markets

	(1)	(2)	(3)	(4)
$RelatBasis\_pos_{i,t}$	**0.045**	**0.047**	**0.048**	**0.060**
	(2.87)	***(2.63)***	***(2.68)***	***(3.47)***
$RelatBasis\_neg_{i,t}$	0.016	0.007	0.006	0.019
	(1.17)	*(0.49)*	*(0.45)*	*(1.21)*
$ResidBasis_{i,t}$			-0.012	
			(-1.42)	
$TradtBasis_{i,t}$				-0.012
				(-1.42)
$Momentum_{i,t}$		0.012	0.016	0.016
		(2.61)	*(2.98)*	*(2.98)*
$BasisMom_{i,t}$		0.039	0.046	0.046
		(1.93)	*(2.22)*	*(2.22)*
Adj R^2	4.3%	11.8%	14.5%	14.5%

Portfolio sorting based on relative basis in the Business Cycle

		P1	P3	P3-P1
contraction	next month	-0.08%	0.30%	0.38%
				(*1.40*)
	next quarter	-0.68%	1.07%	1.75%
				(*3.44*)
expansion	next month	-0.36%	0.88%	1.24%
				(*4.45*)
	next quarter	-1.10%	2.56%	3.66%
				(*7.81*)
Expansion - contraction	next month			**0.86%**
				(*2.21*)
	next quarter			**1.91%**
				(*2.77*)

The competing explanations

- Kang, Rouwenhorst, and Tang (2020) propose a smoothed-hedging pressure measure as the one-year moving average of the net positions of commercial hedgers.
  - When relative basis and smoothed-hedging pressure are included in the same regression, both variables retain their return forecasting power.

- Boon and Prado (2019) propose a basis-momentum measure, defined as the difference between the 12-month cumulative return of the first-nearby futures contract and that of the second-nearby contract.
  - The return predictability of relative basis and that of basis momentum likely arise from different economic channels.

Robustness Tests

- We conduct additional robustness tests.
  - Observe a stronger futures return prediction in the next quarter.
  - Re-do the futures return prediction using panel regressions
  - Re-do the futures return prediction regression in two sub-periods, 1979-1999 and 2000-2019.
  - Re-do the futures return prediction regression in an alternative sample, where we adjust the maturities of the first, second, and third nearby contract of energy commodities crude oil , so that relative basis employs the same horizon for all commodities.
  - Excluding the precious metal contracts (such as Gold, Silver, and Platinum that behave somewhat like financial instruments) from our sample of commodity futures has virtually no impact on the return predictability of relative basis.

Conclusions

- We propose a new basis measure, the Relative Basis.
  - The relative basis can be viewed as the fast-moving component of the traditional basis and a better proxy for the convenience yield.
  - is more closely linked to physical inventories (particularly inventory decreases).

- The relative basis measure is a strong return predictor for commodity futures.
  - relative basis significantly predicts commodity futures returns.
  - robust to controlling other commodity characteristics.

- We therefore call for a new theory of commodity futures that ties together inventories, convenience yields, and expected commodity futures returns.