# A new strategy using term-structure dynamics of commodity futures

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The term structure of commodity futures is important information for traders and investors. Traditional term-structure strategies are static; they tend to use the slope of term structure at a given moment. Instead, our trading strategy uses the change of term structure and generates statistically significant return. It also produces significant abnormal return in excess of the traditional two factors, i.e. the returns from static-slope strategy and daily momentum. Thus, its return includes orthogonal information or excess return that standard static-slope and momentum strategies cannot explain. This suggests a novel risk factor in the asset class of commodity futures or robust trading opportunities.

Keywords: commodity, futures, backwardation, contango, momentum, term structure dynamic-slope strategy

JEL Classification: G13, G14

This paper proposes a trading strategy for commodity futures. Two types of trading strategies are popular for commodity futures (Bodie and Rosansky, 1980; Erb and Harvey, 2006; Gorton and Rouwenhorst, 2006). The first uses the static slope of term structure. The second uses the dynamics of returns (e.g. momentum). These two are used together in practice. For example, traders take long position on the commodity futures showing both large momentum and backwardation.

In contrast, our novel strategy combines the intuition of both the first and second. We suggest a long position on the commodity futures exhibiting dynamic backwardation and a short position on the dynamic contango. Dynamic backwardation means the tendency of stiffening backwardation. The opposite is dynamic contango in which the extent of contango elevates. We call this strategy a dynamic-slope strategy. We find our dynamic-slope strategy generates significant excess returns even after considering the two popular strategies for commodity futures as well as transaction costs.

# Data

We collect the data about commodity futures from Thomson Reuters Quantitative Analytic Direct (QAD). Gold and silver futures are not included because these are often considered as financial contracts. We collect daily closing prices of 20 futures contracts that are listed in CME group or ICE. The data span from January 1990 to June 2012. The list of the commodity contracts are provided in Table 1.

In order to exclude roll-yield effect, we exclude the return data from the last to the next trading date. Since the return data are all from the nearest futures contracts without roll-yields, they should resemble spot return. We clean the data by eliminating where daily prices vary over 20% per day.

INSERT Table 1 ABOUT HERE

## Analysis of dynamic-slope strategy

As a benchmark, Table 2 provides daily returns from the traditional term structure strategy (static-slope strategy): long near futures on backwardation and short them on contango. First, we computed a hypothetical 100-day-to-be-matured contract price via linear interpolation. The interpolation uses two closest futures contracts with maturities right before and after 100 days ahead. We undertook this computation and interpolation each day. Then we measure the slope between 1) the hypothetical futures contract price expiring in 100 days and 2) the nearest contract, the value of which should be similar to spot price. The slopes are also measured at the close prices each day.

The traditional 'static-slope strategy' longs the nearest futures when the term structure slope is negative (backwardation), and shorts the nearest futures when the slope is positive (contango). Long or short positions are entered at the close price. The positions are cleared at the close prices the next trading day for each commodity future. Opposite positions for each future are taken with cash. Transaction costs are considered. Panel A shows the statistics for the whole sample period while the other panels provide statistics for the sub periods. The results clearly show that this long-short strategy works very well for all and sub periods. For the whole period, its trading profit is 0.036% per day or around 10% per annum.

INSERT Table 2 ABOUT HERE

We propose 'dynamic-slope strategy' extending this traditional static-slope strategy of using term structure of commodity futures. The daily implementation of dynamic-slope strategy is similar to the traditional static-slope strategy described in Table 2. More specifically, first we compute daily the hypothetical 100-day-to-be-matured contract price. Second, we calculate the slope between the nearest contract and 100-day-to-be-matured contract price. Third, we compute the *change of the slope* daily. This slope change can be regarded as the sensitivity of farther contract price with respect to the change of spot price.

For convenience, we use two terms: dynamic backwardation and dynamic contango. Dynamic backwardation occurs if the static backwardation goes even deeper or static contango becomes flatter. Dynamic contango arises if the static backwardation becomes flatter or the static contango gets steeper. Then, for each commodity future, we short the nearest futures when dynamic contango happens, but long when dynamic backwardation. The opposite position is taken on cash. Table 3 shows the return statistics from daily trading upon this strategy after transaction cost. Panel A shows the statistics for the whole sample period while the other panels provide statistics for the sub-periods.

INSERT Table 3 ABOUT HERE

Apparently, the dynamic-slope strategy produces a larger trading profit than the traditional static-slope strategy. The size of profit is 0.095% per day or 24% per annum, more than twice of the static-slope strategy. Practically speaking, this result may suggest new trading strategy orthogonal to the existing ones. It is also very easy to implement this new strategy. Academically speaking, dynamic-slope strategy may suggest a novel risk factor for commodity futures. Such practical and academic potentials are examined in Table 4.

INSERT Table 4 ABOUT HERE

We check whether the dynamic-slope strategy is simple combination of traditional strategies or whether the profits are robust to the well-known factors in commodity futures. Momentum and static-slope factors have been two popular factors for tactical asset allocation (See Jensen, Johnson, and Mercer, 2002; Wang and Yu, 2004; Erb and Harvey 2006; Miffre and Rallis, 2007; Fuertes, Miffre and Rallis, 2010; and more fundamentally Keynes 1930).

Table 4 provides a regression analysis to verify orthogonality of the dynamic-slope strategy. We run OLS regressions on two factors. A dependent variable is the returns from the dynamic-slope strategy after transaction costs. Independent variables are the returns from static-slope and daily-momentum strategies after transaction costs. Static-slope factor returns are those described in Table 2. Daily-momentum returns at day *t* are computed as: long the commodity futures whose returns at day *t*-1 are above median returns and short those whose *t*-1 returns were below the median. Opposite positions for each future are taken with cash. Shaded cells denote significance at 5%.

The results confirm the validity of the dynamic-slope strategy. First, the dynamic-slope strategy is not spanned by traditional static-slope and momentum strategies. Equivalently, the trading profits from the dynamic-slope strategy suggest a new risk factor not explained by the well-known two factors. After accounting for the static-slope and momentum strategies, the dynamic-slope strategy generates 4 bps per day or 10% per annum.

Second, the dynamic-slope return is explained better by the momentum return than by the static-slope return. The *abnormal return* from the dynamic-slope strategy is always robust when only static-slope returns are included. However, the abnormal return disappears during 1990-2004 when momentum returns are included although it emerges after 2004.

# Conclusion

Commodities are important because of their risk-return and inflation-hedging characteristics. They are easily invested with futures contracts which offer standardization, liquidity and low settlement and counterparty risks.

We suggest a novel trading strategy called the dynamic-slope strategy. This strategy longs near commodity futures on dynamic backwardation and shorts on dynamic contango. Dynamic backwardation means the term structure of commodity futures become more negative. Dynamic contango is opposite. Such trading generates large profits. In addition, its profit remains robust after accounting for two traditional factors of commodity futures, i.e. the profits from static term-structure and momentum strategies, as well as transaction costs. The dynamic-slope strategy is also intuitive and easily implementable.

Future research can extend this paper in many ways. Extending our basic formulation, the dynamic-slope strategy can be refined to produce further trading profits. In addition, this strategy can be examined commodity by commodity instead of our portfolio analysis.

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**Table 1: List of commodity futures**

Corn
Cocoa
Crude oil
Cotton
Milk
Live cattle
Gasoline
Copper
Heating oil
Coffee
Orange juice
Lumber
Lean hog
Natural gas
Oats
Palladium
Platinum
Soy beans
Sugar
Wheat

**Table 2: Summary statistics of static-slope strategy**
This table provides daily returns from traditional term structure strategy (static-slope strategy) using backwardation and contango.

| Strategies | Average | Std.Dev | p-value |
|---|---|---|---|
| Panel A: Whole Period (1990.1 ~ 2012. 6) | | | |
| Backwardation | 0.038% | 1.007% | 0.005 |
| Contango | 0.003% | 0.809% | 0.810 |
| Long-Short | 0.036% | 1.042% | 0.010 |
| Panel B: Sub Period (1990.1 ~ 1997. 5) | | | |
| Backwardation | 0.044% | 0.818% | 0.020 |
| Contango | 0.015% | 0.581% | 0.247 |
| Long-Short | 0.026% | 0.899% | 0.210 |
| Panel C: Sub Period (1997.6 ~ 2004. 11) | | | |
| Backwardation | 0.045% | 0.987% | 0.048 |
| Contango | -0.005% | 0.731% | 0.750 |
| Long-Short | 0.054% | 1.077% | 0.027 |
| Panel D: Sub Period (2004. 12 ~ 2012. 6) | | | |
| Backwardation | 0.025% | 1.182% | 0.361 |
| Contango | -0.002% | 1.045% | 0.920 |
| Long-Short | 0.027% | 1.136% | 0.302 |

**Table 3: Summary statistics of dynamic-slope strategy**
d.backwardation and d.contango dynamic backwardation and dynamic contango. Dynamic backwardation (dynamic contango) means more backwardation (contango) at t day than at t-1 day.

| Strategies | Average | Std.Dev | p-value |
|---|---|---|---|
| Panel A: Whole Period (1990.1 ~ 2012. 6) | | | |
| d.Backwardation | 0.082% | 1.144% | 0.002 |
| d.Contango | -0.016% | 1.136% | 0.537 |
| Long-Short | 0.095% | 1.133% | 0.000 |
| Panel B: Sub Period (1990.1 ~ 1997. 5) | | | |
| d.Backwardation | 0.071% | 0.819% | 0.000 |
| d.Contango | -0.007% | 0.701% | 0.671 |
| Long-Short | 0.081% | 0.968% | 0.000 |
| Panel C: Sub Period (1997.6 ~ 2004. 11) | | | |
| d.Backwardation | 0.046% | 0.877% | 0.022 |
| d.Contango | -0.011% | 0.875% | 0.587 |
| Long-Short | 0.060% | 1.062% | 0.014 |
| Panel D: Sub Period (2004. 12 ~ 2012. 6) | | | |
| d.Backwardation | 0.082% | 1.144% | 0.002 |
| d.Contango | -0.016% | 1.136% | 0.537 |
| Long-Short | 0.095% | 1.133% | 0.000 |

**Table 4: Two-factor analysis**

Shaded are significant at 5%.

Dependent variable: daily return from dynamic-slope strategy

| Intercept | | static-slope strategy | | Daily momentum | | Adj. $R^2$ |
|---|---|---|---|---|---|---|
| coefficient | p-value | coefficient | p-value | coefficient | p-value | |
| Panel A: Whole Period (1990.1 ~ 2012. 6) | | | | | | |
| 0.0007 | < 0.01 | 0.1603 | < 0.01 | | | 0.0249 |
| 0.0005 | < 0.01 | | | 0.2698 | < 0.01 | 0.0617 |
| 0.0004 | < 0.01 | 0.149 | < 0.01 | 0.266 | < 0.01 | 0.0840 |
| Panel B: Sub Period (1990.1 ~ 1997. 5) | | | | | | |
| 0.0008 | < 0.01 | 0.1916 | < 0.01 | | | 0.0312 |
| 0.0004 | 0.09 | | | 0.3145 | < 0.01 | 0.0768 |
| 0.0003 | 0.13 | 0.1822 | < 0.01 | 0.3142 | < 0.01 | 0.1063 |
| Panel C: Sub Period (1997.6 ~ 2004. 11) | | | | | | |
| 0.0005 | 0.033 | 0.1624 | < 0.01 | | | 0.0266 |
| 0.0004 | 0.125 | | | 0.2311 | < 0.01 | 0.0499 |
| 0.0003 | 0.225 | 0.1533 | < 0.01 | 0.2286 | < 0.01 | 0.0745 |
| Panel D: Sub Period (2004. 12 ~ 2012. 6) | | | | | | |
| 0.0009 | < 0.01 | 0.1395 | < 0.01 | | | 0.0192 |
| 0.0007 | < 0.01 | | | 0.2783 | < 0.01 | 0.0628 |
| 0.0007 | < 0.01 | 0.1248 | < 0.01 | 0.2716 | < 0.01 | 0.0786 |