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New indices of adequate and excess speculation and their relationship with volatility in the crude oil futures market

Latha Shanker

Department of Finance, John Molson School of Business, Concordia University, 1455 de Maisonneuve Boulevard, West Montreal, QC, Canada H3G 1M8

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ABSTRACT

I develop new indices of adequate and excess speculation in futures markets, defining adequate speculation as speculation which equals unbalanced hedging, while excess speculation is speculation in excess of this amount. The indices explicitly account for balancing hedging and balancing speculative contracts. I demonstrate that these indices accurately estimate Working's (1960) *conceptual definition* for his speculative index as the ratio of speculation to unbalanced hedging in all situations, while Working's *formula* for his speculative index *T* does not. I compare these indices to Working's formula for 21 futures contracts, including commodity, financial, cash-settled and physical delivery contracts. I apply these indices to investigate the relationship between speculation and volatility of the NYMEX's West Texas Intermediate (WTI) crude oil futures contract, over 1986 through 2015, while controlling for market fundamental risk. The results suggest that volatility in the crude oil futures market decreases with adequate speculation and increases with excess speculation.

1. Introduction

I build on previous research by Working (1960) to develop two new indices: 1) an index of adequate speculation, which measures the degree of speculation which is just sufficient to meet unbalanced hedging, and, 2) an index of excess speculation, which measures the degree of speculation in excess of adequate speculation. In these definitions, I explicitly recognize that *not all* of long hedging may balance short hedging, since short and long hedgers may differ on the duration, size and timing of their hedging positions. Keynes (1923) notes that commodity producers initiate short futures hedges much before production is completed, while users hold long futures hedges for shorter periods. Hirshleifer (1990) notes that commodity producers tend to be large enterprises which use large hedges, while users tend to be small enterprises which use small hedges. Peck (1979–80) notes that short and long hedgers differ on seasonal needs, timing and duration of hedging. In comparison, Ward's (1974) speculative index is defined as long speculation divided by the excess of short hedging over long hedging.

I illustrate the importance of recognizing that *not all* of long hedging contracts balance short hedging by a numerical example. Suppose that open futures positions are as follows: short hedging consists of 100 contracts, and long hedging consists of 60 contracts, so that open short hedging exceeds open long hedging. However, suppose that only 40% of long hedging contracts or 0.4×60=24 contracts are balancing hedging contracts, which Working (1960, page 197, footnote 15) describes as "the amount of "balancing" long hedging, that serves to carry, or "balance", an equal amount of short hedging". Then unbalanced hedging, which is short hedging minus balancing hedging contracts, equals 100-24=76 contracts. Adequate long speculation, which is just sufficient to equal unbalanced short hedging, equals 76 contracts. Suppose further, that actual long speculation consists of 110 contracts. Then

E-mail address: latha.shanker@concordia.ca.

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excess long speculation, which exceeds the amount needed to meet unbalanced short hedging, equals 110-76=34 contracts. If we assume that all long hedging balances short hedging, then we would under-estimate adequate speculation at 100-60=40 contracts, and over-estimate excess speculation at 110-40=70 contracts.

Note that actual long speculation equals the sum of: 1) a portion which equals unbalanced hedging; and 2) a portion which balances short speculation. Dividing both sides of the above identity by short hedging, I obtain the true linear relationship between the speculative ratio (ratio of long speculation to short hedging), and the hedging ratio (ratio of long hedging to short hedging). The slope of this relationship is the negative of the ratio of balancing hedging contracts to long hedging, and the intercept is 1 plus the ratio of balancing speculative contracts to short hedging. I define the index of adequate speculation as the ratio of unbalanced hedging to short hedging, and the index of excess speculation as the ratio of balancing speculative contracts to short hedging. In the above numerical example, the index of adequate speculation equals 76/100=0.76, while the index of excess speculation equals 34/100=0.34. The index of adequate speculation captures the presence of speculators who take on the risk transferred by hedgers. The index of excess speculation captures the presence of speculators who trade with other speculators.

These indices offer an alternative to Working's *formula* for his speculative index *T*, which is used extensively, as in Sanders et al (2010), Du et al (2011) and Büyükşahin and Harris (2011). Working (1960, page 209, second paragraph, lines 2–4) provides a *conceptual definition* for his speculative index as the ratio of long speculation to unbalanced short hedging, in stating, "The excess of long speculation ... over unbalanced short hedging... is an excess that should be measured by the speculative index, according to our definition of that index...". He notes that in a futures market with no long hedging, the speculative index is the ratio of long speculation to short hedging. He then adds that "If there is a purely logical reason for deducing how to write the formula for a speculative index for markets *with* long hedging, it escapes me". For a futures market with short and long hedging, he arrives at a *formula* for his speculative index as 1 plus the ratio of short speculation to the sum of short and long hedging, by assuming a particular relationship between the speculative ratio and the hedging ratio. I show that Working's *conceptual definition* equals 1 plus the ratio of the index of excess speculation to the index of adequate speculation, for markets with both short and long hedging. These indices share the intuition behind Working's *concept* of measuring speculation relative to unbalanced hedging. However, Working's *formula* for his speculative index is difficult to explain for markets *with* long hedging, does not explicitly incorporate balancing hedging, accurately measures his conceptual definition only for a market with no long hedging, and implies that excess speculation exists in markets in which it is absent. I illustrate these results with numerical examples.

I use data provided by the Commodity Futures Trading Commission (CFTC) in its Commitments of Traders (COT) reports to compare the indices of adequate and excess speculation, and Working's speculative index, for 21 futures contracts in 7 groups, energy, grains and oilseeds, livestock, metals, equity indexes, interest rates, and foreign exchange, over the period 31 January 1986 or the date of contract initiation till 29 December 2015. Estimation of the indices of adequate and excess speculation needs estimates of balancing hedging and balancing speculative contracts, for which no data are directly available. I estimate these unobservable quantities by applying a Kalman (1960) filter approach with inequality constraints imposed on the state variables, which are the time-varying intercept and slope of the true linear relationship between the speculative and hedging ratio for each contract. The estimation is more complex than that used to calculate Working's *formula*, which is a ratio of observables.

I contribute to the debate on the role of market fundamentals and speculation upon the volatility of crude oil prices. I investigate the relationship between volatility in the WTI crude oil futures market and the indices of adequate and excess speculation, while accounting for the risk contributed by market fundamentals, over 1986–2015. Previous research offers conflicting implications for the relationship between volatility in the crude oil futures market and the index of adequate speculation. Keynes (1930) notes that speculators must be induced to take long positions to meet net short hedging demand by a risk premium which reduces the current futures price below the expected future spot price. Cootner (1960) adds that hedgers may be net long as well, which could cause the risk premium to increase the current futures price. These, and other papers on hedging pressure (Hirshleifer (1990)), imply that there should be a positive relationship between volatility in the crude oil futures market and the index of adequate speculation. However, Cheng et al (2015) note that when financial traders accommodate hedging needs as opposed to trading for their own purposes, their presence would dampen futures price changes, implying a negative relationship between volatility in the crude oil futures market and the index of adequate speculation. Previous research also offers conflicting implications for the relationship between volatility in the crude oil futures market and the index of excess speculation. Friedman (1953) argues that rational arbitrageurs in currency markets stabilize prices. De Long et al. (1990a) note that noise traders could move an asset's price away from its fundamental value, while De Long et al. (1990b) note that even rational speculators in a market with positive feedback traders could do likewise. Thus, an asset's price risk is the sum of the risk contributed by market fundamentals and that contributed by speculation. I estimate the volatility of the crude oil futures market by the stochastic variance of the log return on the futures contract. I estimate the risk contributed by market fundamentals by the stochastic variance of the growth in the log demand for crude oil in the U.S., building on research by Chatrath et al (2009), who model the price of crude oil as a function of the demand for crude oil in the U.S. and other variables.

In Section 2, I describe the indices of adequate and excess speculation, analytically compare them to Working's conceptual speculative index, as well as his formula, and compare these indices with Working's formula for the 21 different futures contracts. In Section 3, I describe the estimation of the indices, and, the estimate of the relationship between volatility in the crude oil futures market, the risk contributed by market fundamentals, and the indices of adequate and excess speculation, as well as Working's formula, and provide results. Section 4 concludes.