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Estimation of Canadian commodity market risk premiums under price limits: Two-phase fuzzy approach

Kamal Smimou*, 1

I.H. Asper School of Business, The University of Manitoba, Winnipeg, Manitoba, Canada R3T-5V4

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Abstract

This paper is written with two complementary purposes in mind. The first is to provide estimates of systematic risk for Canadian commodities futures (western barley, canola, flaxseed, feed wheat) using a market portfolio based on a similar weighting scheme suggested by Marcus. The second is to estimate systematic risk with the induction of price limits in the capital asset pricing model (CAPM) and the deployment of fuzzy regression method. A comparative investigation has been provided to show the importance of the fuzzy regression to estimate the existing risk premiums in the commodity futures.

Keywords: Finance; Fuzzy sets and data analysis; LP optimization; Fuzzy regression; CAPM; Systematic risk; Price limits; Commodity futures

1. Introduction

The price limit bounds the daily commodity price to move within the predetermined level above or below the previous day's closing price. Therefore, the equilibrium price is unobserved when it moves outside the limits. Under price limitation, since the observed price is not equal to the equilibrium price, estimating using the observed price may yield biased parameter estimates. Actually, many studies propose econometric analysis to tackle the data distortion caused by price limits. Kodres [1] used the maximum likelihood approach to estimate the parameters of two limit robit models. Roll [2] adopted the proxy variable to substitute the limit move data. The daily commodity price on any trading day cannot be higher (lower) than the previous closing price plus (minus) a limit. The price limits bound the daily commodity price movements, and shorten the distribution of equilibrium price changes, allowing for the use of the fuzzy theory developed by Zadeh [3]. Therefore, the equilibrium return may be treated as fuzzy random. The aim of this study is to estimate systematic risk using commodity futures prices with the existence of price limits. The estimation process has been conducted in two different phases. With the help of the ordinary least squares (OLS) method, the systematic risk has been estimated using the settlement price of the commodity futures, which are assumed to be sharply defined. The second phase is to investigate the impact and effectiveness of price limits on estimating the beta risk of commodities return by using an optimization model.

In the following section, we present a short review of the literature related to price limits and to CAPM when applied to commodity futures. In Section 3, we present the modeling environment of both CAPM and a two-phase fuzzy regression approach, and in Section 4, the data and methodology are demonstrated. Our concluding remarks are offered in Section 5.

* Tel.: +1 403 329 2439.
E-mail address: kamal.smimou@uleth.ca.
[1] All errors are the exclusive fault of the author.

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2. Short review of the literature: price limits and CAPM with futures markets

Recently, various studies investigated the modeling of the price limits and their impacts on stock and futures prices, for example [4–7]. A feature of most, futures markets, is a daily price limit rule. Price limits have been imposed on daily price volatility for stabilizing the market. In a market with daily price limit rule, trading is permitted only at prices within limits determined by the settlement price of the previous day. The settlement price is an average of the transactions' prices in the closing periods of trading or, if trading is halted at the close, it is the relevant price limit. For instance, the Winnipeg Commodity Exchange regulates the prices by prohibiting trading during any trading day, in futures of commodities traded at a price that exceeds the settlement price of the previous day's session by a certain amount higher or lower. Table 1 represents the price limits of the feed wheat, western barley, canola and flaxseed commodities, excluding the new contract delivery month. Such limits are based upon the Board's lot quotations. In addition, in the case of trading in a contract that is eligible in that month, there shall be no daily limit on price movement on the last day of trading.

Brennan [8], first, proposed a theory explaining why a price limit exists in some futures markets. In a market with price limits, when a shock happens, the equilibrium price moves outside the daily maximum allowable increase/decrease interval, it becomes unobserved, and what we observe is merely a limit price. He pointed out:

"…for agricultural commodities, where the basis risk is typically substantial, we expect to find a role for price limits, at least in the distant contract months"

He found out that as the precision of the external signal regarding the equilibrium price increases, the price limits is expected to be either relaxed or ignored. Thus, that precision is not assumed in this paper.

Roll [2] argued that the price data that is usually used may or may not reflect an actual transactions, is determined by members of the exchange at the close of each day's trading. Roll [2] discussed that:

"When a significant event, such as a freeze in Florida, causes the price to move the limit, the settlement price on that day cannot fully reflect all available information. In other words, limit rules cause a type of market information inefficiency (but not a profit opportunity). This might be inconsequential if limit moves occurred rarely; unfortunately, they are rather common."

There are many empirical studies that have dealt with futures prices behavior in practice. Gray's [9] study looked at corn futures prices during 1921–1959 and resulted in findings similar to those of Telser. Dusak's [10] study used data on corn, wheat and soybeans during 1952–1967. Her study attempted to estimate the systematic risk of an investment in these commodities by calculating the correlation of movements in the commodity prices with movements in the S&P 500. However, the results obtained by Dusak [10] suggest that there is no systematic risk. Then, she concluded that these futures contracts are not risky assets when held as part of a large portfolio assets. Research done by Chang [11] using the same commodities, supported the existence of a positive systematic risk. Elam and Vaught [12] (hereafter referred to as EV) investigated the existence of risk and return in cattle and hog futures. They found significant systematic risk for the one hog and four cattle futures contracts. They combined 90% on the S&P 500 index and 10% on the Dow–Jones cash commodity index, as proxy index.

Table 1
Price limits per commodities futures traded in Winnipeg Commodity Exchange (WCE). Sample period: 01:1991–12:2000

Commodities	Price limits \$/tonne[a]	Price limits \$/tonne[b]
Western barley	5.00	7.50
Canola and flaxseed	10.0	30.0
Feed wheat	5.00	7.50

[a]Daily price limits before October 10, 2000.
[b]Daily price limits effective October 10, 2000.

The estimation in futures markets is usually faced by the existence of price limit regulations and may call for another approach to estimate systematic risk. Thus, it is important to analyze the behavior of futures prices when the exchange is regulated by price limits. Also, it is well known that the regulation responds to the trading behavior of market members. When traders are confronted with market barriers, they revise their expectations accordingly.

Park [13], in his study, investigated price limits in futures markets and pointed out that price limits serve to delay gains and losses that might occur with large price swings. Price limits function similarly to margin accounts by limiting the amount of price exposure risk. According to Park [13]:

"Unfortunately, there is no generally accepted theory on how price limits influence price behavior."

3. The modeling environment

3.1. Necessary assumptions

As a rule, an observation is subject to different kinds of uncertainty from objective sources (e.g., the coarseness of the computer used to collect and register data) or from subjective ones (e.g., the evaluation of the observer, trader, or investor with respect to the reliability of the observation). Thus, observation is subject to fuzzy structures specification, which can take place at each daily price. In fuzzy set, it is