Futures contracts as a risk management technique—an adjusted timing model analysis

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ABSTRACT

This study employs an adjusted timing model (i.e., a market timing model adjusted by both a lower as well as an upper arbitrage bound) in order to gain insights concerning the potential efficacy of futures contracts as a risk management technique. Unexpectedly, the overall results suggest that a majority of the daily futures prices analyzed in this study are located outside the related lower or upper arbitrage bounds estimated in this study. Admittedly, to varying degrees, these results may be associated with the limitations of the study. In this regard, the limitations of this study are provided to enhance future research.

Keywords: arbitrage bound, corn, futures contracts, risk management, soybeans, timing model

INTRODUCTION AND MOTIVATION

While agricultural markets are important to non-producers (e.g., speculators), such markets are perhaps more important to producers (i.e., farmers) given that the agricultural policy of the United States shifted away from the use of farm subsidies with the passage of the Federal Agriculture Improvement and Reform (FAIR) Act of 1996 (Lence and Hayes, 2002). Admittedly, while some subsidies continue to be granted, such subsidies are ad hoc in nature perhaps due, in part, to the notion that subsidies are controversial (Sumner, 2008; Bekkerman, Belasco and Watson, 2015). Thus, producers must seek other alternatives to manage risks associated with potential income instability.

One risk management alternative is greater participation in crop insurance programs (Young, Vandeveer and Schnepf, 2001; Innes, 2003; Environmental Working Group, 2018). Admittedly, this risk management technique primarily relates to the (physical) loss of crops resulting from extreme weather conditions, disease, or possibly other issues (e.g., fire). Thus a much broader risk management technique is needed with respect to mitigating potential income instability. Hedging is one such technique.

Generally speaking, hedging is the practice of taking an equal but opposite position in the futures market to offset the price risk inherent in any cash market position to protect oneself or a business from adverse price changes which may occur between the current date and the date of the desired sale/purchase of the commodity (Commodity Trading Manual, 1994). With respect to producers, hedging is the practice of selling a commodity futures contract and/or forward contract to offset the price risk inherent in price changes which may occur between the current date (perhaps the planting date) and the date of the desired sale (perhaps the harvest date). A futures contract is a legally binding arrangement, developed on the trading floor of a futures exchange, to buy/sell a commodity at a stated point in the future; the only variable for futures contracts (which are standardized as to quality, quantity, and delivery time/location for each commodity) is price, which is discovered on an exchange trading floor (Commodity Trading Manual, 1994). Somewhat similarly, a forward contract is a cash contract where a seller agrees to deliver a specific commodity to a buyer at a specified future point; however, unlike futures contracts, forward contracts are privately negotiated and are not standardized (Commodity Trading Manual, 1994).

Given the rather private nature of forward contracts (versus futures contracts), information relating to forward contracts are not as readily observable/transparent as futures contracts. Thus, given the relative lack of transparency of forward contracts, this study focuses on futures contracts as a potential risk management technique to mitigate potential income instability. As discussed in the next section, information transparency is critical to market efficiency.

BACKGROUND AND HYPOTHESIS DEVELOPMENT

Fama (1970), in a capital market context, defines a weak-form efficient market as a market where prices reflect all historical price/return information. In turn, he defines a semi-strong form efficient market as a market where prices reflect all historical price/return information and all publicly available information. Finally, Fama defines a strong form efficient market as a market incorporating all historical, public, and private information.

The extent to which markets are efficient has significant implications for prices of stocks in capital markets as well as commodities in futures markets. Extrapolating from the thoughts of Fama (1970), if a market is not efficient, then traders with private information could manipulate that market on a consistent (more often than not) basis to achieve excess returns at the expense of trading partners such as producers; when a market is efficient, then traders cannot use "private" information to manipulate that market and achieve excess returns on a consistent basis. Thus information transparency is critical to market efficiency.

Interestingly, the results of the following studies indicate that some level of inefficiency may exist in the commodity futures market: Johnson, Zulauf, Irwin and Gerlow (1991); Milonas (1991); DeCoster, Labys and Mitchell (1992); Khoury and Yourougou (1993); Dorfman (1993); Gay, Kale, Kolb and Noe (1994); Bessembinder, Coughenour, Seguin and Smoller (1995); Irwin, Zulauf and Jackson (1996); and, Urcola and Irwin (2011). Specifically, with respect to the association between commodity futures prices and the related cash spot prices, Telser (1958) rejects backwardation while studies by Bodie and Rosansky (1980), Chang (1985), Fama and French (1987), Kolb (1992), and Beck (1993) support backwardation for certain commodities. In a somewhat related vein, Dusak (1973) as well as Fama and French (1987) conclude futures prices provide some forecast power of future spot prices while Kenyon, Jones and McGuirk (1993) as well as Zulauf, Irwin, Ropp and Sberna (1999) indicate futures prices are not good indicators of future spot prices for corn or soybeans.

Importantly, given that the results of the studies noted in the previous paragraph allow for the possibility of over or under pricing in the commodities markets, this suggests that the possibility exists that hedgers might, to some extent, overpay or underpay for their futures contracts. Admittedly, to determine if a hedger overpaid or underpaid for futures contracts, a fair price (for a futures contract) must be established for comparison purposes. Thus, as delineated in the next section, for the purposes of this study, a fair price for a futures contract is the related daily cash spot price plus costs impacting arbitrage decisions—such as transaction costs (Kolb, 1999). Given this definition of a fair price for a futures contract, and given that the possibility exists that hedgers might, to some extent, overpay or underpay for their futures contracts, the following research question is specified:

Research Question: Will the purchase/sale of daily futures contracts consistently (i.e., more often than not) yield higher/lower prices than the related daily cash spot prices, after adjusting for an arbitrage bound?

Given their large futures trading volume as well as their high production volume (when compared to other agricultural commodities), data relating to corn and soybeans are analyzed to gain insights regarding the above research question. In turn, for analysis purposes, the above research question is restated in terms of the following hypothesis.

Hypothesis: A time frame does not exist in which daily corn and/or soybean futures prices are consistently (i.e., more often than not) higher/lower than the related daily cash spot prices, after adjusting for an arbitrage bound.

METHODOLOGY AND MODEL DEVELOPMENT

The methodology utilized in this study to evaluate the above hypothesis is grounded in the conceptual as well as the methodological underpinnings of the market timing model employed by Cumby and Modest (1987) as well as the futures pricing model proposed by Kolb (1999). With respect to the futures pricing model, Kolb (1999) indicates that futures contract prices should consider not only the cash spot price, but also transaction costs (e.g., commissions) as well as any applicable carrying costs (e.g., interest). Additionally, Kolb (1999) suggests that the spot cash price, adjusted for transaction costs as well as any applicable carrying costs, represents an arbitrage bound (or a no-arbitrage bound if appropriate for the situation) with respect to a futures contract buy/sell decision. Further, Kolb (1999) indicates that a lower as well as an upper arbitrage bound should be considered. With respect to the market timing model, Cumby and Modest (1987) employ a contingency analysis procedure to categorize and report their results. For model development purposes, the above noted elements of Cumby and Modest (1987) as well as Kolb (1999) are synthesized in the next two paragraphs.

As specified in Table 1 (Appendix), the futures pricing model includes a lower arbitrage bound as well as an upper arbitrage bound. The foundation for both the lower arbitrage bound as well as the upper arbitrage bound of the model is S_o, that is, the daily cash spot price. If S_o is employed in calculating the lower arbitrage bound, then S_o is adjusted by both transaction costs $(1 - T)$ as well as interest—based on the lenders' interest rate $(1 + C_L)$. In turn, if S_o is employed in calculating the upper arbitrage bound, then S_o is adjusted by both the transaction costs $(1 + T)$ as well as interest—based on the borrower's interest rate $(1 + C_B)$.

To determine if an arbitrage bound is violated, the lower and upper arbitrage bounds are compared to the related daily futures contract price (F_o) for a specific trading day prior to the contract expiration. Based on the results of the comparison, one of three categorical labels is assigned to the trading day. Specifically, if the futures price exceeds the upper arbitrage bound, the comparison is reported as an "Above Violation" trading day. In turn, if the futures price is below the lower arbitrage bound, the comparison is reported as a "Below Violation" trading day. Finally, if the futures price falls within the lower and upper arbitrage bounds or on either the lower or upper arbitrage bound, then the comparison is reported as a "No Violation" trading day. After completing this comparison process for each trading day, the total number of trading days assigned to each of the three categories is calculated for overall assessment purposes.

In summary, the methodology employed in this study is extrapolated from the concepts underpinning the timing model employed by Cumby and Modest (1987) as well as the arbitrage bounds proposed by Kolb (1999); hence, the phrase "adjusted timing model" (i.e., a market timing model adjusted by both a lower as well as an upper arbitrage bound). Data collection and data alignment procedures are discussed in the next section. However, before discussing the data collection and alignment procedures, it appropriate to note that the data set employed in this study was also employed in Hunter and Luehlfing (2010). In this regard, it is important to note that Hunter and Luehlfing (2010) focused on "partial hedging" assumptions in contrast to the potential efficacy of futures contracts as a risk management technique (which is the focus of this study).

DATA AND DATA ALIGNMENT

The daily cash settlement price and the daily futures contract price data employed in this study were obtained from the Futures Industry Institute. Specifically, data were obtained for the September (November) corn (soybean) futures contracts as well as the December (January) corn (soybean) futures contracts for the years 1970 through 2000. Unfortunately, the Futures Industry Institute terminated sales of such data as of April 2003. However, given that major market structural changes occurred relatively soon thereafter (Irwin and Sanders, 2012), the time horizon of this study provides for longitudinal consistency.

Since the raw data reflected non-trading days such as holidays and weekends, and since the dates of these non-trading days often varied each year, the raw data had to be aligned; in this regard, non-trading days were removed from each year of data for the daily cash settlement prices as well as the daily futures contract prices. Also, during the contract expiration month, the number of days the contract trades varies by year and contract month. For example, one year the September corn contract may trade until September 12 and in another year it may trade until September 18. For consistency, trade day one (Day 1) is defined as the last trade day of the month before the contract expiration month. Therefore, Day 1 for a September 2000 corn futures contract is Thursday, August 31, 2000 while Day 1 for a September 1997 contract corresponds to Friday, August 29, 1997.

The interest rates for lenders and producers employed in this study are taken from the Interest Rates and Bond Yields table (typically page 30) in the monthly report, "Economic Indicators/prepared for the Joint Committee on the Economic Report by the Council of Economic Advisors." Additionally, the transaction cost component employed in this study (0.1%) is based on the average commission for a producer as quoted by such companies as: efutures.com, Farmer's Grain, Infinity Brokerage Services and ORION Futures Group. After the various data collection and data alignment procedures were completed, the upper and lower arbitrage bounds were calculated and the comparison process for each trading day was performed (as delineated in the previous section). The overall results are reported in the next section.

RESULTS

Due to the volume of data, Table 2 (Appendix) displays the results of the (previously delineated) comparison procedures in summary format for the September/December corn contracts as well as the November/January soybean contracts. Please recall that if the futures price exceeds the upper arbitrage bound, the comparison is reported as an "Above Violation" trading day. In turn, if the futures price is below the lower arbitrage bound, the comparison is reported as a "Below Violation" trading day. Finally, if the futures price falls within the lower and upper arbitrage bounds or on either the lower or upper arbitrage bound, then the comparison is reported as a "No Violation" trading day.

As reported in Table 2, most of the daily futures prices analyzed in this study are located either outside the related lower or upper arbitrage bounds estimated in this study. On the average, 15.7% of the daily futures prices had “Above Violations,” 72.1% had “Below Violations,” and 12.2% had “No Violations” across the two corn and two soybean contracts. Thus with respect to the data evaluated in this study, the overall results are unexpected, at best, and troublesome, at worst. In turn, sensitivity tests were performed to gain insights regarding this situation.

Please recall that the results reported in Table 2 relate to arbitrage bounds employing a 0.1% transaction cost assumption. After expanding the transaction cost assumption to 2.0% (from 0.1), the adjusted results suggested that, on the average, 10.5% of the daily futures prices had “Above Violation” trading days, 61.2% had “Below Violation” trading days, and 28.3% had “No Violation” trading days, across the two corn and two soybean contracts. Thereafter, after expanding the transaction cost assumption to 4% (from 2%), the adjusted results suggested that, on the average, 7.2% of the daily futures prices had “Above Violation” trading days, 47.3% had “Below Violation” trading days, and 45.5% had “No Violation” trading days, across the two corn and two soybean contracts. Admittedly, while the expanded transaction cost assumptions (and, in turn, the expanded arbitrage bounds) in these sensitivity tests yielded fewer combined arbitrage bound violations, the overall percentage of violations was still troublesome.

Additionally, a sensitivity test was performed with respect to the interest costs employed in determining the results reported in Table 2. In this regard, the interest rate applicable to the contract trade date was adjusted for the time remaining to contract expiration. In turn, after making this assumption change, the adjusted results suggested that, on the average, 45.6% of the daily futures prices had “Above Violation” trading days, 46.6% had “Below Violations” trading days, and 7.8% had “No Violation” trading days, across the two corn and two soybean contracts. However, in contrast to the results of the previous sensitivity tests concerning transaction costs noted above, the results of the interest cost sensitivity test yielded more (not fewer) combined arbitrage bound violations—which is, again, troublesome.

In summary, the overall results suggest that a majority of the daily futures prices analyzed in this study are located either outside the related lower or upper arbitrage bounds estimated in this study. Admittedly, to varying degrees, these results may be associated with the limitations of the study. In this regard, the limitations of this study are provided (in the next section) to enhance future research.

LIMITATIONS AND FUTURE RESEARCH CONSIDERATIONS

Given that transaction costs and interest rates are critical components of the arbitrage bounds estimated in this study, and given that such components could vary under different circumstances (e.g., transaction size, trading partner size/affiliation, trading partner financial stability, trading partner policies and/or regulatory charges/fees, etc.), future research could employ Monte Carlo analysis with respect to transaction costs and interest rates. Additionally, other costs (e.g., storage, insurance, and/or transportation, etc.) could also be included in the Monte Carlo analysis. In turn, more complex models (e.g., Bekkerman, Brewster and Taylor,

2016) and/or the use of various "partial hedging" assumptions (e.g., Rolfo,1980; Howard and D'Antonio, 2005) might also be employed.

Admittedly, the results of this study are based on daily settlement prices for both daily cash spot prices and daily futures prices. Given that settlement prices often reflect an average of several prices "discovered" at the end of the trading day, the prices used may not equal an actual trade price. Alternatively, using opening prices on the following trade day may result in a very different trade price as well. Additionally, the results of this study may have differed if intraday futures and cash spot price data had been used. Addressing one or more of these limitations in future research could prove fruitful.

Arguably perhaps, while the results of this study relate to two corn futures contracts (September and December) and two soybean futures contracts (November and January), there is no reason to believe that corn and soybean futures are not representative of other actively traded grain futures or of each other. Admittedly, future research focusing on different contract months and/or different agricultural commodities should be performed (if for no other reason than to gain additional insights regarding the unexpected results of this study). Additionally, given the historical perspective of this study, future research could focus on data subsequent to the time horizon of this study; such an extension may prove especially fruitful given that Irwin and Sanders (2012) report that major market structural changes occurred relatively soon thereafter.

Finally, while the results of this study (albeit unexpected) allow for the possibility of over or under pricing, inferring trading rules from the results is inappropriate. In this regard, please see Azizan, Mohamed and M'ng (2011) for critical insights concerning trading rule specification. Admittedly, over or under pricing (to the extent that it actually exists) may be associated with private information or some erroneous/inappropriate activities; for example, poor forecasting models relating to projected yields and/or expected usage, etc.—with or without the actual/assumed existence of tariffs.

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APPENDIX: TABLES

Table 1: Futures Pricing Model

$$S_o\,(1\text{-}T)\,(1+C_L) \;\leq\; F_o \;\leq\; S_o\,(1+T)\,(1+C_B)$$

where,

S_o	=	Daily cash spot price
F_o	=	Daily futures contract price
T	=	Transaction cost (on a percentage basis)
C_L	=	Lender's interest rate
C_B	=	Borrower's interest rate

Source: Adapted from Kolb (1999).

Table 2: Summary of Market Timing Model Results

	Violations Above		Violations Below		No Violations		Total	
	#	%	#	%	#	%	#	%
Corn								
September	1,915	26.6	4,523	62.9	754	10.5	7,192	100.0
December	1,657	23.0	4,869	67.7	666	9.3	7,192	100.0
Soybeans								
November	370	5.1	5,752	80.0	1,070	14.9	7,192	100.0
January	580	8.1	5,580	77.6	1,032	14.3	7,192	100.0
Total	4,522	15.7	20,724	72.1	3,522	12.2	28,768	100.0

\# Number of trading days.

% Percentage of trading days.

Source: Adapted from Cumby and Modest (1987).