Commodity price risk management using option strategies

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Abstract: In the world of increasing price volatility, it is more important than ever to understand how to manage the price risk. The paper deals with the price risk management issues associated with commodities. Using options is performed by an analysis of hedging strategies in the commodity market. The authors focus on the application of the vanilla option strategies to risk management in order to point out the advantages and disadvantages of each hedging strategy. Based on the general expressions of selling price intervals, there are modelled various hedged scenarios of wheat. The authors look at the wheat option contracts traded on the Chicago Board of Trade. The comparative comparison of the option hedging strategies has shown the best results for the commodity seller who hedges against a price decline.

Key words: commodity market, hedging strategies, vanilla options

Shields (2012) states that commodities represent the fastest growing markets in the world of globalized economies. Globalization brings the participants in agricultural business many new benefits, but on the other hand, it involves more potential risks. The increased volatility in prices is one of the major threats receiving the attention in the last years. The commodity market participants tend to more focus on the commodity price risk. The management of price risk is also defined as hedging. According to Zmeškal (2004), the main idea of hedging is to add financial instruments (usually derivatives) to a risky asset in order to create a new portfolio, the so-called hedged portfolio. The purpose of using the risk management tools is to protect against an unfavourable commodity price movement.

Hedging techniques used to manage the commodity risk are more complex than ever before and are a regular theme of the current scientific papers. The handbook (Labuszewski et al. 2011) provides the essentials for understanding risk management. Geman (2012) have contributed significantly to the analysis of the risk management, with an emphasis on financial derivatives. The paper (Odilon José and Fabio Gallo 2014) examines the effectiveness of cross hedging operations for the Uruguayan steer in the futures market of the Brazilian live cattle in relation to risk and return. Leoni et al. (2013) investigate hedging strategies for the energy derivatives. Sanda et al. (2013) analyse the risk management trends in the electricity commodity markets.

Hedging in the commodity risk management is also investigated in the paper (Taušer and Čajka 2014). The authors compared three basic hedging techniques – commodity futures, forward and option contracts. The most sophisticated technique to manage the commodity risk is hedging using the option strategies that we intend to present.

Option strategies are studied in the popular derivative books including Carol (2008), Chorafas (2008), Hull (2008) and many paper for example Santa-Clara and Saretto (2009), Amaitiek et al. (2010), Šoltés (2010), Gardijan (2011), Mugwagwa et al. (2012) and Šoltés (2012). Generally, an option strategy involves the simultaneous combination of two or more option positions (Long Call, Short Call, Long Put, and Short Put). The paper Lazar and Lazar (2011) presents some of the most used option strategies in the market. Butterfly, Condor, Spreads along with Straddles, Strangles, Combos and Ladders are some of the option strategies.

This paper is designed to help the sellers in the commodity market learning how to integrate options into the effective hedging strategies. Commodity sellers (producers) are the individuals or firms responsible for the eventual sale of the physical raw commodities (e.g. wheat, rice, corn). For example, the commodity sellers can be farmers, grain elevators, grain cooperatives or exporters. Although they have different functions in the agricultural industry, they share a common risk – falling prices and a common need to manage that price risk. The principal aim is

to perform an analysis and comparison of the option hedging strategies relevant for managing the commodity risk. We focus on the application for wheat producers as potential hedgers, but the results are robust for various commodities.

COMMODITY RISK AND STRATEGIES

The commodity risk for producers in the agricultural business refers to the uncertainty about the expected value of price raised from the sale of agricultural commodities. For example, let us suppose the producer of commodity expects the price of the commodity is going to drop in the future. This would be a good time to hedge against a price decrease in the future for ensuring the commodity selling price level using the relevant option hedging strategy. The price risk management involves holding the opposite positions in the cash and futures markets. If the value of the hedger's cash market position decreases, the value of the hedger's futures market position increases and vice-versa. With an option, a hedger is protected against an unfavourable price change. This feature allows sellers of the commodities to establish the floor (minimum) selling prices for protection against the falling markets. Likewise, the options allow the buyers of agricultural products to set the ceiling (maximum) buying prices and to protect themselves from price increases. An option is the right, but not the obligation, to buy or sell an underlying asset at a specific predetermined price (strike price) at any time within a specified expiration period (the American style) or at the expiration date (the European style). Options are either negotiated between two parties in the over-the-counter (OTC) market or traded on the organized exchanges.

A commodity option, also known as an option on a futures contract, contains the right to buy or sell a commodity futures contract. There are four distinct types of the commodity options. A call option gives the holder (buyer)/writer (seller) the right to buy/the obligation to sell a commodity futures contract at a

fixed strike price. A put option gives the buyer/seller the right to sell/the obligation to buy a commodity futures contract at a fixed strike price. The purchaser of an option has to pay an initial sum of money called the premium to the seller of the contract.

To understand commodity options on futures, it is necessary to know something about futures markets. A futures contract is a commitment to make or take delivery of a specific quantity and quality of a given commodity in the future.

Hedging with futures is based on the principle that the cash market prices and the futures market prices tend to move up and down together. Taking the opposite positions allows losses in one market to be offset by gains in the other and to establish a hedge price level.

To give you a better idea of how hedging with futures works, let s suppose that it is May and you are a wheat producer with a crop in the field. In the market terminology, you have a short cash market position. If the price goes up between now and October, when you plan to sell, you will gain. On the other hand, if the price goes down during that time, you will face a loss. To protect yourself against a possible price decline during the coming months, you can hedge by selling a corresponding number of bushels in the futures market now and buying them back later in October. If the cash price declines, any loss incurred will be offset by a gain from the hedge in the futures market. This particular type of hedge is known as a short hedge because of the initial short futures position.

Let us assume that the current cash market price for wheat to be delivered in October is $6.15 per bushel. You are able to establish a price level for a cash market transaction by selling futures with the current future market price for wheat to be delivered in October $6.50 per bushel. The basis is $0.35 under ($6.15–$6.50). Let us suppose that the cash market price and the future market price decline by $0.50 per bushel in October. The basis is $0.35 under ($5.65–$6.00).You buy wheat futures for the

Table 1. Basis change

	Wheat cash market position	Wheat cash price ($)	Wheat futures market position	Wheat futures price ($)	Basis ($)
May	–	6.15	sell November wheat futures contract	6.50	−0.35
October	sell wheat	5.60	buy November wheat futures contract	6.00	−0.40
Change		−0.55		0.50	−0.05
Selling price		$5.60 + $0.50 = $6.10 or $6.15 − $0.05 = $6.10			

future market price $6.00 per bushel. The gain from the hedge in the futures market is $0.50 per bushel. At the same time, you sell wheat in the cash market for the cash market price $5.65 per bushel. Your net selling price is $6.15 per bushel ($5.65 + $0.50).

The movement between the local cash market price and the futures price is not necessarily identical. The relationship between them is known as the basis (cash price – futures price = basis at a specific point in time).

The Table 1 illustrates the example of a negative basis change between the cash market price and the futures price. Let us assume the wheat cash price at $6.15 per bushel and the wheat futures price at $6.50 per bushel in May. The basis is $0.35 under ($6.15–$6.50). You expect the price drop in the future. Therefore, you decide to sell the November wheat futures contract at $6.50 per bushel in May. Suppose the cash price declines by $0.55 per bushel and the futures price decline by $0.50 per bushel in October. The basis is $0.40 under ($5.60–$6.00). You buy the November wheat futures contract at $6.00 per bushel. The gain from the hedge in the futures market is $0.50 per bushel ($6.50–$6.00). You sell wheat in the cash market for the cash market price $5.60 per bushel. The net selling price is $6.10 per bushel ($5.60+$0.50). Because the basis change is $0.05 under, the net selling price $6.10 per bushel is lower than the cash market price $6.15 per bushel at the time of the strategy conclusion.

The options may be combined, by the means of which new forms and attractive investment opportunities are created. In the Table 2 there are option strategies suitable as the hedging instruments against a commodity price decrease. The Long Combo strategy was investigated by Šoltés (2011). In the papers Šoltés and Amaitiek (2010), the authors analyse the usage of the Inverse Vertical Ratio Put Spread strategy in hedging.

The selection of a suitable option hedging strategy is a systematic process based on the volatility of the underlying asset expectation, the investor's attitude to risk and expected payoff quantification. Each of the strategies has strengths and weaknesses, which will be discussed in the following part.

Table 2. Option strategies and characteristics

	Volatility	Risk
Long Put	bearish	low
Long Combo	bearish	high
Inverse Vertical Ratio Put Spread	bearish	low

WHEAT PRICE RISK MANAGEMENT

The wheat producer is a potential hedger against a commodity price decrease. Assume that the producer decides to hedge against a possible price decrease using the option strategy. Each commodity seller with their own profit/risk profile will have to make a decision – which strategy is the best for his/her needs.

All of the following strategies being analysed and compared assume the wheat futures options prices quotes for May 2015 wheat contract traded on the Chicago Board of Trade (CBOT). The premiums for May 2015 wheat call and put options are in the Table 3. The data consists of the American style standard commodity options traded on the underlying futures contract. Exercising a standard option will the result in a futures position in the same contract month as the option at the specified strike price. To illustrate, May Wheat put option contract at the strike price $6.00 per bushel will result in selling the May wheat futures contract $6.00 per bushel. One wheat option contract size is 5000 bushels. We consider the prices per bushel and assume a basis of $0 and transaction cost of $0 because of the simplification.

The following strategies are examples of how to manage the falling price risks using the option contracts. They allow the producer to establish a minimum floor selling price and to provide different risk management benefits.

Table 3. Wheat futures call and put option premiums

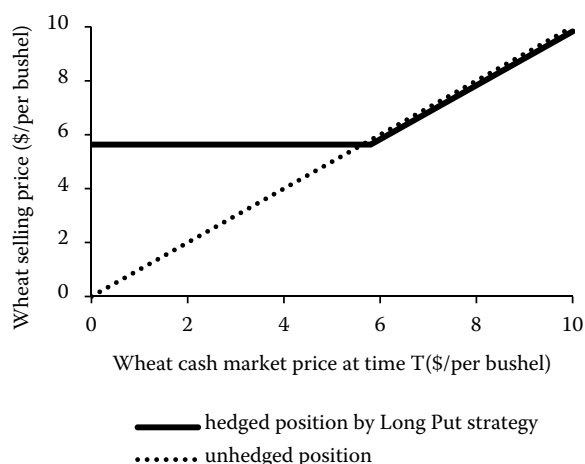| Call option premium per bushel	Strike price per bushel	Put option premium per bushel
1.302	5.50	0.100
1.223	5.60	0.121
1.146	5.70	0.143
1.074	5.80	0.171
1.004	5.90	0.200
0.936	6.00	0.232
0.873	6.10	0.266
0.812	6.20	0.305
0.753	6.30	0.345
0.697	6.40	0.391
0.645	6.50	0.436

Source: CME Group

Figure 1. Final wheat selling price using the Long Put strategy

Long Put strategy

The Long Put (LP) strategy is a simple bearish strategy. By buying put option, the producer has the right, but not the obligation, to sell a future commodity contract at a strike price X at any time T within a specified time period. For this right, the producer has to pay an option premium p_L. For an option buyer, the premium represents the maximum cost or amount that can be lost, since the option buyer is limited only to the initial investment.

The option position only serves as a hedging tool without the physical delivery of a commodity in the future market. The hedger would like to gain from the future market transactions in order to cover the loss from the future cash market falling commodity price. Two variants of the commodity price scenarios can

Table 4. Final selling price using the Long Put strategy

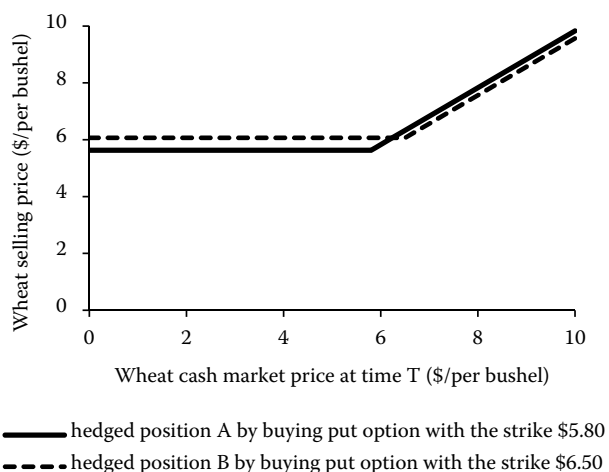| Commodity price scenarios	Cash market price	Future market payoff	Final selling price
$S_T < X$	S_T	$X - S_T - p_L$	$X - p_L$
$S_T \geq X$	S_T	p_L	$S_T - p_L$

Figure 2. Comparison of the final wheat selling prices using the Long Put strategy with various strike prices

occur in the future. If the future cash market price S_T of the given commodity is below the strike price, then the hedger will add to the cash market price the payoff of purchased put option $(X - S_T - p_L)$. If the future cash market price in the future is above the strike price, the hedger will deduct from the cash market price the option premium p_L, which is the cost of the risk management benefit. The Table 4 shows the final selling price as the sum of the cash market price and the future market payoff, in this case payoff of the Long Put strategy. The final selling price depends on the future cash market price.

If the cash market price is lower than the strike price, than the producer will hedge the final selling commodity price $(X - p_L)$. Otherwise, the put option will not be excercised and the produrer will hedge the final selling commodity price $(S_T - p_L)$.

Assume the producer buys a May Wheat put option contract at the strike price $5.80 per bushel for the option premium $0.171 per bushel. The final wheat selling price using the Long Put strategy and the potential profits/losses of the hedging strategy are indicated in the Table 5.

Table 5. Final wheat selling price using the Long Put strategy

Wheat price scenarios	Final wheat selling price	Profit of hedging		Loss of hedging	
		minimum (min)	maximum (max)	min	max
$S_T < 5.629$	5.629	0	5.629	–	–
$5.629 \leq S_T \geq 5.8$	5.629	–	–	0	−0.171
$5.8 \leq S_T$	$S_T - 0.171$	–	–	−0.171	−0.171

$/per bushel, basis of $0

The Figure 1 also illustrates the results noted into the Table 5. If the cash market price is below $5.629, the seller will receive a minimum selling price $5.629 per bushel. That is the option trike rice ($5.80) minus the the premium paid for the option ($0.171). In this case, the hedging strategy is profitable. The profit/loss is the difference between the final wheat selling price (hedged position) and the cash market price (unhedged position) at the time T. The unhedged position provides a zero price risk management against a falling market, as indicated in the figure. The loss of hedging by the Long Put strategy will occur if the wheat cash market price increases above $5.629. The maximum loss of hedging by the Long Put strategy is the premium $0.171. By the Long Put strategy, the producer has a protection against lower prices without giving up the opportunity to profit if the prices increase.

If the producer buys a May Wheat put option contract at the strike price $6.50 per bushel, he/she will pay the option premium $0.436 per bushel. The commodity seller will establish the higher floor selling price level $6.064 per bushel but he/she will pay the higher premium for buying the put option contract (Figure 2). Using the various options, we can calculate different selling prices based upon the strike prices chosen.

Long Combo strategy

The Long Combo (LC) strategy is a bearish strategy that can be created at zero-cost. It is formed by buying a put option with a lower strike price X_1 and an option premium $p_{L1,}$ and at the same by selling a call option on the same future commodity contract with a higher strike price X_2 and an option premium c_{S2}. The future market payoff and the final selling price for every price scenarios is given in the Table 6.

By combining the Long Put position with the Short Call position, the commodity seller establishes the floor price level $(X_1 - p_{L1} + c_{S2})$ and the ceiling price level $(X_2 - p_{L1} + c_{S2})$.

Assume the producer buys a May Wheat put option contract at the strike price $5.80 per bushel for the option premium $0.171 per bushel and sells a May Wheat call option contract at the strike price $6.50 per bushel for the option premium $0.645 per bushel. In this example, the Table 7 lists the final selling prices for a variety of futures price scenarios.

The premium received from the sale of the call increases the minimum selling price ($6.521). But note that there are risks associated with establishing a maximum selling price ($6.821). The commodity seller using this strategy establishes a selling price range. This is also illustrated in the Figure 3.

The selling price range is determined by the strike prices. The greater the difference between the put and call strike prices, the wider the selling price range (Figure 4).

Inverse Vertical Ratio Put Spread strategy

The Inverse Vertical Ratio Put Spread (IVRPS) strategy is a spread option strategy formed by buying a higher number of put options n_1 with a lower

Table 6. Final selling price using the Long Combo strategy

Commodity price scenarios	Cash market price	Future market payoff	Final selling price
$S_T < X_1$	S_T	$X_1 - S_T - p_{L1} + c_{S2}$	$X_1 - p_{L1} + c_{S2}$
$X_1 < S_T \leq X_2$	S_T	$c_{S2} - p_{L1}$	$S_T - p_{L1} + c_{S2}$
$S_T \geq X_2$	S_T	$X_2 - S_T - p_{L1} + c_{S2}$	$X_2 - p_{L1} + c_{S2}$

Table 7. Final wheat selling price using the Long Combo strategy

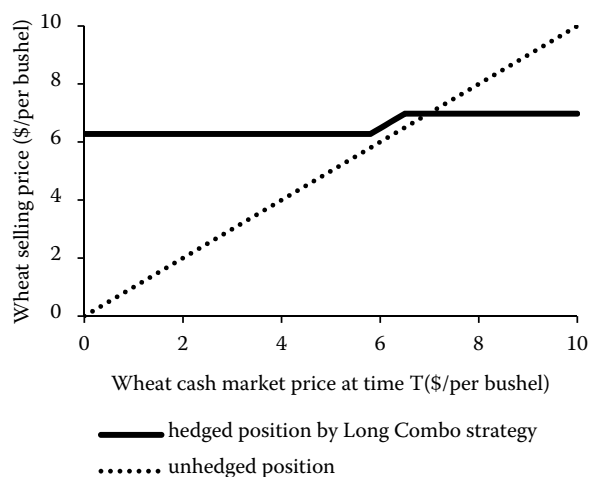| Wheat price scenarios	Final wheat selling price	Profit of hedging		Loss of hedging	
		min	max	min	max
$S_T < 5.80$	6.274	0.474	6.274	–	–
$5.80 \leq S_T < 6.50$	$S_T + 0.474$	0.474	0.474	–	–
$6.50 \leq S_T < 6.974$	6.974	0	0.474	–	–
$6.974 \leq S_T$	6.974	–	–	0	∞

$/per bushel, basis of $0
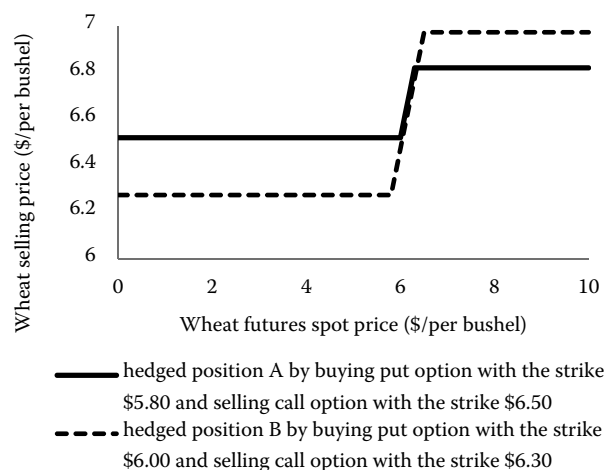
Figure 3. Final wheat selling price using the Long Combo strategy

Figure 4. Comparison of the final wheat selling prices using the Long Combo strategy with various strike prices

strike price strike price X_1 and an option premium p_{L1}, and at the same by selling a lower number of put option n_2 on the same commodity with a strike price X_2, maturity T and an option premium p_{S2}. The selection the number of options should by in a way which enables $n = n_1 - n_2$, $(n > 0)$. If we choose $n_1 = 2$ and $n_2 = 1$, we will get the well-known Long Two By One Ratio Put strategy (some authors call it the Put Backspread). Šoltés and Amaitiek (2010) propose the usage of the IVRPS strategy formed by the vanilla options in hedging and derived the final selling price given in Table 8. They propose hedging

against a price drop of an underlying asset in a way which enables hedging with the zero-cost, when the following condition $n_2 \times p_{S2} \geq n_1 \times p_{L1}$ is fulfilled.

The Inverse Vertical Ratio Put Spread strategy provides protection against the falling commodity prices but also allows the seller to improve the selling price if the market grows.

Assume the producer buys 2 May Wheat put option contracts at the strike price $5.80 per bushel for the option premium $0.171 per bushel and sells 1 May. Wheat put option contract at the strike price $6.50 per bushel for the option premium $0.436 per

Table 8. Final selling price using the Inverse Vertical Ratio Put Spread strategy

Commodity price scenarios	Cash market price	Future market payoff	Final selling price
$S_T < X_1$	S_T	$n_2 \times S_T - n_1 \times S_T + n_1 \times X_1 - n_2 \times X_2 - n_1 \times p_{L1} \times n_2 \times p_{S2}$	$n_1 \times X_1 - n_2 \times X_2 - n_1 \times p_{L1} + n_2 \times p_{S2}$
$X_1 < S_T \leq X_2$	S_T	$n_2 \times S_T - n_2 \times X_2 - n_1 \times p_{L1} + n_2 \times p_{S2}$	$n_1 \times S_T - n_2 \times X_2 - n_1 \times p_{L1} + n_2 \times p_{S2}$
$S_T \geq X_2$	S_T	$n_2 \times p_{S2} - n_1 \times p_{L1}$	$(n_1 - n_2) \times S_T - n_1 \times p_{L1} + n_2 \times p_{S2}$

Table 9. Final wheat selling price using the Inverse Vertical Ratio Put Spread strategy

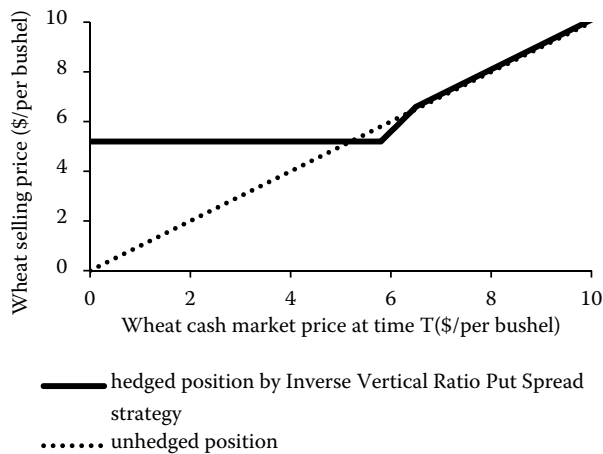| Wheat price scenarios	Final wheat selling price	Profit of hedging		Loss of hedging	
		min	max	min	max
$S_T < 5.194$	5.194	0	5.194	–	–
$5.194 \leq S_T < 5.8$	5.194	–	–	0	0.606
$5.8 \leq S_T < 6.406$	$2S_T - 6.406$	–	–	0	0.606
$6.406 \leq S_T < 6.5$	$2S_T - 6.406$	0	0.094	–	–
$6.5 \leq S_T$	$S_T + 0.094$	0.094	0.094	–	–

$/per bushel, basis of $0

Figure 5. Final wheat selling price using the Inverse Vertical Ratio Put Spread strategy

bushel. Using the formulas to evaluate this strategy listed above, we calculated the final wheat selling prices in Table 9.

The Inverse Vertical Ratio Put Spread strategy provides protection against the falling wheat prices but also allows the seller to participate in the price increase. In the comparison chart (Figure 5), the hedge position provides the falling price protection and a better selling price when the market grows compared to the unhedged position.

The selling price range is also determined by the numbers of put options. The greater the ratio n_1/n_2, the higher the floor selling price, but the lower selling price in the price increase. Figure 6 shows the comparison of two variants of this strategy using different strike ratios, the ratio 2 (2/1) and ratio 1.25 (5/4).
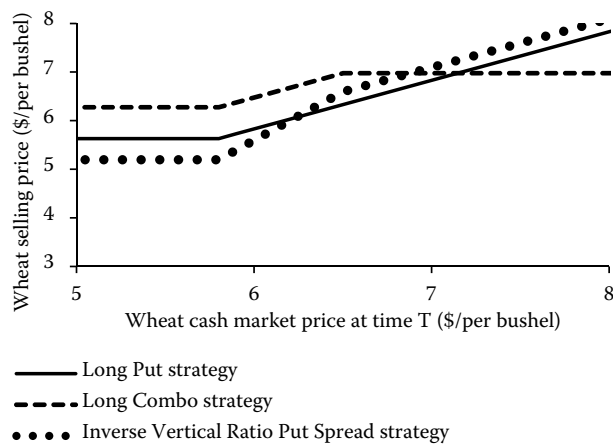

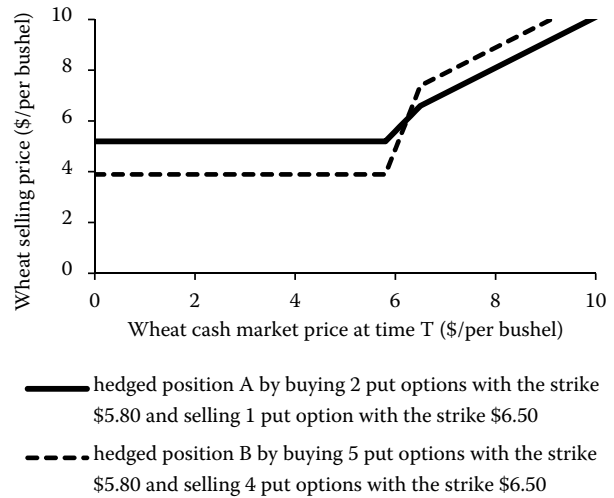Figure 7. Comparison of A wheat price risk management strategies

Figure 6. Comparison of final wheat selling prices using the Inverse Vertical Ratio Put Spread strategy with various strike prices

COMPARISON OF THE WHEAT PRICE RISK MANAGEMENT STRATEGIES

Commodity sellers do not have one "perfect" strategy that will fit all market conditions. Therefore, they should learn how to evaluate and compare the strategies. The Figure 7 compares the commodity selling strategies and illustrates the final wheat selling prices under the potential wheat future cash market prices. Each of the strategies has their own strengths and weaknesses.

It can be seen, but also calculated exactly using the data from the Table 5, 7, 9 that:
– the Long Combo strategy ensures the highest wheat selling price if the wheat future cash market price is lower than $6.88, but it does not enable to participate in the wheat price increase;
– the Inverse Vertical Ratio Put Spread strategy ensures the highest wheat selling price if the wheat future cash market price is higher than $6.88 but the lowest wheat selling price if the wheat future cash market price is lower than $6.235;the long put option position establishes the selling prices in the middle.

We can deduce following conclusions. By the Long Combo strategy, the commodity seller establishes the highest floor price level because of the premium received for selling the call. The cost of this benefit is that the Short Call position limits the opportunity of higher prices by establishing a maximum price level. This strategy is available to a seller who expects the price decrease without a participation in the increasing price. The Inverse Vertical Ratio Put Spread strategy

Table 10. Comparison of profit of A wheat price risk management strategies

| Wheat price scenarios | Profit of hedging | | | | | |
| | BP | | LC | | IVRPS | |
	min	max	min	max	min	max
$0 \leq S_T < 5.194$	0.435	5.194	1.08	6.274	0	5.194
$5.194 \leq S_T < 5.629$	0	0.435	0.645	1.08	−0.435	0
$5.629 \leq S_T < 5.8$	−0.171	0	0.474	0.645	−0.606	−0.435
$5.8 \leq S_T < 6.235$	−0.171	−0.171	0.474	0.474	−0.171	−0.606
$6.235 \leq S_T < 6.406$	−0.171	−0.171	0.474	0.474	0	−0.171
$6.406 \leq S_T < 6.5$	−0.171	−0.171	0.474	0.474	0.094	0
$6.5 \leq S_T < 6.88$	−0.171	−0.171	0.094	0.474	0.094	0.094
$6.88 \leq S_T < 6.974$	−0.171	−0.171	0	0.094	0.094	0.094
$6.974 \leq S_T < 7.145$	−0.171	−0.171	−0.171	0	0.094	0.094
$7.145 \leq S_T < \infty$	−0.171	−0.171	∞	−0.171	0.094	0.094

and the Long Put Option Position provide the floor price level but also allow the seller to participate in the price increase. There are strategies available to a commodity seller who hedges against a price decrease and at the same time speculates on a price increase.

The Table 10 compares the final selling prices of A hedged positions by the studied strategies with the cash market prices of the unhegded position. A minimum (Min) and maximum (Max) profit of hedging is calculated as a difference between the particular secured position and unsecured position. If the profit is higher than 0, then the secured position will ensure a higher income than the unsecured position.

The Table 11 summarizes several important facts to remember the commodity hedging with option strategies.

CONCLUSIONS

With the advent of commodity derivatives, the risk management strategies opened for agribusinesses. This paper focused on option strategies for agricultural producers – the Long Put strategy, the Long Combo strategy and the Inverse Vertical Ratio Put

Spread strategy. The aim was analysed and compared the option hedging strategies. The results can be used in practice as priceless aid in deciding which hedging strategy is the most suitable. We showed how to apply these strategies in hedging of wheat. We demonstrated their usage in hedging against a price decline in some model variants. The mutual comparison of the analysed strategies was presented as well. The performed analysis and comparison have shown more remarkable results.

The Long Put strategy establishes a minimum selling price level for a cost (premium). If the prices fall below this level, the producer has the right to sell the underlying commodity futures at a specific strike price. If the prices are above the strike price level, the producer can sell the commodity production at a higher market price.

The zero-cost Long Combo strategy eliminates the price level risk if the markets move downside. By this strategy, the commodity seller establishes a higher floor price level but limits the opportunity of higher prices by establishing a ceiling price level. The selling price range is determined by the strike prices. The greater the difference between the put and call strike prices, the wider the selling price range.

Table 11. Facts about the commodity option hedging strategies

Option hedging strategy	Floor price level	Ceiling price level	Profit of hedging	Loss of hedging	Zero-cost
Long Put	limited	unlimited	unlimited	limited	no
Long Combo	limited	limited	unlimited	unlimited	yes
Inverse Vertical Ratio Put Spread	limited	unlimited	unlimited	limited	yes

The Inverse Vertical Ratio Put Spread strategy enables to hedge a floor price level and at the same time to participate in the price increase. The selling price range by the Inverse Vertical Ratio Put Spread strategy is not only determined by the strike prices but also by the numbers of options. The greater the ratio of the numbers of options, the higher the floor selling price.

These strategies have to illustrate the diversity of ways in which the agricultural options can be used. The key to using the options successfully is the ability of the producer to match an appropriate strategy to a particular objective at a given time. The flexibility of strike price selection allows the producers to adjust their market risk exposure to any level with which they are comfortable. The commodity selling strategies we looked at in this paper are fairly common ones, but by no means, there are many other strategies which have to by considered in the risk management.

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