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THE IRON CONDOR STRATEGY IN FINANCIAL RISK MANAGEMENT

SRATEGIA *IRON CONDOR* W ZARZĄDZANIU RYZYKIEM FINANSOWYM

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Summary: The iron condor strategy is a complex option strategy that combines two option spread strategies. The design of this strategy makes it possible to make profits from underlying instruments whose prices are in horizontal trends over a certain period. The research objective of the article is to analyse the risk resulting from the iron condor strategy. The article presents the structure of the strategy, the pricing model, the impact of the price of the underlying instrument on the value of the strategy and on the value of the delta, gamma, vega, and theta ratios. These ratios are measures of the risk of option contracts. The empirical illustration contained in the article is based on the simulation of the valuation of currency options issued in EUR/PLN.

Keywords: financial instruments, option, option strategy, measures of the risk of option.

Streszczenie: Strategia *iron condor* jest złożoną strategią opcyjną, która polega na łączeniu dwóch strategii opcyjnych rozpiętościowych. Jej konstrukcja umożliwia osiaganie zysków z instrumentów podstawowych, których ceny w pewnym okresie znajdują się w trendach horyzontalnych. Celem artykułu jest analiza ryzyka strategii *iron condor*. Przedstawiono w nim konstrukcję strategii, model wyceny, wpływ ceny instrumentu bazowego na wartość strategii oraz na kształtowanie się wartości współczynników delta, gamma, vega i theta. Współczynniki te są głównymi miarami ryzyka kontraktów opcyjnych. Określają wpływ zmiany wartości czynnika ryzyka na cenę kontraktu. Ilustrację empiryczną zawartą w artykule przeprowadzono na podstawie symulacji wyceny opcji walutowych wystawionych na EUR/PLN.

Słowa kluczowe: instrumenty finansowe, opcje, strategie opcyjne, miary ryzyka opcji.

1. Introduction

The iron condor strategy is a complex option strategy that combines two option spread strategies. Option contracts are a unique risk management instrument because they are characterized by the asymmetrical rights and obligations imposed on the parties of the transaction (Bartram, 2006; Cao, Simin, and Zhao, 2008; Carenter, 2000; Hull, 2005; Rajgopal and Shevlin, 2002). The buyer of the option contract has the right (but not the obligation) to exercise the contract. The option writer is obliged to perform the contract when the buyer of the option decides to execute the contract.

The development of the Black-Scholes model for the European call option without dividend right (Black and Scholes, 1973) gave rise to the concept of solving problems related to option valuation. New analytical models valuing options issued on various types of underlying instruments and models valuing options while reducing certain assumptions that were adopted in the developed Black-Scholes model were created (Bo, Wang, and Yang, 2010; Musiela and Rutkowski, 2011). Thus, the Merton model for the valuation of the European option with dividend rights (Merton, 1973), the Black model for the valuation of options for futures contracts (Black, 1976), the Ingersoll model (Ingersoll, 1976) valuing the options while reducing the assumption of the absence of tax and transaction costs, or the Garman-Kohlhagen model (Amin and Jarrow, 1991; Garman and Kohlhagen, 1983;) for the valuation of currency options were created based on the Black-Scholes model.

Some of the assumptions adopted in the developed Black-Scholes model, *e.g.* the normality of the distribution of returns from the underlying instrument, were questioned by many scientists, including Rosenberg and Ohlson (1976), Hull and White (1987), Scott (1987), and Peters (1991). However, the development of the Black-Scholes model has contributed to the significant development of the option contracts market.

Creating option strategies by combining different types of option contracts with different exercise prices and expiry dates allows for the more effective risk management of adverse changes in the price of the underlying instrument.

Due to the asymmetrical rights and obligations imposed on the parties of the transaction, when using options in financial transactions it is crucial to consider the risk that may be generated by the options in the event of unfavourable changes in market conditions. An example would be the experience of some companies which in 2008-2009 suffered significant financial losses from option transactions.

The research objective of the article is to analyse the risk resulting from the iron condor strategy. The article presents the structure of the strategy, the pricing model, the impact of the price of the underlying instrument on the value of the strategy and on the value of the delta, gamma, vega, and theta ratios. These ratios are very important measures of the risk of option contracts. The issue of the risk measures of the iron condor strategy is analyzed only fragmentarily in the subject literature.

The empirical illustration contained in the article is based on the simulation of the valuation of currency options issued in EUR/PLN.

The research methodology consists of several stages. The first stage is determining the valuation model of the iron condor strategy. Next, the impact of the price of the underlying instrument on the value of the analysed strategy was examined. In the next stage, risk measures were determined based on the strategy valuation model: the delta and vega and theta ratios, and an analysis of the impact of the change in the price of the underlying instrument on the development of the determined risk measures was performed.

2. The construction and value of the iron condor strategy

The iron condor strategy belongs to the group of complex option strategies. It is created by folding two optional spread strategies. The construction of the iron condor strategy involves the simultaneous display of two spreads: a bear call spread above the current price of the underlying and a bull put spread below the current price of the underlying instrument (Dziawgo, 2010). The strategy is applied when it is expected that the price of the underlying instrument will be between the exercise prices of options issued in spreads within a specified period. So, if the price of the instrument does not break (neither up, nor down) any of the spreads, then the strategy used gives the maximum profit, which is limited to the amount of premiums received. The attractiveness of the iron condor strategy is that premiums are obtained from two spreads, while the loss can be incurred only in the case of one spread. The loss from the iron condor strategy used is limited.

The value of the iron condor strategy equals:

$$c(t) = \left(c_1(t) - c_2(t)\right) + \left(p_1(t) - p_2(t)\right),$$

where: $c(t)$ – the value of the iron condor strategy in time t, $t \in [0; T]$,

T – the time to maturity,

$c_1(t)$ – the price of issued call option,

$c_2(t)$ – the price of purchased call option,

$p_1(t)$ – the price of issued put option,

$p_2(t)$ – the price of purchased put option,

$$c_1(t) = Q_t e^{-r_f(T-t)} N(d_1) - K_1 e^{-r(T-t)} N(d_2),$$

$$c_2(t) = Q_t e^{-r_f(T-t)} N(d_1') - K_2 e^{-r(T-t)} N(d_2'),$$

$$p_1(t) = -Q_t e^{-r_f(T-t)} N(-d_3) + K_3 e^{-r(T-t)} N(-d_4),$$

$$p_2(t) = -Q_t e^{-r_f(T-t)} N(-d_3') + K_4 e^{-r(T-t)} N(-d_4'),$$

$$d_1 = \frac{\ln \frac{Q_t}{K_1} + (r - r_f + 0{,}5\sigma^2)(T-t)}{\sigma\sqrt{T-t}}, \quad d_2 = d_1 - \sigma\sqrt{T-t},$$

$$d_1' = \frac{\ln\frac{Q_t}{K_2} + (r - r_f + 0{,}5\sigma^2)(T-t)}{\sigma\sqrt{T-t}}, \; d_2' = d_1' - \sigma\sqrt{T-t},$$

$$d_3 = \frac{\ln\frac{Q_t}{K_3} + (r - r_f + 0{,}5\sigma^2)(T-t)}{\sigma\sqrt{T-t}}, \; d_4 = d_3 - \sigma\sqrt{T-t},$$

$$d_3' = \frac{\ln\frac{Q_t}{K_4} + (r - r_f + 0{,}5\sigma^2)(T-t)}{\sigma\sqrt{T-t}}, \; d_4' = d_3' - \sigma\sqrt{T-t},$$

Q_t – the price of underlying instrument in time t,
r_f – the foreign risk-free interest rate,
r – the domestic risk-free interest rate,
σ – the price volatility of the underlying instrument,
K_1 – the strike price of issued call option,
K_2 – the strike price of purchased call option,
K_3 – the strike price of issued put option,
K_4 – the strike price of purchased put option,
$N(d)$ – cumulative probability function of the standardised normal distribution.

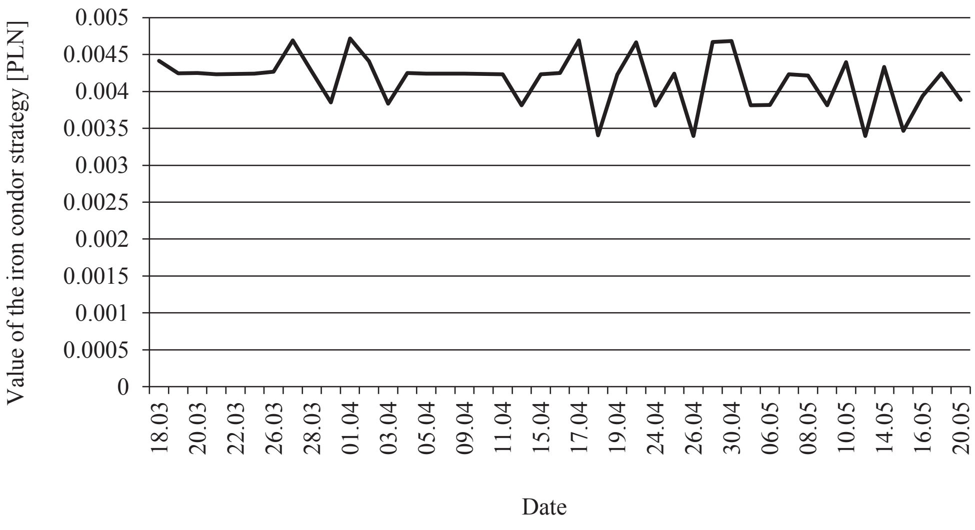

Fig. 1. The shaping of the value of the analysed iron condor strategy

Source: elaborated by the author based on own calculations.

The considerations apply to the formation of a value of the iron condor strategy. Currency options were used to construct the iron condor strategy. The empirical illustration is based on the simulation of the valuation of call and put options on EUR/PLN. The analysis covers the period from 18 March 2019 to 20 May 2019. The strike price of issued call and put options is 4.3000 PLN and 4.2750 PLN, respectively. In turn, the prices of exercise of put and call options purchased are PLN 4.2700 and PLN 4.3050. The time to expiry of the considered options is two months.

Figure 1 presents the evolution of the value of the analysed iron condor strategy in the period from 18 March 2019 to 20 May 2019. In the case under consideration, the price of the underlying instrument approached the exercise price of the put option issued in the period: 2 April 2019-3 April 2019, 26 April 2019, 10 May 2019, and 14 May 2019-15 May 2019. On 17 May 2019 there was a significant increase in the price of the underlying instrument. In turn, on 16 April-17 April 2019 and 6 May 2019, the price of the underlying instrument was close to the price for exercising the put option. On 17 April 2019 there was a significant drop in the price of the underlying instrument.

Approaching the price of the underlying instrument to the prices of the issued put option or call option was the cause of significant fluctuations in the value of the iron condor strategy.

3. The analysis of risk of the iron condor strategy

In using option contracts in financial transactions, it is particularly important to analyse the risks that under unfavourable market conditions can be generated by options.

The major factors affecting the value of the iron condor strategy are the price of the underlying instrument, the volatility of the price of the underlying instrument and the strategy's expiry time. Therefore, the article analyses the formation of delta, vega, and theta ratios. These are measures of sensitivity that characterize the change in the price of options under the influence of fluctuations in the value of the risk factor (Hull, 2005; Dziawgo, 2003; Sorwar and Dowd, 2010).

3.1. Delta ratio

The delta ratio determines the effect of the underlying instrument price change on the option price.

Figure 2 presents the value of the delta ratio of the analysed strategy. The values of the delta ratio of the iron condor strategy are contained in the range [-1; 1]. A positive delta value means that an increase/decrease in the price of the underlying affects the increase/decrease in the value of the strategy. On the other hand, if the delta ratio is negative, then an increase/decrease in the price of the underlying instrument causes a decrease/increase in the value of the iron condor strategy.

During the period under consideration, the delta ratio values of the iron condor strategy fluctuate significantly. The lowest delta value occurred in the case of a significant increase in the price of the underlying instrument (on 17 May 2019). In turn, the highest value was recorded for the delta ratio in the case of a significant drop in the price of the underlying instrument (on 17 April 2019).

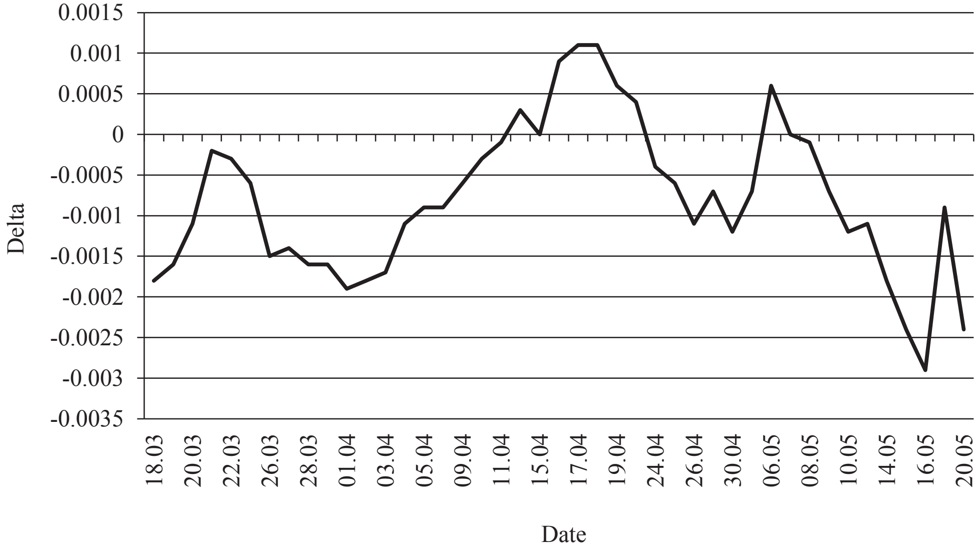

Fig. 2. The shaping of the value delta of the analysed iron condor strategy

Source: elaborated by the author based on own calculations.

Table 1 presents the impact of the price of the underlying instrument on the delta of the iron condor strategy.

Table 1. Impact of the price of the underlying instrument on the value of the delta of the iron condor strategy

Price of the underlying instrument [PLN]	Value of the delta ratio	Price of the underlying instrument [PLN]	Value of the delta ratio	Price of the underlying instrument [PLN]	Value of the delta ratio
4.2700	0.001598	4.2825	0.0002	4.2950	-0.0012
4.2725	0.001298	4.2850	0.0001	4.2975	-0.0014
4.2750	0.001098	4.2875	-0.00004	4.3000	-0.0016
4.2775	0.000699	4.2900	-0.0006	4.3025	-0.002
4.2800	0.000399	4.2925	-0.0009	4.3050	-0.0022

Source: elaborated by the author based on own calculations.

An increase/decrease in the price of the underlying instrument affects the decrease/increase in the delta ratio. The highest absolute value of the delta ratio occurs when the price of the underlying instrument equals the exercise price of the options purchased. In this case, the value of the strategy is most sensitive to changes in the price of the underlying instrument. Approaching the price of the underlying instrument to the centre of the range, whose ends are determined by the exercise prices of options purchased, causes a decrease in the absolute value of the delta ratio. Then the iron condor strategy is characterized by the lowest sensitivity to changes in the price of the underlying instrument. If the price of the underlying instrument is lower/higher than the centre of the given range, then the delta ratio takes positive/negative values.

3.2. Gamma ratio

The gamma indicates how the delta will change when the price of the underlying changes by one unit.

Figure 3 illustrates the evolution of the iron condor strategy gamma value. The values of this ratio are negative. It follows that the increase/decrease in the price of the underlying instrument affects the decrease/increase in the delta ratio. A higher absolute value of the gamma coefficient indicates a greater sensitivity of the delta ratio to the price change of the underlying instrument. Approaching the price of the underlying instrument to the exercise price of the listed options results in a decrease in the absolute value of the gamma ratio.

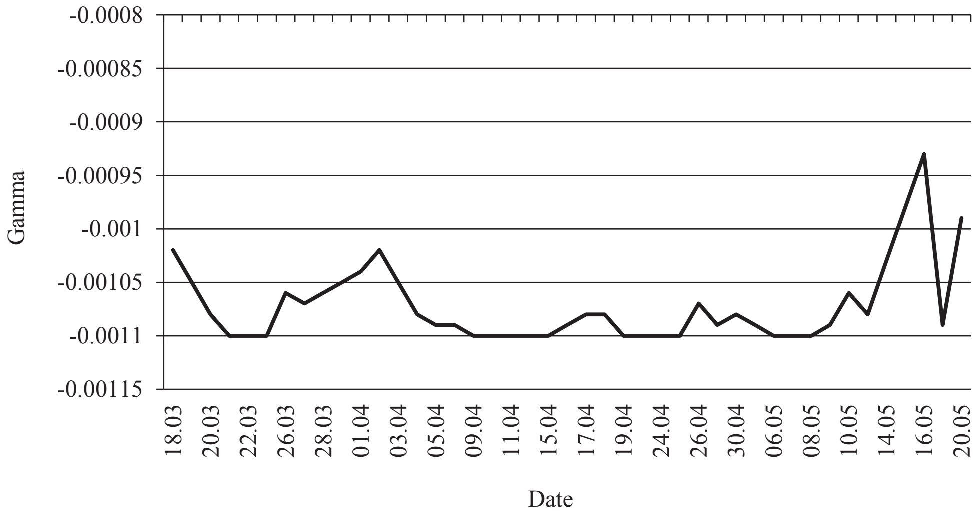

Fig. 3. The shaping of the value of gamma of the analysed iron condor strategy

Source: elaborated by the author based on own calculations.

Table 2 shows the impact of the price of the underlying instrument on the gamma of the iron condor strategy.

Table 2. Impact of the price of the underlying instrument on the value of the gamma of the iron condor strategy

Price of the underlying instrument [PLN]	Value of the gamma ratio	Price of the underlying instrument [PLN]	Value of the gamma ratio	Price of the underlying instrument [PLN]	Value of the gamma ratio
4.2700	-0.00106	4.2825	-0.001102	4.2950	-0.00108
4.2725	-0.00107	4.2850	-0.001104	4.2975	-0.00106
4.2750	-0.00108	4.2875	-0.001109	4.3000	-0.00105
4.2775	-0.00109	4.2900	-0.001101	4.3025	-0.00103
4.2800	-0.0011	4.2925	-0.00109	4.3050	-0.00101

Source: elaborated by the author based on own calculations.

If the price of the underlying instrument is close to the centre of the range, the ends of which determine the exercise prices of the options purchased, then the highest absolute value of the gamma ratio occurs. In this case, the delta ratio values are characterized by the highest sensitivity to changes in the price of the underlying instrument. The decrease in the absolute value of the gamma ratio occurs when the price of the underlying instrument moves away from the centre of the designated range. Then the sensitivity of the iron condor strategy delta to the change in the price of the underlying instrument also decreases.

3.3. Vega ratio

Another ratio, vega, describes the impact of fluctuations in the price of the underlying instrument on the price of the option.

Figure 4 is an illustration of the value of the iron condor strategy vega ratio.

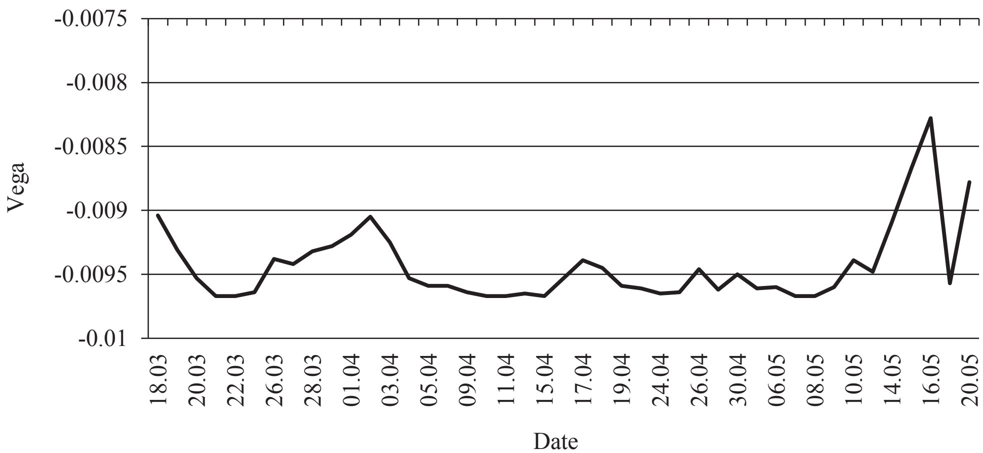

Fig. 4. The shaping of the value of vega of the analysed iron condor strategy

Source: elaborated by the author based on own calculations.

Values of the vega ratio fluctuate significantly. This factor takes negative values which means that an increase/decrease in the price volatility of the underlying instrument affects the decrease/increase in the value of the strategy. The lowest absolute value of the vega ratio was noted in the case of a significant increase in the price of the underlying instrument (on 17 May 2019).

Table 3 shows the value of vega ratio depending on the existing price of the underlying instrument.

Table 3. Impact of the price of the underlying instrument on the value of the vega of the iron condor strategy

Price of the underlying instrument [PLN]	Value of the vega ratio	Price of the underlying instrument [PLN]	Value of the vega ratio	Price of the underlying instrument [PLN]	Value of the vega ratio
4.2700	-0.0092	4.2825	-0.00965	4.2950	-0.0095
4.2725	-0.00934	4.2850	-0.00967	4.2975	-0.00939
4.2750	-0.00945	4.2875	-0.00969	4.3000	-0.00927
4.2775	-0.00954	4.2900	-0.00963	4.3025	-0.00912
4.2800	-0.00961	4.2925	-0.00958	4.3050	-0.00895

Source: elaborated by the author based on own calculations.

The approach of the price of the underlying instrument to the middle of the range, the ends of which are the exercise prices of the options purchased, increases the absolute value of the vega ratio. The highest absolute value occurs when the price of the underlying instrument equals the price, which is the centre of the designated range. Then the value of the iron condor strategy is characterized by the highest sensitivity to fluctuations in the price of the underlying instrument. The increase/decrease in the price of the underlying instrument compared to the centre of the designated range contributes to a decrease in the absolute value of the vega ratio, and thus to a decrease in the sensitivity of the strategy value to fluctuations in the price of the underlying instrument.

3.4. Theta ratio

The theta ratio illustrates the impact of an approaching expiry date on the option price.

Figure 5 illustrates the value of the theta ratio of the considered iron condor strategy. Theta ratio values are positive, therefore the shorter expiry time increases the value of the strategy. There are significant fluctuations in the theta ratio of the iron condor strategy. In the event of a significant increase or decrease in the price of the underlying instrument, a decrease in the value of the theta ratio of the strategy is noted. The lowest value of the theta ratio occurred on 17 May 2019. At that time, a significant increase in the price of the underlying instrument was recorded.

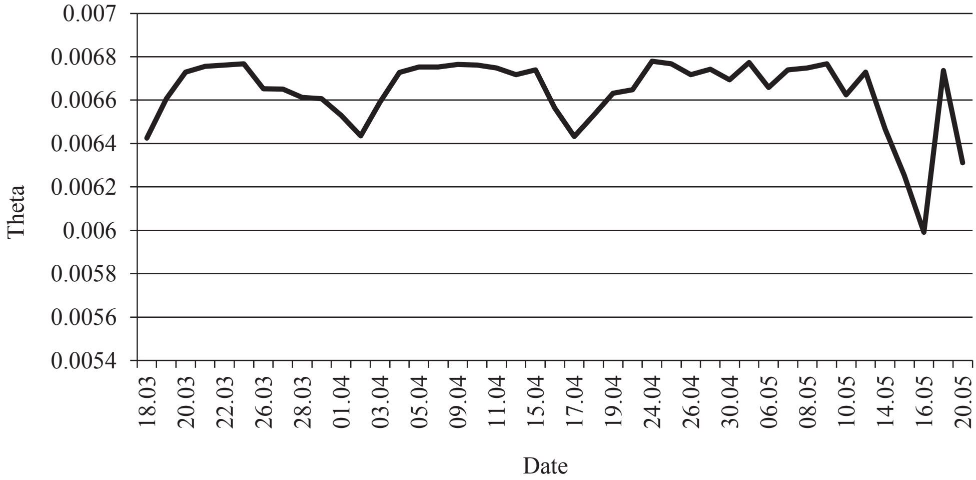

Fig. 5. The shaping of the value theta of the analysed iron condor strategy

Source: elaborated by the author based on own calculations.

Table 4 presents the value of the theta ratio depending on the existing price of the underlying instrument.

Table 4. Impact of the price of the underlying instrument on the value of the theta of the iron condor strategy

Price of the underlying instrument [PLN]	Value of the theta ratio	Price of the underlying instrument [PLN]	Value of the theta ratio	Price of the underlying instrument [PLN]	Value of the theta ratio
4.2700	0.006323	4.2825	0.006711	4.2950	0.006693
4.2725	0.006395	4.2850	0.006748	4.2975	0.006635
4.2750	0.006532	4.2875	0.006755	4.3000	0.006598
4.2775	0.006592	4.2900	0.006751	4.3025	0.006503
4.2800	0.006645	4.2925	0.006745	4.3050	0.006353

Source: elaborated by the author based on own calculations.

If the price of the underlying instrument approaches the middle of the range with the margins determined by the exercise prices of the options purchased, an increase in the theta value is noted. The highest value of the theta ratio exists when the price of the underlying instrument equals the price which is the centre of the designated range. Therefore, in this situation, the value of the strategy will be characterized by the greatest sensitivity to approaching the expiry date of the strategy. An increase/decrease in the price of the underlying instrument relative to the centre of the designated range contributes to a decrease in the theta ratio. The sensitivity of the strategy's value to the passing time also decreases.

4. Conclusion

In the event of changing market conditions, analysing the value of risk measures enables more effective risk management of the option strategy. Depending on one's expectations as to the future price of the underlying instrument, options with an appropriate strike price and expiry time can be selected for the construction of option strategies. In this way, one can influence the formation of various income level profiles based on the option strategies applied.

The analyses carried out show that in the case of the iron condor strategy, the greatest sensitivity of its value to the approaching expiry time and fluctuations in the price of the underlying instrument occurs when the price of the underlying instrument is near the middle of the range, whose end points are the exercise prices of the options purchased. In turn, the largest absolute values of the delta ratio are marked when the price of the underlying instrument approaches the option exercise price. Then there is the greatest sensitivity of the value of the iron condor strategy to the price change of the underlying instrument.

The analysis shows that all measures of risk of the iron condor strategy fluctuate significantly over time. This means that the value of the strategy is very sensitive to changes in the price of the underlying instrument, fluctuations in the price of the underlying instrument and to the approaching expiry of the strategy. This increases the attractiveness of this strategy when used in speculative transactions.

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