Estimation of Discount Factor and Implicit Dividend with put-call parity

Valentina Tonazzo, ID: 2060939 †

(Dated: March 2023)

Abstract—**The purpose of this report is to extract important information on options for a fixed dividend-paying asset of Clorox Company using the box-spread strategy and put-call parity formula. The first strategy is used to deduce the discount factor at certain maturity T, which is then used to find the implicit dividend for the same maturity T using At The Money options. The calculated discount factor and implicit dividend can provide valuable insights into market sentiment and expectations for future dividends. These insights can be used by investors and analysts to make informed decisions about investing in Clorox Company.**

Index Terms—**Put-call parity, Box spread strategy, CLX**

I. COMPANY DESCRIPTION

Clorox Chemical Company [1] is an American multinational corporation that specializes in manufacturing and marketing consumer and professional products.

The company was founded in 1913 and is headquartered in Oakland, California; it is one of the largest manufacturers of cleaning and disinfecting products in the world. The company was established, at first with the name *Electro-Alkaline Company*, by five entrepreneurs: Archibald Taft, Edward Hughes, Charles Husband, Rufus Myers, and William Hussey, who saw a need for a new product: liquid bleach. The company's name, Clorox, is derived from the product's key ingredient, chlorine. The public, however, was unfamiliar with liquid bleach. The company started slowly and was about to collapse when it was taken over by investor William Murray in 1916, who installed himself as general manager. His wife Annie prompted the creation of a less concentrated liquid bleach for home use, and built customer demand by giving away 15-ounce sample bottles at the family's grocery store in downtown Oakland. Word shortly began to spread, and in 1917 the company began shipping Clorox bleach to the East Coast via the Panama Canal.

On May 28, 1928, the company went public on the San Francisco stock exchange and changed to its actual name, and later on it was strong enough to survive the Great Depression during the 1930s, achieving national distribution of its bleach.

Over the years, Clorox has expanded its product portfolio to include a wide range of cleaning and disinfecting products. The company's success can be attributed to its strong brand recognition and commitment to quality. Clorox has been recognized as a leader in the industry, and its products are widely trusted by consumers and professionals alike. In 2008, The Clorox Company became the first major consumer packaged goods company to develop and nationally launch a green cleaning line, Green Works, into the mainstream cleaning aisle. In 2011, the Clorox Company integrated corporate social responsibility (CSR) reporting with financial reporting. The company's annual report for the fiscal year ending in June 2011 shared data on financial performance as well as advances in environmental, social and governance performance. Clorox was named to the inaugural Bloomberg Gender Equality Index in 2018, then, the following year, it topped the Axios Harris Poll 100 corporate reputation rankings.In 2019, Clorox ranked seventh in Barron's "100 Most Sustainable U.S. Companies" list.

II. METHODS

A. Discount factor

A spread trading strategy [2], [3] involves taking a position in two or more options of the same type (two or more calls or two or more puts). One of the most popular types of spreads is the so called bull spread. This can be created by buying a European call option on a stock with a certain strike price and selling a European call option on the same stock with a higher strike price. Both options have the same expiration date. An investor who enters into a bull spread is hoping that the stock price will increase. By contrast, an investor who enters into a bear spread is hoping that the stock price will decline. Bear spreads can be created by buying a European put with one strike price and selling a European put with another strike price. A box spread is a combination of a bull call spread with strike prices K_1 and K_2 and a bear put spread with the same two strike prices; the payoff from a box spread is always K_2-K_1. The value of a box spread is therefore always the present value of this payoff or $(K2-K1)e^{rT}$. If it has a different value there is an arbitrage opportunity. If the market price of the box spread is too low, it is profitable to buy the box. This involves buying a call with strike price K_1, buying a put with strike price K_2, selling a call with strike price K_2, and selling a put with strike price K_1 . If the market price of the box spread is too high, it is profitable to sell the box. This involves buying a call with strike price K_2, buying a put with strike price K_1, selling a call with strike price K_1, and selling a put with strike price K_2.

The discount factor can be deduced from the **box spread's price** B, in fact it corresponds to a multiple of the **discount factor** $D_0(T)$ at maturity T:

$$B = D_0(T) \cdot (K_2 - K_1), \tag{1}$$

but from a mathematical argument it can be obtained that:

$$(S - K_1)^+ - (K_1 - S)^+ = S - K_1, \tag{2}$$
$$-(S - K_2)^+ + (K_2 - S)^+ = K_2 - S.$$

Combining the two eq. in 2, it can be obtained the value of the box spread:

$$K_1 - K_2 = (S - K_1)^+ - (S - K_2)^+ + K_2 - S)^+ - (K_1 - S)^+ \tag{3}$$

where it can be recognized the prices of call and put option at respective strike prices, so imposing the equality with 1:

$$C_{K_1} - C_{K_2} + P_{K_2} - P_{K_1} = (K_2 - K_1) \cdot D_0(T),$$

$$\Rightarrow D_0(T) = \frac{C_{K_1} - C_{K_2} + P_{K_2} - P_{K_1}}{K_2 - K_1} \tag{4}$$

In order to calculate the discount factor, for each maturity time $T = 1, 2, 3, 6, 12$ four options were considered from Yahoo Finance: two calls and two puts with two different strike prices K_1 and K_2, with $K_2 >> K_1$, when possible. The summary information are shown in table 4. As a first step it was calculated the mid price of each option as the average between the mid and the ask prices, and finally for each maturity time it was calculated the discount factor as mentioned in eq. 4.

B. Implicit dividend

To estimate the *implicit dividend* factor it was used a put-call parity strategy: it consist in a relationship between the price C, of a European call option on a stock and the price P, of a European put option on a stock. Knowing that forward contracts are not typically quoted directly in financial markets, and supposing it is possible to find quotes for Call and Put option At The Money with the same strike and same maturity, it has been set up a strategy which consists in:

- buy a Call with strike K and expiry at T, and
- buy a Put with strike K and expiry at T.

More details on the chosen option can be found in table 4.
In this case the **payoff** of the strategy can be written as:

$$(S(T) - K)^+ - (K - S(T))^+ = S(T) - K \tag{5}$$

On the other hand the market value of the quantity $S(T) - K$ can be represented as:

$$C_0(T, K) - P_0(T, K) = D_0(T)(F_0(T) - K), \tag{6}$$

where $F_0(T)$ stands for the **strike price** of the **forward contract**. Hence, $F_0(T)$ can be trivially obtained from $C_0(T, K), P_0(T, K)$ and $D_0(T)$:

$$F_0(T) = \frac{C_0(T, K) - P_0(T, K)}{D_0(T)} + K. \quad (7)$$

Nevertheless the amount of forward is different according to the fact that the underlying delivers dividends or not, so considering a portfolio as shown in table 1:

	0	T
Long Forward	0	$S - F_0(T)$
short S	S	$-S + div$
riskless	$(F_0(T) + div) \cdot D_0(T)$	$F_0(T) + div$
TOT	$S - (F_0(T) + div) \cdot D_0(T)$	0

TABLE 1: The portfolio's values for the chosen strategy

And from no arbitrage opportunity arguments it can be recovered the value for the implicit dividend:

$$S - (F_0(T) + div) \cdot D_0(T) = 0$$
$$\Rightarrow div = \frac{S}{D_0(T)} - F_0(T). \quad (8)$$

III. Results

During the whole analysis was chosen one CLX share S_0 of price equal to S_0 = 157,5$ at (15:18), 26/03/23. The Discounted factors calculated for each maturity time T are reported in table 2.

Time[months]	$D_0(T)$
2	0,79
1	0,86
3	0,89
6	1,05
12	0,98

TABLE 2: Discounted Factors at maturity T

Finally, after obtaining the **Forward contract price** $F_0(T)$ via eq. 7, it was possible to calculate the **Implicit dividend factor** div, through eq. 8, numerical results are shown in table 3:

T [months]	$F_0(T)$ [$]	div [$]
2	158	40,87
1	155	27,69
3	156,23	20,32
6	156,71	-6,77
12	157,26	4,24

TABLE 3: Forward contract prices and calculated implicit dividend factors for different maturities

IV. Concluding Remarks

As can be seen in table 2 for maturity $T = 6$ the Discount factor's corresponding result is > 1, which is a non realistic result since it implies a negative interest rate R. Another proof of this anomaly is shown in table 3, where the corresponding Implicit Dividend factor results negative. This poor result could be due to the fact that in this particular case American option have been treated as European options, and the box-spread strategy applies only on the latter ones, besides the fact that the considered models do not take into account some more sophisticated dynamics that happen in the market.

References

[1] Wikipedia contributors, "Clorox — Wikipedia, the free encyclopedia." https://en.wikipedia.org/w/index.php?title=Clorox&oldid=1141247898, 2023. [Online; accessed 30-March-2023].

[2] J. Hull, *Option, Future, and other Derivatives*. Pearson, 2006.

[3] T. Bjork, *Arbitrage Theory in Continuous Time*. Oxford University Press, 2009.

T[months]	Option	Contract Name	Last Trade Date	Strike	Last Price	Bid	Ask
2	call	CLX230519C00110000	2023-01-03	110	30,4	33,6	34,1
2	call	CLX230519C00175000	2023-03-24	175	0,85	0,95	1,1
2	put	CLX230519P00110000	2023-03-08	110	0,28	0,05	0,75
2	put	CLX230519P00175000	2023-03-15	175	22,2	18,3	20,2
1	call	CLX230421C00090000	2022-10-13	90	42,40	52,40	55,30
1	call	CLX230421C00200000	2022-11-21	200	0,38	0,05	0,25
1	put	CLX230421P00090000	2022-12-21	90	0,30	0,00	0,25
1	put	CLX230421P00200000	2022-11-18	200	53,11	53,70	57,10
3	call	CLX230721C00095000	2023-01-03	95	46	45,6	49,4
3	call	CLX230721C00190000	2023-03-03	190	0,65	0	0
3	put	CLX230721P00095000	2023-02-15	95	0,2	0	0,3
3	put	CLX230721P00190000	2023-03-09	190	39,6	0	0
6	call	CLX231020C00145000	2023-03-23	145	18,46	0	0
6	call	CLX231020C00170000	2023-03-24	170	6,6	0	0
6	put	CLX231020P00145000	2023-03-22	145	6,3	0	0
6	put	CLX231020P00170000	2023-03-06	170	20,7	0	0
12	call	CLX240119C00065000	2022-11-03	65	71,86	84,6	87,7
12	call	CLX240119C00260000	2023-01-13	260	0,15	0,05	0,25
12	put	CLX240119P00065000	2023-03-15	65	0,15	0	0
12	put	CLX240119P00260000	2023-01-05	260	118,61	104,3	107,5

TABLE 4: Chosen options for different maturities with strikes $K_1 << K_2$

T[months]	Option	Contract Name	Last Trade Date	Strike	Last Price	Bid	Ask	Mid
2	call	CLX230519C00155000	2023-03-22	155	7,29	7,8	8,2	8
2	put	CLX230519P00155000	2023-03-24	155	5,81	5,4	5,8	5,6
1	call	CLX230421C00157500	2023-03-24	157,5	3,4	2,13	1,8	1,95
1	put	CLX230421P00157500	2023-03-22	157,5	3,4	3,9	3,8	4,1
3	call	CLX230721C00155000	2023-03-24	155	9,5	9,1	8,3	8,6
3	put	CLX230721P00155000	2023-03-20	155	7,6	6,43	7,2	7,5
6	call	CLX231020C00155000	2023-03-24	155	13	13,61	11,5	12,1
6	put	CLX231020P00155000	2023-03-24	155	10,8	10,8	9,8	10,3
12	call	CLX240119C00155000	2023-03-24	155	15,7	15,6	14,1	14,6
12	put	CLX240119P00155000	2023-03-24	155	11,95	12	12,1	12,4

TABLE 5: CLX options with ATM strike for different maturities