Stochastic Methods for Finance

2nd Report

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1. Goal

This report aims at deducing the Discount factor D (0, T) on a dividend paying asset, starting from two fixed strikes K1 and K2 (with K1 << K2) and from the corresponding Call and Put options at maturity T.
Then, after having calculated D (0, T), we proceed to find the implicit dividend for maturity T using the Put-Call parity and a strike ATM (At the Money).

2. Overview and statistics on the company: Mastercard Incorporated

Mastercard Incorporated is a technology company that provides transaction processing and other payment-related services in the United States and internationally. It facilitates the processing of payment transactions, including authorization, clearing, and settlement, as well as delivers other payment-related products.
The company offers payment solutions and services under the MasterCard, Maestro, and Cirrus. Mastercard provides open banking and digital identity platforms services, it issues licenses to banks all over the world for the issuance of their cards (issuing licenses) and for the recruitment of contractors (acquiring licenses).
Founded in 1966 and headquartered in Purchase (NY), Mastercard is one of the two major international companies for payment cards (credit cards, debit cards and prepaid cards), alongside VISA.

The corporation counts 24.00K employees. Looking at the major holders, 10.86% of the shares are held by All Insider, while 77.72% are held by Institutions. Vanguard Group, Inc. (The) with 70,152,808 shares and Blackrock Inc. with 65,712,258 are the top institutional holders.
Meta is the 21st company in the world by market capitalization with $359.27B and it has an Enterprise Value of $365.28B. As regard the income statement the Revenue (ttm) is $18.88B, the Gross Profit (ttm) $18.88B and the Net Income $8.69B.
Analysing the profitability and management effectiveness of the company there is a Profit Margin of 46.00% and a Return on Assets and Return on Equity of 18.01% and 124.73% respectively. The Beta (5Y Monthly) value is 1.09.
Today, March 29, 2022- 6:00 pm Rome GMT+01:00, the price of an option is $367.55.
At the open it was $359.22 and at the previous close the price was $357.38.
The day's range settles between $358.17 and $367.89, while the 52 week's one ranges between $305.61 and $401.50. The Forward Dividend & Yeld is 1.96 (0.55%) and theEx-Dividend Date is April 07, 2022.

3. Maturity T=1 month

In the Options section of Yahoo Finance I set the maturity at 1 month, with date April 29, 2022. I choose two strikes approximately ±20% from the strike ATM ($365.00), in this case K1=300, K2= 420. I compute the correspondent Mid Price for both Call and Put options, calculating the mean between Bid and Ask at the given strike. Mid prices that will be the Call and Put prices with strike K1=300 and K2=420 at maturity T= 1/12 , that I am using in the following equation to deduce the **Discount factor D(0,T)**:

$$C(K1) - C(K2) + P(K2) - P(K1) = (K2 - K1) * D(0,T)$$

The values obtained are:
C(K1) = $64.28   P(K1) = $1.09 C(K2)= $0.60   P(K2)= $57.63

Therefore, I can compute the Discount factor:

$$D(0,T) = \frac{\mathrm{C(K1) - C(K2) + P(K2) - P(K1)}}{\mathrm{(K2 - K1)}}$$

The value turns out to be 1.0018333, when it should be less than 1. This discrepancy might be due to market variables that our model does not consider, such as mixed options American- European or others. I will still use these results for the next calculations, aware that the outcomes will not be very accurate.

Now that D(0,T) is known I can exploit the **Put-Call parity**:

$$C(K) - P(K) = s - K * D(0,T) - s * \exp(qT) * D(0,T)$$

where K is the strike ATM = 365.00, C(K) = $18.80, P(K) = $20.48,

S is the spot value = $367.55 and T = 1/12 (1 month)

to obtain this relation

$$C_0(T,K) - P_0(T,K) = D_0(T)(F_0(T) - K)$$

and deduce **F(0,T)**, the **forward strike** compatible with absence of arbitrage opportunity at maturity 1 month.

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

With F(0,T) = 365.6834221 I can now calculate the **implicit dividend**:

$$div = F_0(T) - s * e^{rT}$$

where I can replace e^{rT} with the discount factor D(0,T) = 1.0018333 found previously

The dividend that results is div = -0.090086274 , a negative dividend, likely the consequence of the discount factor greater than 1.

4. Maturity T=3 m, T = 6 m, T = 1 year

I repeat the same procedure for T = 3 months, T = 6 months and T = 1 year.

T = 3 months	
June 17, 2022	
T	3/12
K	365
S	367.55
Call	18.8
Put	20.48
Call-Put	-1.68
F(0,T)	363.3118
D(0,T)	0.995167
div	-2.46167

T = 6 months	
Sept 16, 2022	
T	1/2
K	360
S	367.55
Call	31.4
Put	26.83
Call-Put	4.57
F(0,T)	364.5563
D(0,T)	1.003
div	-4.09632

T= 1 year (10 m)	
Jan 20, 2023	
T	10/12
K	365
S	367.55
Call	38.98
Put	36.83
Call-Put	2.15
F(0,T)	367.1604
D(0,T)	0.995167
div	1.386934
div rate	0.003773

For maturity 1 year the closest date available was Jan 20, 2023, therefore I chose a maturity T = 10 months. Furthermore, since in this last case I obtained a positive dividend, I calculated the **dividend rate =** div / S = 0.003773, which corresponds to a dividend yield of 0.3773 % .

5. Conclusion

Unfortunately, the results were heavily biased by market variables that this model does not take into account. Nonetheless, I tried to maintain the procedure as rigorous as possible. It would be interesting to understand the measure in which the limits of the method affected the estimation of the discount factor and implicit dividend, compared to other factors external to it.