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| **Statement of integrity:** By typing the names of all group members in the text boxes below, you confirm that the assignment submitted is original work produced by the group (excluding any non-contributing members identified with an “X” above). | |
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1. ***Pricing European Options with different correlations related to Q5,6,7,8,9,10 :***

| European Option | Call Price ($) | Put Price ($) | Call  Gamma | Call  Delta | Put  Gamma | Put  Delta |
| --- | --- | --- | --- | --- | --- | --- |
| Using Heston model with | 2.86 | 2.83 | 0.13 | 0.54 | 0.1 | -0.45 |
| Using Heston model with | 2.08 | 3.45 | 0.13 | 0.48 | 0.1 | -0.49 |
| Using Merton model at | 8.29 | 7.22 | 560458.93 | 94.01 | 124309.50 | -23.46 |
| Using Merton model at | 6.84 | 5.75 | -63495.22 | -93.47 | -292010.44 | 73.45 |

1. The prices of the call and put options from the Heston Model with a correlation of -0.3 do not satisfy put-call parity. The theoretical call and put prices are $3.92 and $1.77, respectively, using the given parameters. While the respective call and put prices using the Heston model $2.86 and $2.83. Similarly, the call and put prices from the Heston Model with a correlation of -0.7 does not satisfy put-call parity. Using the given parameters, the theoretical call and put prices are $4.54 and $0.99, respectively. While the respective call and put prices using the Heston model are $2.08 and $3.45. See table (a) below.

The prices of the call and put from the Merton Model with a jump intensity of 0.75 satisfy put-call parity. The theoretical call and put prices are $8.32 and $7.20, respectively using the given parameters. While the respective call and put prices using the Merton model $8.29 and $7.22. Even better is the result obtained for a jump intensity of 0.25. Not only do the prices for the call and put from the Merton Model with a jump intensity of 0.25 satisfy put-call parity. The theoretical call and put prices of $6.84 and $5.75 respectively also equals the prices obtained from the Merton pricing model ($6.84 and $5.75). See table (a) below.

Table (a): Summary of the result of Put-Call parity test for ATM option with parameters:

Where: is the correlation and is jump intensity for the Heston and Merton models respectively.

|  | Call Price ($) | Put Price ($) | Theoretical Call Price ($) | Theoretical Put Price ($) | Put-Call Parity Test |
| --- | --- | --- | --- | --- | --- |
| Using Heston model with | 2.86 | 2.83 | 3.92 | 1.77 | Failed |
| Using Heston model with | 2.08 | 3.45 | 4.54 | 0.99 | Failed |
| Using Merton model at | 8.29 | 7.22 | 8.32 | 7.20 | Passed |
| Using Merton model at | 6.84 | 5.75 | 6.84 | 5.75 | Passed |

1. ***A Heston Model with Correlation of -0.3***

| ***Moneyness*** | ***Heston European Call Price*** | ***Heston European Put Price*** |
| --- | --- | --- |
| 0.85 | 0.1 | 14 |
| 0.9 | 0.41 | 9.15 |
| 0.95 | 1.24 | 5.36 |
| 1 | 2.86 | 2.83 |
| 1.05 | 5.17 | 1.38 |
| 1.1 | 7.85 | 0.65 |

***B Heston Model with Correlation of -0.7***

| ***Moneyness*** | ***Heston European Call Price*** | ***Heston European Put Price*** |
| --- | --- | --- |
| 0.85 | 0.01 | 15.31 |
| 0.9 | 0.12 | 10.26 |
| 0.95 | 0.68 | 6.21 |
| 1 | 2.08 | 3.45 |
| 1.05 | 4.22 | 1.84 |
| 1.1 | 6.76 | 0.96 |

***C.) Merton Model with Jump Intensity of 0.75***

| ***Moneyness*** | ***Merton European Call Price*** | ***Merton European Put Price*** |
| --- | --- | --- |
| 0.85 | 2.76 | 15.86 |
| 0.9 | 4.27 | 12.21 |
| 0.95 | 6.09 | 9.41 |
| 1 | 8.14 | 7.31 |
| 1.05 | 10.35 | 5.76 |
| 1.1 | 12.63 | 4.63 |

***D.) Merton Model with Jump Intensity of 0.25***

| ***Moneyness*** | ***Merton European Call Price*** | ***Merton European Put Price*** |
| --- | --- | --- |
| 0.85 | 2.01 | 14.83 |
| 0.9 | 3.33 | 10.96 |
| 0.95 | 4.93 | 7.98 |
| 1 | 6.86 | 5.75 |
| 1.05 | 8.98 | 4.12 |
| 1.1 | 11.23 | 2.96 |

1. ***Pricing American Options :***

| American Option | Call Price | Put Price | Parameter |
| --- | --- | --- | --- |
| Using Heston model | 2.85 | 2.83 |  |
| Using Merton model | 14.13 | 11.60 |  |

1. Various insights into the characteristics and market valuation for each type of option can be unveiled through a comparison of the price received from an Up-and-In call option (UAI) with a simple European call.

For a UAI call, the underlying stock price must rise above the barrier level during its lifetime so as to activate it. This additional constraint actually implies that the probability of a UAI being exercised is lower than for an ordinary European call option which has no such constraints. Therefore, UAI calls tend to be priced relatively low.

The pay-off condition for a simple European call (that is, profit is achieved if the stock price at expiration exceeds the strike price regardless of whether the particular barrier was reached during the lifetime) is very straightforward. As it’s more straightforward and has a higher likelihood of being exercised; this typically commands a high price in the market compared to other options.

Therefore, the difference in prices between a UAI call option and a simple European option represents a risk-reward tradeoff inherent to barrier options like UAI calls whereby investors compensate by paying less for the tool so as to account for its activation risks. The comparative analysis highlights the nuances in option pricing and the impact of underlying contract specifications on market valuations.

1. The price of the European put option obtained from using the Down-and-In (DAI) model with a barrier of $65 was the same as that obtained using a simple Merton model for the European. Both gave the same result of $2.77. This indicates that none of the simulated paths had touched or hit the $65 barrier. This means that in all of the Merton jump paths created, there was no place at all where the stock price fell below the barrier level of $65 before expiration.

This could be as a result of specific parameter values selected to be used in running simulations. The likelihood of whether or not a barrier will be hit is influenced by parameters such as barrier level, and volatility among others. In case the barrier is too high or if jump intensity is not enough, it may be less likely for the barrier to be reached, resulting in similar prices for the DAI put option and the European put option.

To observe a price for when the barrier is reached, we can change B(the barrier level), lamb(jump intensity), and other inputs to see how they affect the pricing of the DAI Put Option.

Works Cited

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