

Rotman Online Trading Competition 2018

January 13th, 2018



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Important Information

Practice Servers

Practice servers will be made available starting on December 22nd, 2017 and will operate 24 hours a day 7 days a week until the start of the competition.

Information on how to download and install the RIT v2.0 Client is available on the [RIT website](#).

We will post information on how to login to any server port. Remember that you can type in any username and password and it will automatically create an account if it does not exist. If you have forgotten your password or the username appears to be taken, simply choose a new username and password to create a new account.

Scoring and Ranking Methodology

The Scoring and Ranking Methodology document will be released prior to the start of the competition on the ROTC website.

Schedule and Timeline

The competition is held online, it will start at 10:00 am on January 13th and end at 1:00 pm and it will be run until the number of heats described further in this document is completed. The Finance Lab team will not wait for anyone who is late. Competition Servers will be set up 10 minutes before the start. In the event of a server failure, the case session will be rerun and the scores from that session will not be kept.

Case Summaries

Sales and Trader Case

The Sales and Trader Case challenges participants to put their critical thinking and analytical abilities to the test in an environment that allows traders to have significant flexibility on the trading strategy they choose to implement. Traders will be faced with multiple tender offers requiring participants to make rapid judgments on the profitability and subsequent execution of these offers. Profits can be generated by taking advantage of pricing discrepancies, large tender offers, and market-making opportunities.

Options Trading Case

The Options Trading Case will test competitors on their ability to implement volatility trading strategies through options. This will be achieved through positions in mispriced options whilst hedging delta exposure. Taking place over a one month period, competitors will receive accurate estimates on forecasted volatility for underlying assets. Competitors will need to analyze market information and update expectations in order to execute a profitable strategy.

Credit Risk Case

The Credit Risk Case challenges participants to build and apply a credit risk model in a simulation where corporate bonds are traded. Participants will use both a Structural Model and the Altman Z-Score to predict potential changes to the companies' credit ratings. Periodic news updates will require participants to make appropriate adjustments to the assumptions in their models and rebalance their portfolios accordingly. This case will test participants' ability to develop a credit risk model, assess the impact of news releases on credit risk, and execute trading strategies accordingly to profit from mispricing opportunities.

Sales & Trader Case

Overview

The Sales and Trader Case challenges participants to put their critical thinking and analytical abilities to the test in an environment that allows traders to have significant flexibility on the trading strategy they choose to implement. Traders will be faced with multiple tender offers requiring participants to make rapid judgments on the profitability and subsequent execution of these offers. Profits can be generated by taking advantage of pricing discrepancies, large tender offers, and market-making opportunities.

Description

The trading session will consist of five, 10-minute heats with each heat to be independently traded and representing one month of calendar time. Each heat will have a unique objective and could involve up to four securities with different volatility and liquidity characteristics.

Parameter	Value
Number of trading heats	5
Trading time per heat	600 seconds (10 minutes)
Calendar time per heat	1 month (20 trading days)

Tender offers will be generated by computerized traders and distributed at random intervals to random participants. Traders must subsequently evaluate the profitability of these tenders when accepting or bidding on them. Trading from excel using Rotman API will be disabled. Real time data (RTD) links will be enabled.

Market Dynamics

There are five heats each with unique market dynamics and parameters ranging from changes in the spread of tender orders to the liquidity and volatility of various stocks. Below, you can find details regarding each heat allowing for participants to formulate trading strategies.

Heat 1					
Stock	Price	Commissions	Tender Spread	Volatility	Liquidity
GOLF	\$25	\$0.02	High	Low	Medium
POLO	\$13	\$0.01	Medium	Medium	Medium

Heat 2					
Stock	Price	Commissions	Tender Spread	Volatility	Liquidity
SUIT	\$30	\$0.02	High	Low	High
TIE	\$15	\$0.01	Medium	Medium	Medium

Heat 3					
Stock	Price	Commissions	Tender Spread	Volatility	Liquidity
NYC	\$8	\$0.02	Medium	Medium	Medium
LONDON	\$15	\$0.02	Medium	Medium	Medium
PARIS	\$33	\$0.01	High	High	Medium

Heat 4					
Stock	Price	Commissions	Tender Spread	Volatility	Liquidity
THUNDER	\$8	\$0.02	High	High	Medium
BULL	\$15	\$0.02	Medium	High	High
ROCK	\$33	\$0.03	Medium	Medium	High

Heat 5					
Stock	Price	Commissions	Tender Spread	Volatility	Liquidity
MOE	\$20	\$0.03	Medium	Medium	Medium
LARRY	\$15	\$0.02	Medium	High	Low
CURLY(ETF)	\$35	\$0.05	High	High	Medium

Note: Heat 5 includes a third security which is an ETF. The ETF CURLY is comprised equally of securities MOE and LARRY. This means that at any given point in time the price of CURLY should be the combined price of LARRY and MOE. The implication of this ETF also means that CURLY will close out at the price equal to the price of MOE and LARRY if held until the end of the case instead of the last traded price.

During each heat, traders will occasionally receive one of three different types of tender offers: private tenders, competitive auctions and winner takes all. Tender offers are generated by the server and randomly distributed to traders at different times. **Each participant will get the same number of tender offers with variations in price and quantity.**

Private tenders are routed to individual traders and are offers to purchase or sell a fixed volume of stock at a fixed price. The tender price is influenced by the same pre-generated path that the liquidity traders follow in an attempt to drive the market price towards that path. Private tenders

will give a spread based on the mid-market price when the order was generated (if the mid-market price is \$10, and the spread was 1-2%, the tender offer will offer to buy shares for an amount between \$10.10 and \$10.20).

Competitive auction offers will be sent to every participant at the same time. Traders will be required to determine a competitive, yet profitable price to submit for a given volume of stock from the auction. Any trader that submits an order that is better than the base-line reserve price (hidden from traders) will automatically have their order filled, regardless of other traders' bids. If accepted, the fills will occur at the price that the trader submits.

Winner takes all tenders request traders to submit bids to buy or sell a fixed volume of stock. After all prices have been received, the tender is awarded to the single highest bidder or lowest offer. The winning price however must meet a base-line reserve price. If no offer meets the reserve price, then the trade may not be awarded to anyone (i.e. if all traders bid \$2.00 for a \$10 stock, nobody will win).

Calculation of the Profit or Loss of Traders

The prices generated by the RIT for this case follow a random walk process using a return drawn from a normal distribution with a mean of zero. That is, at any point in the simulation, the probability that the price will go up is equal to the probability that the price will go down. This means that participants cannot predict the future price of the ETFs without "taking a bet". Therefore, the scoring committee will consider buying (selling) ETFs for reasons other than reducing the exposure associated with accepting a tender offer to be equivalent to speculating (taking a bet) on the price movement. These types of trades will be marked as "speculative trades".

Participants will have time to think about the offer before they accept it. For example, one may receive a tender offer at time $t = 0$ and will have until $t = 30$ to decide whether to accept. Any trades made by a participant during this time without accepting the tender offer will be considered as "front-running"¹ since the participant had the advance knowledge of a pending institutional order. The scoring committee will mark these trades as "front-running trades".

This case is designed to only reward the participants for identifying, accepting, and closing out² tender offer positions at a profit while managing liquidity risk and execution risk. Any other

¹ *Front-running is the unethical and illegal practice of trading a security for your own account while taking advantage of the information contained in the pending orders from your institutional clients.*

² *"Closing out" a position means that a participant is executing a trade that is the opposite of the current position in order to eliminate the exposure.*

strategy will not be considered. In particular, the total profit of each participant³ will be categorized into two parts: “profits from tender offers” and “profit from speculation”; the latter category includes the profits that are a result of either speculative trades or front-running trades.

Profits from tenders are the profits (or losses) gained from efficiently closing out the position from accepted tenders into the market. Profits from speculation are profits (or losses) generated through trades that are not associated with tenders (speculative trades or front-running trades). An “adjusted P&L” will be calculated based on the following formula:

$$\text{Adjusted P\&L} = \text{Profit From Tenders} + \text{Min}(0, \text{Profit From Speculation})$$

Participants will be **ranked and scored** based on their *Adjusted P&L*.

For example, consider a participant who has made \$10,000 from tenders and \$50,000 from speculation, the total profit is \$60,000 (= \$10,000 + \$50,000) but the *Adjusted P&L* will be only \$10,000 [= \$10,000 + $\text{min}(0, \$50,000)$]. Another example, consider a participant who has made \$35,000 from tenders and lost \$20,000 from speculation (*Profit From Speculation* = -\$20,000); the total profit is \$15,000 (\$35,000 - \$20,000) and it is the same as the *Adjusted P&L* [\$15,000 = \$35,000 + $\text{min}(0, -\$20,000)$]. From the last example, please note that any losses from speculation will still be considered and therefore, negatively affect your *Adjusted P&L*.

The *Adjusted P&L* will be calculated by the ROTC scoring committee at the end of each heat and it will **not be included** in the P&L calculation in RIT. However, participants will be provided with an Excel tool⁴, the “Performance Evaluation Tool”, that will allow them to calculate the *Adjusted P&L*.

Trading Limits and Transaction Costs

Each trader will be subject to gross and net trading limits: the net and gross trading limits for all of the versions are NET 250,000 shares, or GROSS 250,000 shares. The gross trading limit reflects the sum of the absolute values of the long and short positions across all securities, while the net trading limit reflects the sum of long and short positions such that short positions negate any long positions. Trading limits will be strictly enforced and traders will not be able to exceed them.

³ Total profit of each participant is the profit (or loss) that you can observe in the RIT at the end of a heat/iteration.

⁴ The “Performance Evaluation Tool” is uploaded on the ROTC website.



The maximum trade size will be 25,000 shares, restricting the volume of shares transacted per trade to 25,000.

There is a maximum stop loss of \$1.5 Million per person for each trading heat. If a user loses more than \$1.5 Million, he/she will be forced to stop trading for the remainder of the heat.

Position Close-Out

Any non-zero position will be closed out at the end of trading based on the last traded price. This includes any long or short position open in any security. Computerized market makers will increase the liquidity in the market towards the end of trading to ensure the closing price cannot be manipulated.

Key Objectives

Objective 1:

Generate profits by market making in order to capture the bid-ask spread. Develop trading strategies based on the case descriptions to be distributed prior to the trading period in order to customize profitable trading strategies to each heat.

Objective 2:

Evaluate the profitability of tender offers and accept those that will generate profits while rejecting those that will create losses. Submit competitive, yet profitable, bids and offers on above reserve and winner takes all tenders in order to maximize potential profits.

Objective 3:

Limit market risk by managing open positions and optimally utilizing the gross and net trading limits to maximize profits. Maintaining large short or long positions may result in the market trading away from your transaction price, resulting in losses. Use a combination of limit and market orders to mitigate any liquidity and price risks from holding open positions.

Options Trading Case

Overview

The Options Trading case will test competitors on their ability to implement volatility trading strategies through options. This will be achieved through positions in mispriced options whilst hedging delta exposure. Taking place over a one month period, competitors will receive accurate estimates on forecasted volatility for underlying assets. Competitors will need to analyze market information and update expectations in order to execute a profitable strategy.

Description

The trading session will consist of five, 10-minute heats with each heat to be independently traded and representing one month of calendar time. Each heat will have different volatility characteristics which Traders must subsequently evaluate to identify mispricing. Trading from excel using Rotman API will be disabled. Real time data (RTD) links will be enabled.

Parameter	Value
Number of trading heats	5
Trading time per heat	600 seconds (10 minutes)
Calendar time per heat	1 month (20 trading days)

Market Dynamics

As a trader you will focus on trading options for one security, RTM, which is a non-dividend paying Exchange Traded Fund (ETF) that tracks a major stock index. The price of the ETF is generated using the following (martingale) process:

$$P_{RTM,t} = P_{RTM,t-1} * (1 + r_t); \text{where } r_t \sim N(0, \sigma_t)$$

That is the ETF price is based on the previous price adjusted by a return that is drawn from a normal distribution with a mean of zero and standard deviation (volatility) of sigma. Sigma's starting value is 16% (on an annualized basis). The following table illustrates the 1-month call/put options with 5 different strike prices.

Call Ticker	Strike Price	Put Ticker
RTM48C	48	RTM48P
RTM49C	49	RTM49P
RTM50C	50	RTM50P
RTM51C	51	RTM51P
RTM52C	52	RTM52P

RTM is a large ETF with its options priced by a large market-maker who will always quote a bid/ask spread of 2 cents. The bids and asks are for an infinite quantity meaning there are no liquidity constraints in the case.

The market maker quotes options using the Black-Scholes pricing model whilst assuming a risk-free interest rate of 0%. Furthermore, the volatility forecasts made by the market maker are uninformed and will **not** accurately reflect the future volatility of the underlying asset. Due to the highly volatile nature of option prices the market maker will demand a volatility risk premium. The market maker has determined a constant 4% volatility risk premium on an annualized basis. That is, the implied volatility quoted by the market maker for the option is 4% higher than the expected volatility of the underlying stock.

Your analysts have developed a very effective model to forecast the realized volatility of the underlying asset and will send the trader weekly updates. The trader must use this information to identify mispricing opportunities in the options markets and profit from that mispricing. When a mispricing opportunity occurs, you should take a position in the mispriced options while at the same time trading the underlying security to hedge your delta exposure in order to build a delta neutral portfolio.

At the beginning of each week, the volatility value will shift and a new value will be provided by analysts to each trader. In addition, at the middle of each week an estimate of next week's volatility value will be announced. Sample news provided by analysts is shown below.

Time	Week	Release
1	Week 1	The analysts have informed you that the volatility of RTM for this week will be 16%
75	Week 1	The analysts have informed you that the volatility of RTM for next week will be between 20-23%
150	Week 2	The analysts have informed you that the volatility of RTM for this week will be 22%
....		
450	Week 4	The analysts have informed you that the volatility of RTM for this week will be 26%

Trading Limits and Transaction Costs

Each trader will be subject to gross and net trading limits specific to the security type as specified below. The gross trading limit reflects the sum of the absolute values of the long and short positions across all securities of the same type, while the net trading limit reflects the sum of long and short positions such that short positions negate any long positions. Trading limits will be enforced and students will not be able to exceed them.

Security Type	Gross Limit	Net Limit
RTM ETF	50,000 Shares	50,000 Shares
RTM Options	2,500 Contracts	1,000 Contracts

The maximum volume per trade will be 10,000 shares for the RTM ETF and 100 contracts for RTM options. There are no transaction fees.

Position Close-Out

Any outstanding position in the RTM ETF will be closed at the end of trading based on the last-traded price. There are no liquidity constraints for either the options or the ETF. All options will be cash-settled based on their exercise value.

Credit Risk Case

Overview

This Credit Risk Case challenges participants to build and apply a credit risk model in a fixed income market where corporate bonds are traded. Participants will use both a Structural Model and the Altman Z-Score to predict potential changes to the companies' credit ratings. Periodic news updates will require appropriate adjustments to the assumptions in their models and rebalancing of portfolios accordingly. This case will test participants' ability to develop a credit risk model, assess the impact of news releases on credit risk, and execute trading strategies accordingly to profit from mispricing opportunities.

Description

In this case there will be 3 heats and each heat will span 16 minutes, representing two calendar years. Each heat will involve 5 tradable securities. Trading from Excel using the Rotman API will be disabled. Real Time Data (RTD) links will be enabled.

Parameter	Value
Number of trading heats	4
Trading time per heat	16 minutes (960 seconds)
Calendar time per heat	2 calendar years (4 weeks per month, 12 months in a year – total of 48 weeks in a year)
Compounding interval	1 week (10 seconds)
Maximum order size	500 contracts

This case assumes that participants are working at a fixed income trading desk as a junior analyst. Participants are strongly encouraged to build a credit risk model according to the information presented in the "Market Dynamics" section below. Two models will be introduced, the "Structural Model" and the "Altman Z-Score Model". The Structural Model will be used to calculate the implied credit spreads for the bonds, while the Altman Z-Score Model can be used to determine the Z-Score and associated financial solvency category of the company. With the use of the two models, participants will be able to calculate the probabilities of a rating upgrade/downgrade and the fair prices of the corporate bonds. Then they will be able to implement a trading strategy and profit from mispricing opportunities.

News items will be periodically released during the case, which may have an impact on the variables used in the two models. As these variables change, the implied credit spread and/or the Altman Z-Score may change, affecting the likelihood of a rating upgrade/downgrade. Participants will then have to adjust their trading strategies and portfolio positions. For more details about the variables used in the models and the news releases, please see the “Market Dynamics” and “News Releases” sections, respectively.

Market Dynamics

There are five tradable zero-coupon corporate bonds that are issued by non-dividend paying public companies. All of these bonds have the same credit ratings at the beginning of the case.

The characteristics of the bonds can be found in the table below.

	BondA	BondB	BondC	BondD	BondE
Face Value	100	100	100	100	100
Coupon	0	0	0	0	0
Maturity	5 years from now	5 years from now	5 years from now	5 years from now	5 years from now
Credit Rating	A	A	A	A	A
Issuer Info	Anderson Shipping	Barbell Gaming Technologies	Cataran Industries	Dysol Solutions Company	Evolution Entertainment
Volatility of Company's Assets	36%	35%	54%	35%	46%
Total Asset Value (in 100 millions)	100	185	130	80	140
Total Debt Value (in 100 millions)	60	110	35	50	55
Market Value of Equity (in 100 millions)	40	75	95	30	85
Sales (at t=0) (in 100 millions)	100	160	35	60	60

	BondA	BondB	BondC	BondD	BondE
EBIT (Earnings Before Interest and Taxes) (<i>in 100 millions</i>)	20	60	10	40	35
Retained Earnings (<i>in 100 millions</i>)	15	30	5	10	25
Working Capital (<i>in 100 millions</i>)	40	20	10	10	20

There is a risk free rate (r) and a table provided by the credit rating agency with credit spreads (s_r) that correspond to each rating. In equilibrium, bonds will be priced such that the implied yield to maturity (y) is equal to $r + s_r$ (risk free rate plus credit spread), where T is the time to maturity:

$$P_0 = \frac{100}{(1 + y)^T} = \frac{100}{(1 + r + s_r)^T}$$

Rating Agency Credit Ratings

Rating	Credit Spread (s_r)
AAA	0.50%
AA+	1.00%
AA	1.50%
AA-	2.00%
A+	2.50%
A	3.00%
A-	3.50%
BBB+	4.00%
BBB	4.50%
BBB-	5.00%
BB+	5.50%
BB	6.00%
BB-	6.50%
B+	7.00%

The credit rating agency will be releasing the updated credit ratings for each company on a quarterly basis. A company's credit rating can be upgraded or downgraded by the credit rating agency by only one notch at a time. For example, if a company has a current credit rating of A, its rating will be A+ in case of upgrade and A- in case of downgrade.

The senior fixed income fund managers understand that a change in the financial situation for a company will not be reflected immediately in these ratings since they are only updated quarterly. Therefore, they have suggested that you can also calculate an implied credit spread (s_m) using a Structural Model with real-time market data, as explained in the following subsection.

Structural Model:

The company's liabilities are composed of two parts: equity and debt. We assume that the equity does not receive dividends and that the debt is in the form of a zero coupon bond with face value (D) and maturity (T). If at time (t), the value of the assets is greater than the value of the debt, the company will pay its debt. If instead, the value of the assets, A , is smaller than the value of the debt, the company will go bankrupt. If this occurs, the bondholders will receive the value of the assets and the shareholders will not receive anything.

Conceptually, this means that the equity portion of a company can be modelled as a European call option written on the value of the assets (A) with a strike price equal to the face value of the debt (D).

Therefore, Black-Scholes can be used to model the value of the equity, leading to the following model⁵ for the implied credit spread: let L be the measure for the company's leverage and defined as:

$$L = \frac{\text{current value of debt}}{\text{current value of assets}} = \frac{D e^{-rT}}{A_0}$$

Where,

D is the face value of debt;

r is the risk free rate;

T is the time to maturity;

A_0 is the current value of assets at the present time.

The implied credit spread is then calculated as:

$$s_m = -\frac{\ln\left(N(d_2) + \frac{N(-d_1)}{L}\right)}{T}$$

Where,

$$d_1 = \frac{-\ln(L)}{\sigma_A \sqrt{T}} + \frac{1}{2} \sigma_A \sqrt{T}$$

$$d_2 = d_1 - \sigma_A \sqrt{T}.$$

T is the time to maturity of the zero-coupon bond in years;

σ_A is the volatility of the company's assets;

$N(x)$ is the standard normal cumulative distribution function of x .

For further details, including a formal derivation of this Structural Model, please see the Appendix.

Altman Z-Score Model:

The fund managers suggest that you also consider the Altman Z-Score to estimate the default probability of the companies. The Altman Z-Score is calculated as follows:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.99X_5$$

Where,

X_1 is Working Capital/Total Assets;

X_2 is Retained Earnings/Total Assets;

X_3 is EBIT/Total assets;

X_4 is Market Value of Equity/Total Debt;

X_5 is Sales/Total Debt.

⁵ The model presented is known in the literature as the Merton Model and is a type of structural model.

Based on the Z-Score, the company can be classified into one of three different categories:

- If $Z > 2.99$, there is a low probability of bankruptcy ("Safe" Zone).
- If $1.81 < Z < 2.99$, there is a moderate probability of bankruptcy ("Grey" Zone).
- If $Z < 1.81$, there is a high probability of bankruptcy ("Distress" Zone).

Evaluating the Probability of Credit Rating Downgrade/Upgrade

Your senior analysts have come up with the following table, which predicts the probability of a rating upgrade/downgrade. The rows of the table are based on the difference between the Structural Model implied credit spread (s_m) and the credit spread associated with the current credit rating (s_r), while the columns are based on the categories found using the Altman Z-Score Model.

Difference ($s_m - s_r$)	Probability of Downgrade			Probability of Upgrade		
	Safe	Grey	Distressed	Safe	Grey	Distressed
$s_m - s_r < -2.0\%$	0.0%	0.0%	0.0%	75.0%	65.0%	55.0%
$-2.0\% \leq s_m - s_r < -1.5\%$	0.0%	0.0%	0.0%	65.0%	55.0%	45.0%
$-1.5\% \leq s_m - s_r < -1.0\%$	0.0%	0.0%	0.0%	55.0%	45.0%	35.0%
$-1.0\% \leq s_m - s_r < -0.5\%$	0.0%	0.0%	0.0%	45.0%	35.0%	25.0%
$-0.5\% \leq s_m - s_r < 0.0\%$	25.0%	35.0%	45.0%	40.0%	30.0%	20.0%
$0.0\% \leq s_m - s_r < 0.5\%$	35.0%	45.0%	55.0%	35.0%	25.0%	15.0%
$0.5\% \leq s_m - s_r < 1.0\%$	45.0%	55.0%	65.0%	0.0%	0.0%	0.0%
$1.0\% \leq s_m - s_r < 1.5\%$	55.0%	65.0%	75.0%	0.0%	0.0%	0.0%
$1.5\% \leq s_m - s_r < 2.0\%$	65.0%	75.0%	85.0%	0.0%	0.0%	0.0%
$s_m - s_r \geq 2.0\%$	75.0%	85.0%	95.0%	0.0%	0.0%	0.0%

These probabilities should be used to find the expected credit spread as shown in the formula below:

$$E(s) = p_u \cdot s_r^u + p_d \cdot s_r^d + (1 - p_u - p_d) \cdot s_r$$

Where,

p_u and p_d are, respectively, the probabilities of a rating upgrade or downgrade;

s_r^u is the credit spread in the case of upgrade according to the rating agency's table of credit ratings;

s_r^d is the credit spread in case of downgrade according to the rating agency's table of credit ratings;

s_r is the current credit spread according to the rating agency's table of credit ratings.

This expected credit spread should then be used to calculate the fair value for the zero-coupon bond. Participants are expected to compare this fair value to the market value and make appropriate trading decisions.

Below, an example of how participants should price a bond with a company rating of A, two years left to maturity, a risk free rate of 2% annualized weekly compounded.

Input:

- Company Rating=A
- Expected credit spread $E(s) = 3.00\%$
- Time to Maturity (T) = 2 years
- Risk free rate annualized weekly compounded $r_w = 2\%$

The equivalent annual rate r_a is

$$r_a = \left(1 + \frac{r_w}{n}\right)^n = \left(1 + \frac{2\%}{48}\right)^{48} \approx 2.0197\%$$

n is the number of weeks. In this case, we assume that there are 48 weeks in a year.

The price of the bond (P_0) is therefore:

$$P_0 = \frac{100}{(1 + r_a + E(s))^T} = \frac{100}{(1 + 2.0197\% + 3.00\%)^2} \approx 90.67$$

News Release:

News items will be released every quarter. They will affect the variables within the Structural Model and the Altman Z-Score Model. Participants should be able to identify relevant news, assess its impact, and execute appropriate trading strategies.

A sample news release affecting the Structural Model is:

“Company C takes on an additional \$1B of debt financing for their share repurchase program”

This will increase the level of total debt of Company C by \$1 billion, which will directly increase the company's leverage, (L). This in turn increases the implied credit spread (s_m) in the Structural Model through the variables d_1 and d_2 .

One can then compare this new implied credit spread (s_m) with the credit spread given by the credit rating agency (s_r). For example, if the initial difference between the two credit spreads ($s_m - s_r$) was 0.40%, the impact of the news may move the difference to 0.90%. Looking at the upgrade/downgrade

table, if the company is in the “Safe” zone, the probability of downgrade will increase from 35% to 45% and the probability of upgrade will decrease from 35% to 0%.

Note that the increase in total debt associated with this news will also affect the Altman Z-Score Model through variables X_4 (Market Value of Equity/Total Debt) and X_5 (Sales/Total Debt).

A detailed explanation of a news release on the Altman Z-Score Model is given below. A sample news release impacting the Altman Z-Score Model is:

“Major weather conditions reduce demand for Company E’s products, decreasing the company’s revenue by \$500M”

In this case, the news item decreases the sales of Company E by \$500M, which decreases X_5 (Sales/Total Debt) in the Altman Z-Score Model. Hence, the Altman Z-Score decreases for Company E, which in turn could move the state of the company’s financial solvency from either the “Safe” zone to the “Grey” zone or from the “Grey” zone to the “Distress” Zone. For example, assume that Company E is initially in “Safe” zone with a difference between s_m and s_r of 0.00%. If the news release changes the Altman Z-Score Model for Company E so that the company moves from “Safe” zone to “Grey” zone, then the probability of downgrade changes from 35% to 45% and the probability of upgrade changes from 35% to 25%.

Trading Limits and Transaction Costs:

Each participant will be subject to gross and net trading limits. The gross trading limit reflects the sum of the absolute values of the long and short positions across all securities, while the net trading limit reflects the sum of long and short positions such that short positions negate any long positions. Trading limits will be strictly enforced and participants will not be able to exceed them.

Each simulation represents 2 calendar years. The maximum order size will be 500 bonds, and transaction fees will be set to 2 cents per bond.

Parameter	Value
Calendar time	2 calendar years (4 weeks per month, 12 months in a year – total of 48 weeks in a year)
Compounding interval	1 week (10 seconds)
Maximum order size	500 contracts
Transaction fees	2 cents per bond

Position Close Out:

Any open position will be closed out at the end of each heat based on the price of the bond using the credit spread, s_r , provided by the credit rating agency. This includes any long or short position open in any security.

Key Objectives**Objective 1:**

Build a credit risk model that incorporates both the Structural Model and the Altman Z-Score Model to find the expected credit spread and fair value for the zero-coupon bonds. By understanding the variables that drive the credit risk models, participants should be able to identify and exploit mispricing opportunities to generate profits.

Objective 2:

Analyze the impact of news releases on the relevant variables of the model. News items will affect one or more parameters in the Structural Model and/or the Altman Z-Score Model, and consequently the probability of a credit rating change. Participants should update their credit risk models to reflect these changes and rebalance their portfolios accordingly.

Objective 3:

Manage exposure to market risk. To minimize their bond portfolios' exposure to market risk, participants are encouraged to take positions in more than one bond to reduce losses associated with idiosyncratic risks of each bond.

Appendix

The company's liabilities are composed of the following two parts: equity and debt. The equity does not receive dividends and the debt is in the form of a zero coupon bond with face value equal to D and maturity at time T .

If at time T , the value of the of the assets, A , is greater than the value of the debt, the company will pay its debt. If at time T , the value of the of the assets, A , is smaller than the value of the debt, the company will go bankrupt. Bondholders will receive the value of the assets and the shareholders will not receive anything. The company cannot go bankrupt before time T .

Formalizing this description: the value of the assets is assumed to follow a geometric Brownian motion described by the following equation:

$$dA = \mu_A A dt + \sigma_A A dW$$

Where,

μ_A is the drift of the asset value - assumed to be equal to zero in this case;

σ_A is the volatility of the company's assets;

dW is a standard Wiener process.

The value of the assets at time t is then equal to

$$A_t = A_0 \exp \left\{ \left(\mu_A - \frac{\sigma_A^2}{2} \right) t + \sigma_A^2 \sqrt{t} W_t \right\}$$

Where $W_t \sim N(0, t)$.

The expectation of A_t is:

$$E(A_t) = A_0 \exp(\mu_A t)$$

At time T , the value of the equity will be:

$$E_T = \max[A_T - D, 0]$$

The above shows that the value of the equity looks like the payoff of a (European) call option written on the value of the assets (A) with a strike price equal to the face value of the debt (D). Using Black-Scholes:

$$E_0 = A_0 N(d_1) - D e^{-rT} N(d_2)$$

with

$$d_1 = \frac{\ln\left(\frac{A_0 e^{rT}}{D}\right)}{\sigma_A \sqrt{T}} + \frac{1}{2} \sigma_A \sqrt{T}$$

$$d_2 = d_1 - \sigma_A \sqrt{T}$$

Where r is the risk-free rate.

Let L be a measure of the leverage used by the company and defined as:

$$L = \frac{\text{current value of debt}}{\text{current value of assets}} = \frac{D e^{-rT}}{A_0}$$

Then we can write the current value of the Equity as:

$$E_0 = A_0[N(d_1) - L N(d_2)]$$

Where,

$$d_1 = \frac{-\ln(L)}{\sigma_A \sqrt{T}} + \frac{1}{2} \sigma_A \sqrt{T}$$

$$d_2 = d_1 - \sigma_A \sqrt{T}.$$

The current value of the debt (at time zero) is equal to:

$$B_0 = A_0 - E_0$$

Substituting for E_0 from above:

$$B_0 = A_0[N(-d_1) + L N(d_2)]$$

Note that the current value of debt B_0 can also be expressed by discounting the face value at the implied yield to maturity (y):

$$B_0 = D e^{-yT} = D^{-rT} e^{(r-y)T} = A_0 L e^{(r-y)T}$$

It follows that:

$$A_0 L e^{(r-y)T} = A_0[N(-d_1) + L N(d_2)]$$

Therefore, the implied yield to maturity (y) can be calculated as:

$$y = r - \frac{\ln\left(N(d_2) + \frac{N(-d_1)}{L}\right)}{T}$$

Then the implied credit spread (s_m) is calculated as:

$$s_m = y - r = -\frac{\ln\left(N(d_2) + \frac{N(-d_1)}{L}\right)}{T}$$