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Rotman
INTERNATIONAL TRADING COMPETITION 2023

Rotman School of Management
UNIVERSITY OF TORONTO

Case Package

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About RITC

A WARM WELCOME FROM THE ROTMAN COMMUNITY

The Rotman International Trading Competition (RITC) is a one-of-a-kind event hosted annually at the Rotman School of Management at the University of Toronto, in the heart of one of North America's largest financial centres. RITC is the world's largest simulated market challenge and brings together teams of students and faculty advisors representing over 50 top universities across the world.

The competition is predominantly structured around the RIT market simulator and associated decision cases platform (an electronic exchange that matches buyers and sellers in order-driven markets) on which decision cases are run. The cases represent various scenarios for risks and opportunities with a focus on specific investment, portfolio, or risk management objectives. Participants will be challenged to handle a wide range of market environments.

Although we will be gathering online from around the world, RITC 2023 has been designed to promote the skill enhancement and competition spirit that is reminiscent of our past RITC events. We hope to re-connect with everyone in person as soon as possible.

This Case Package provides an overview of the content of RITC 2023. We are thrilled that you will be participating!

Case Summaries

VOLATILITY TRADING CASE

The Volatility Trading Case gives participants the opportunity to generate profits by implementing options strategies to trade volatility. The underlying asset of the options is a non-dividend-paying Exchange Traded Fund (ETF) called RTM that tracks a major stock index. Participants will be able to trade shares of the ETF as well as 1-month and 2-month call/put options at 10 different strike prices. Information including the ETF price, options prices, and news releases will be provided. Participants are encouraged to use the provided information to identify mispricing opportunities and construct options trading strategies accordingly.

ELECTRICITY TRADING CASE

The Electricity Trading Case provides the opportunity for participants to work in a role-based team environment to engage in an electricity trading market controlled by a strict regulatory policy. Participants are required to forecast supply and demand for electricity and execute strategies accordingly while reacting to prevailing market events. Each team will participate in a closed supply and demand market for electricity by producing it using power plant assets and distributing it to customers and will also have access to a forward market. Through the full cycle of electricity markets, participants will need to dynamically formulate their role-based strategies and optimally perform trade executions.

ALGORITHMIC TRADING CASE

The Algorithmic Trading Case is designed to challenge participants' programming skills by developing algorithms using the RIT API to automate trading strategies and react to changing market conditions. Throughout the case, these algorithms will submit orders to profit from arbitrage opportunities and private tender offers. Due to the high-frequency nature of the case, participants are encouraged to develop algorithms that can adapt to rapid changes in market dynamics using their selected programming languages.

LIQUIDITY RISK CASE

The Liquidity Risk Case challenges participants to put their critical thinking and analytical abilities to test in an environment that requires them to evaluate the liquidity risk associated with large tender offers. Participants will be faced with multiple tender offers throughout the case. This will require participants to make rapid judgments on the profitability, subsequent acceptance and execution, or rejection, of each offer. Profits can be generated by taking advantage of price differentials between market prices and prices offered in the private tenders. Once any tender has been accepted, participants should aim to efficiently close out their large positions to maximize returns and minimize liquidity and market risks.

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Volatility Trading Case

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OVERVIEW

The Volatility Trading Case gives participants the opportunity to generate profits by implementing options strategies to trade volatility. The underlying asset of the options is a non-dividend-paying Exchange Traded Fund (ETF) called RTM that tracks a major stock index. Participants will be able to trade shares of the ETF as well as 1-month and 2-month call/put options at 10 different strike prices. Information including the ETF price, options prices, and news releases will be provided. Participants are encouraged to use the provided information to identify mispricing opportunities and construct options trading strategies accordingly.

DESCRIPTION

There will be 5 independent heats with two team members participating in each heat. Please note that only two team members shall trade to represent the team for all heats. Each heat will be 10 minutes long and represent two months of calendar time.

Parameter	Value
Number of trading heats	5
Trading time per heat	600 seconds (10 minutes)
Calendar time per heat	2 months (40 trading days)

News will be released during each heat. Order submissions using the RIT API will be enabled. Data retrieval via Real-time Data (RTD) Links and the RIT API will also be enabled.

MARKET DYNAMICS

Participants will be able to trade RTM and 40 separate options contracts on RTM at the beginning of the case. All options are European, so early exercise is not allowed. After the first period ends, the one-month expiration options will no longer be tradable as they expire.

Starting Option Prices for One-month Expiration

Call Price	Call Ticker	Strike Price	Put Ticker	Put Price
$5.04	RTM1C45	45	RTM1P45	$0.04
$4.09	RTM1C46	46	RTM1P46	$0.09
$3.20	RTM1C47	47	RTM1P47	$0.20
$2.40	RTM1C48	48	RTM1P48	$0.40
$1.71	RTM1C49	49	RTM1P49	$0.71
$1.15	RTM1C50	50	RTM1P50	1.15
$0.73	RTM1C51	51	RTM1P51	$1.73
$0.44	RTM1C52	52	RTM1P52	$2.44
$0.24	RTM1C53	53	RTM1P53	$3.24
$0.13	RTM1C54	54	RTM1P54	$4.13

Starting Option Prices for Two-month Expiration

Call Price	Call Ticker	Strike Price	Put Ticker	Put Price
$5.18	RTM2C45	45	RTM2P45	$0.18
$4.31	RTM2C46	46	RTM2P46	$0.31
$3.51	RTM2C47	47	RTM2P47	$0.51
$2.79	RTM2C48	48	RTM2P48	$0.79
$2.16	RTM2C49	49	RTM2P49	$1.16
$1.63	RTM2C50	50	RTM2P50	1.63
$1.19	RTM2C51	51	RTM2P51	$2.19
$0.85	RTM2C52	52	RTM2P52	$2.85
$0.59	RTM2C53	53	RTM2P53	$3.59
$0.39	RTM2C54	54	RTM2P54	$4.39

All securities are priced by market-makers who will always quote a bid-ask spread of 2 cents (i.e. $49.99*$50.01 for the RTM, or $4.08*$4.10 for the RTM1C46). The bids and asks are for very large quantities (there are no liquidity constraints in this case).

The price of RTM follows a random-walk and the path is generated using the following process:

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

The price of the stock is based on the previous price multiplied by a return that is drawn from a normal distribution with a mean of zero and standard deviation (volatility) of $\sigma_t = 20\%$ (on an annualized basis).

The trading period is divided into 8 weeks, with $t = 1 \ldots 75$ being week one, $t = 76 \ldots 150$ being week two, and so on. At the beginning of each week, the volatility value (σ_t) will shift and the new value will be provided to participants. In addition, at the middle of each week (e.g. $t = 38$) an analyst estimate of next week's volatility value will be announced.

Sample News Release Schedule

Time	Week	Release
1	Week 1	The realized volatility of RTM for this week will be 20%
1	Week 1	The delta limit for this sub-heat is 10,000
38	Week 1	The realized volatility of RTM for next week will be between 27-30%
76	Week 2	The realized volatility of RTM for this week will be 29%
…	…	…
526	Week 8	The realized volatility of RTM for this week will be 26%

The observed and tradable prices of the options will be based on a computerized market-maker posting bids and offers for all options. The market maker will price the options using the Black-

Scholes model. It is important to note that the case assumes a risk-free rate of 0%. The volatility forecasts made by the market maker are uninformed and therefore will not always accurately reflect the future volatility of RTM. Mispricing will occur, creating trading opportunities for market participants. These opportunities could be between specific options with respect to other options, specific options with respect to the underlying, or all options with respect to the underlying.

The focus of this case is on trading volatility without being exposed to price changes of the underlying security, RTM. Participants are therefore required to manage their portfolio's delta exposure. Recognizing the transaction costs and impracticality of perfect delta hedging (i.e. keeping the portfolio's delta at zero at all times), the RITC scoring committee will allow the portfolio's delta to be different from zero but it is required to stay between $-\,delta\ limit$ and $+\,delta\ limit$. Please note that $delta\ limit$ is an integer number greater than 1,000 that will be announced at the beginning of the case via a news release in RIT. For example, the following news could be released: "The delta limit for this heat is 5,000 and the penalty percentage is 0.5%". According to that news, any participant that has a portfolio delta greater than 5,000 will be penalized at the penalty percentage of 0.5% according to the penalties explained below.

For every second that a participant exceeds the limit ($+/-delta\ limit$), s/he will be charged a penalty according to the following formula:

$$Penalty\ at\ second\ t = \begin{cases} \left(\left|\Delta_{p,t}\right| - delta\ limit\right) \times p & if\ \left|\Delta_{p,t}\right| > delta\ limit \\ 0 & if\ \left|\Delta_{p,t}\right| \le delta\ limit \end{cases}$$

Where, $\Delta_{p,t}$ is the portfolio's delta at time t and p is the penalty percentage.

Penalties will be applied at the end of each heat but **will not be included** in the P&L calculation in RIT. Participants will be provided with an Excel tool[1], the "Penalties Computation Tool", that will allow them to calculate the penalties using their results from the practice server.

TRADING LIMITS AND TRANSACTIONS COSTS

Each participant 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 in each security type; 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 participants 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

[1] The "Penalties Computation Tool" will be released on the RITC webpage as outlined in the "Important Information" section above.

The maximum trade size will be 10,000 shares for RTM and 100 contracts for RTM options, restricting the volume of shares and contracts transacted per trade to 10,000 and 100, respectively. Transaction fees will be set at $0.02 per share traded for RTM and $2.00 per contract traded for RTM options. As with standard options markets, each contract represents 100 shares (purchasing 1 option contract for $0.35/option will actually cost $35 plus a $2 commission, and will settle based on the exercise value of 100 shares).

POSITION CLOSE-OUT

Any outstanding position in RTM will be closed at the end of trading based on the last-traded price. There are no liquidity constraints for the options nor RTM. All options will be cash-settled based on the following upon expiration:

$$Call\ Option\ Payout = max\{0, S - K\}$$
$$Put\ Option\ Payout = max\{0, K - S\}$$

Where,

S is the last price of RTM;

K is the strike price of the option.

KEY OBJECTIVES

Objective 1

Build a model to forecast the future volatility of the underlying ETF based on known information and given forecast ranges. Participants should use this model with an options pricing model to determine whether the market prices for options are overvalued or undervalued. They should then trade the specific options accordingly.

Objective 2

Use Greeks to calculate the portfolio exposure and hedge the position to reduce the risk of the portfolio while profiting from volatility differentials across options.

Objective 3

Seek arbitrage opportunities across different options and different expiries using calendar spreads.

Electricity Trading Case

Rotman International Trading Competition 2023

OVERVIEW

The Electricity Trading Case provides the opportunity for participants to work in a role-based team environment to engage in an electricity trading market controlled by a strict regulatory policy. Participants are required to forecast the supply and demand of electricity, and execute strategies accordingly while reacting to prevailing market events. Each team will participate in a closed supply and demand market for electricity by producing it using power plant assets and distributing it to customers, and will also have access to a forward market. Through the full cycle of electricity markets, participants will need to dynamically formulate their role-based strategies and optimally perform trade executions.

DESCRIPTION

The Electricity Trading Case will comprise 4 independent heats with 4 team members competing together. Each heat will be 15 minutes long and represent 5 trading days of calendar time. Order submission using the RIT API will be disabled. Data retrieval via Real time data (RTD) links and the RIT API will be enabled.

Parameter	Value
Number of trading heats	4
Trading time per heat	15 minutes (900 seconds)
Calendar time per heat	5 trading days during the first week of August

TEAM ROLES

In this case, each participant will have 1 of 3 specific roles:

- Producer (one per team)
- Distributor (one per team)
- Trader (two per team)

Example:

The team ROTMAN will have 4 trader-IDs (ROTMAN-1, ROTMAN-2, ROTMAN-3, ROTMAN-4), and roles have been assigned according to the list below.

Trader-ID	Role
ROTMAN-1	Producer
ROTMAN-2	Distributor
ROTMAN-3 and ROTMAN-4	Trader

Producers

The Producers own a solar power plant and a natural gas power plant. Each day, Producers will decide how much electricity to produce the next day. For example, day 3 starts at minute 6:01 (6 minutes and 1 second in the simulation); Producers have to decide by the end of day 3 (by minute 9:00 in the simulation) how much electricity to produce over day 4 (which starts at minute 9:01 in the simulation). The decision is made on day 3 and electricity will be produced and delivered the day after (day 4).

Producers will have access to the electricity forward and spot markets. There is one security traded on each market, ELEC-F on the forward market and ELEC-dayX on the spot market. ELEC-F is a forward contract written on the commodity ELEC-dayX with a contract size of 500 MWh[2] and delivery over the next day (day X). For example, if a Producer sells 1 contract of ELEC-F today (day 1), the Producer will have to deliver 500 MWh of electricity (ELEC-day2) to the counterparty the next day (day 2). ELEC-dayX is the electricity spot, where "X" is the day in the simulation. For example, ELEC-day2 is electricity spot on day 2, ELEC-day3 is electricity spot on day 3, etc. ELEC-dayX can be traded on the spot market on each respective day; 1 contract of ELEC-dayX is equal to 100 MWh.

Since electricity cannot be stored, and it has to be disposed[3] in case it is not delivered, Producers should sell the electricity by the end of the day it is produced, either with a forward contract from sale of the previous day, or on the spot market during the day it is produced. For example, if on day 1 the Producers decide to produce 2,000 MWh of ELEC-day2, they will have to deliver 2,000 MWh of electricity on day 2. They can sell 3 contracts of electricity on the forward market on day 1 so that, on day 2, they will deliver 1,500 MWh of ELEC-day2 (recall that each ELEC-F contract size is 500 MWh). On day 2, Producers can also sell 500 MWh of ELEC-day2 spot (which is 5 contracts of ELEC-day2). Combining the 1,500 MWh delivered through the forward contract with the 500 MWh traded spot, the Producers ensured they did not have any excess MWh of electricity that they had to dispose. If they are able to sell only 1,500 MWh of electricity on the forward market and they did not make any trades on the spot market, Producers will have produced 500 MWh more than they sold and they will have to dispose the excess electricity spot on Day 2 (ELEC-day2) of 500MWh.

The solar power plant generates electricity every day depending on how many hours of sunshine there will be during the day. That is, it is possible to produce more electricity using the solar power plant when there are no clouds. The following equation shows the amount of electricity produced by the solar power plant in relation to the number of hours of sunshine:

$$ELEC_{solar} = 6 \times H_{day}$$

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[2] MWh (megawatt per hour) is the unit of measure of electricity.

[3] Disposing electricity means that Producers will be forced to dump the electricity and will not be able to carry it over to the next day. It's equivalent to selling the electricity for $0.

where
$ELEC_{solar}$ is the number of contracts of electricity produced by the solar power plant over the day;
H_{day} is the number of hours of sunshine over the day.

There is no cost for producing electricity using the solar power plant.

Producers cannot shut down the solar power plant but they will be provided with weather forecasts of how many hours of sunshine are expected the following day. Hence, they will be able to forecast how much electricity will be produced by the solar power plant. The weather forecasts received on day 1 will provide information about the weather on day 2. There will be an initial report at the beginning of each day followed by an update at 12:00pm each day (1 minute and 30 seconds after the start of the day in the simulation) and then there will be the final update in the evening (30 seconds before the end of the day in the simulation). The final update will provide Producers with the correct estimates of the number of hours of sunshine the next day. In other words, in the evening, Producers will know exactly how many hours of sunshine there will be the next day.

Producers will have to decide whether to utilize the natural gas power plant based on the expected solar output and the expected demand for electricity. Indeed, if there is strong demand for electricity, Producers can make additional profits by utilizing the natural gas power plant and selling the electricity on the ELEC-F or ELEC-dayX spot market.

In order to produce electricity using the natural gas power plant, Producers have to buy natural gas spot (NG) and then use the natural gas power plant to transform it into electricity. Each NG contract is for 100MMBtu (million British Thermal Unit). The natural gas power plant is able to convert 800 MMBtu into 100 MWh (that is 8 contracts of NG into 1 contract of ELEC-dayX, where X is the following day). For example, Producers can buy 8 contracts (800 MMBtu) of NG on day 1 and then lease and use the natural gas power plant on day 1. On day 2, they will receive 1 contract (100MWh) of ELEC-day2. There is no cost for the Producers to operate this facility. Producers will decide to operate the natural gas power plant today but the electricity will be delivered the day after since it takes time to convert natural gas into electricity.

In addition, the Ministry of the Environment and Climate Change (MECC) has developed policies that discourage Producers from producing more than they are able to sell. Indeed, for each contract of electricity (ELEC-dayX) that is not delivered by the end of day X and needs to be disposed, the MECC will charge a fee of $20,000. The fee will be collected by MECC at the end of each day. For example, if on day 1 a Producer has decided to produce 20 contracts (2,000 MWh) of ELEC-day2 (by combining the solar and natural gas power plants production) but only 3 contracts (1,500 MWh) of ELEC-F were sold on day 1 and no ELEC-day2 spot was sold over day 2, there is an excess of 5 contracts (500 MWh) of ELEC-day2 and MECC will charge $100,000 (=5 contracts x $20,000/contract) over day 2.

Distributors

Distributors carry the electricity from the Producers to their customers (individual consumers and families). Distributors are able to sell electricity for $70/MWh to the customers but they have to buy the electricity from either the forward or the spot market.

Distributors have seen that, historically, the demand for electricity from customers during the month of August is strongly correlated with the temperature. When the temperature is high, consumption of electricity is also high because air conditioning systems tend to be turned on for longer periods of time due to the higher/longer demand for AC. Similarly, when temperatures are lower than average, the consumption of electricity is also lower than average.

Distributors have developed the following model to forecast the consumption of electricity by customers based on the average temperature over the day:

$$ELEC_{customers} = 200 - 15 \times AT + 0.8 \times AT^2 - 0.01 \times AT^3$$

where

$ELEC_{customers}$ is the number of contracts of electricity demanded by the Distributors' customers;
AT is the average temperature (in degrees Celsius) expected next day;
AT^2 is AT to the power of 2 and AT^3 is AT to the power of 3.

Distributors will receive news during the case. This news contains the weather forecasts and will provide information about the expected average temperature for the next day. The weather forecasts received on day 1 will provide information about the weather on day 2. There will be an initial report at the beginning of each day followed by an update at 12:00pm each day (1 minute and 30 seconds after the start of the day in the simulation) and then there will be the final update in the evening (30 seconds before the end of the day in the simulation). The final update will provide Distributors with the correct estimates of the average temperature for the next day. In other words, in the evening Distributors will know exactly what the average temperature will be the next day.

Distributors will have to buy electricity in the ELEC-F or ELEC-dayX markets in order to provide it to their customers. Distributors are strongly encouraged not to buy more electricity than what is needed to satisfy their consumers; otherwise, for each contract of electricity in excess that has to be disposed, they will be charged by the Ministry of the Environment and Climate Change (MECC) the same fee that is applied to the Producers.

In addition, the contractual agreement between the Distributors and their customers includes a clause that will charge a penalty to the Distributors in case they do not meet the demand for electricity from the customers. For example, if the total electricity demanded by the customers is 3,000 MWh (30 contracts) and the Distributors are only able to buy 2,500 MWh (25 contracts) from the ELEC-F and ELEC-dayX markets, there will be 500 MWh (5 contracts) of excess demand for which they will be charged a penalty. The penalty will be calculated according to the following formula at the end of each day:

$$penalty = \$20{,}000 * ED = \$20{,}000 * 5 = \$100{,}000$$

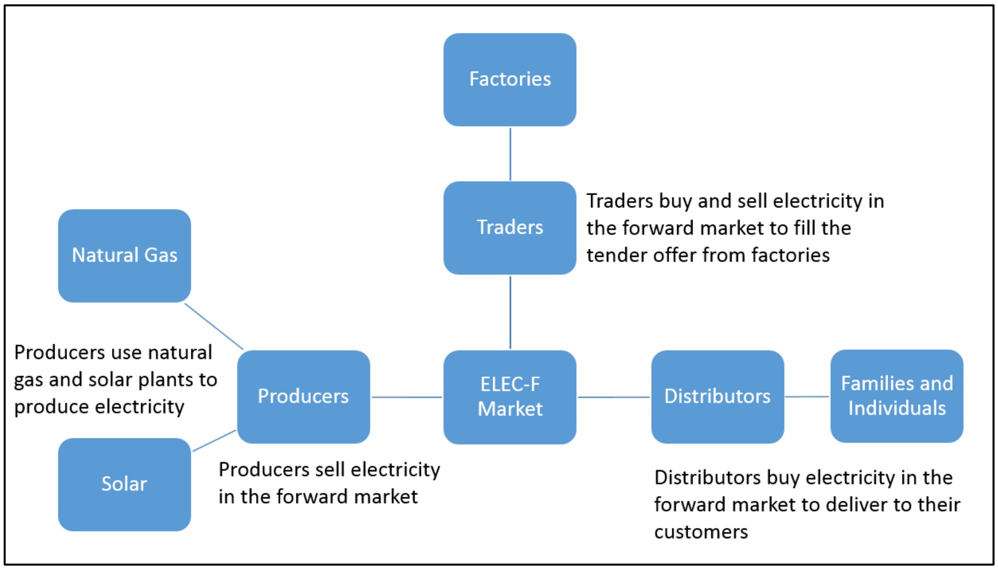
where
ED is the excess demand (expressed in number of contracts) which is the difference between demand for electricity from customers and the electricity that the Distributors bought in the ELEC-F and ELEC-dayX markets.

Traders
During the trading period, Traders will receive institutional orders from some clients who wish to buy or sell large quantities of electricity for the following day. These clients are large factories that intensively use electricity and find it more convenient to buy from the Traders rather than the Distributors. Traders act as the "shock absorber" for the market. They balance the supply and demand and help markets achieve equilibrium. Traders have access to the ELEC-F and ELEC-dayX markets.

Traders will receive "The Factory Tender Report" which describes the expected institutional orders activity via News.

The interaction between different market participants, including their profit maximization objectives and teamwork, is what will largely influence the overall profits of each team. Thus, participants have to optimize the dynamics of each role.

The chart below will summarize the three roles that we have described above.



MARKET DYNAMICS

Producers, Distributors, and Traders will be able to trade the securities according to the table below:

Security	Description	Contract Size	Accessibility	Shortable
ELEC-dayX	Electricity spot on day "X"	100 MWh	Producers, Distributors, Traders	Yes
ELEC-F	Forward for delivery of electricity the day after	500 MWh	Producers, Distributors, Traders	Yes
NG	Natural Gas spot	100 MMBtu	Producers	No

Producers will be able to utilize the following assets:

Asset	Description	Ratio	Conversion Period
NG_POWER_PLANT	Power plant for the production of electricity using natural gas	From 800 MMBtu to 100 MWh	End of day
SOLAR_POWER_PLANT[4]	Solar Panels for the production of electricity	$6 \times H_{day}$	End of Day

Producers will be limited to using 10 natural gas power plants at a time. The natural gas power plant can convert, at a maximum, 80 contracts of NG to 10 contracts of ELEC-dayX. Producers can decide to convert less than 80 NG contracts into ELEC-dayX.

The electricity spot market

The electricity spot market is a market where the prices are controlled by the Regulatory Authority for Electricity (RAE). RAE is an independent entity that regulates, controls and monitors the electricity market. Since electricity cannot be stored and has to be delivered immediately, RAE sets the electricity prices and all market participants will be forced to trade at those prices imposed by the authority.

The RAE will issue a "Price and Volume Bulletin" every day with the forecasted prices for the next day that have been calculated using the expected state of the electricity system, the Producers' offers, and the Distributors' and Traders' demand. The RAE will also have information on the

[4] Please note that the solar power plant will produce electricity every day, which will be distributed as endowment to the Producers in RIT Client. The solar power plant cannot be controlled by Producers and it will not be available in the RIT Client under the module "Assets".

volume of electricity that will be available the next day and will provide this information to the participants. An example "Price and Volume Bulletin" is provided below:

"Given the expected supply and demand in the market, the Regulatory Authority for Electricity board expects that the price for tomorrow will be between $10.00 and $25.00.

There will be 200 contracts available in the entire ELEC market, 100 contracts for buying and 100 contracts for selling. There is a total of 28 Producers, 28 Distributors and 56 Traders in the market.

Please note that the RAE will charge a bid-ask spread of 1 cent."

The RAE issues 2 bulletins per day. The second one will be more accurate than the former since the RAE will have more information to evaluate the supply and demand at noon.

Note that, in the example above, there are only 100 contracts available for buying and 100 contracts available for selling on the spot market. Once participants have bought/sold all the contracts available in the ELEC-dayX market, they will not be able to change their ELEC-dayX position. Participants will be penalized for any open position of ELEC-dayX according to the fines explained above and in the section "POSITION CLOSE OUT" below.

Participants are encouraged to buy/sell electricity on the forward market by trading the security ELEC-F. Waiting until the next day to trade ELEC-dayX on the spot market is much riskier because the volume available to buy/sell will be limited. If participants have any excess electricity in their accounts by the end of the day, they will have to dispose of it.

Please also note that there will be an ELEC-dayX spot market for days 2 through 5 only, as no electricity is produced for delivery on day 1. On day 5, it is possible to produce electricity for day 6 and it is also possible to buy ELEC-F for delivery of electricity on day 6; the settlement of any outstanding position of ELEC-day6 is discussed in the section "POSITION CLOSE OUT" below.

The following is a simplified example of the case:
Assume that on day 1 Producers knew that they would produce 1,500MWh (15 contracts) of electricity for day 2 using the solar power plant (there is no cost for producing electricity using the solar power plant) and also decided to produce 2000 MWh (20 contracts) of electricity using the natural gas power plant at a cost of $14.875/MWh. The average cost for the 3,500 MWh (35 contracts) of electricity produced is $8.5/MWh [=(1,500MWh x $0 + 2,000MWh x $14.875)/(1,500MWh + 2,000MWh)].

On day 1, Distributors have bought 2 contracts (1,000 MWh) of ELEC-F from the Producers and 5 contracts (2,500 MWh) of ELEC-F from the Traders at a price of $40/MWh. Traders initially bought 5 contracts (2,500 MWh) of ELEC-F from the Producers for $25/MWh.

Profit generated by each member (per MWh).

Producers:

Average Selling Price per MWh = $\frac{1000\text{MWh} \times \$40 + 2500\text{MWh} \times \$25}{3500\text{MWh}} \approx \$29.286$

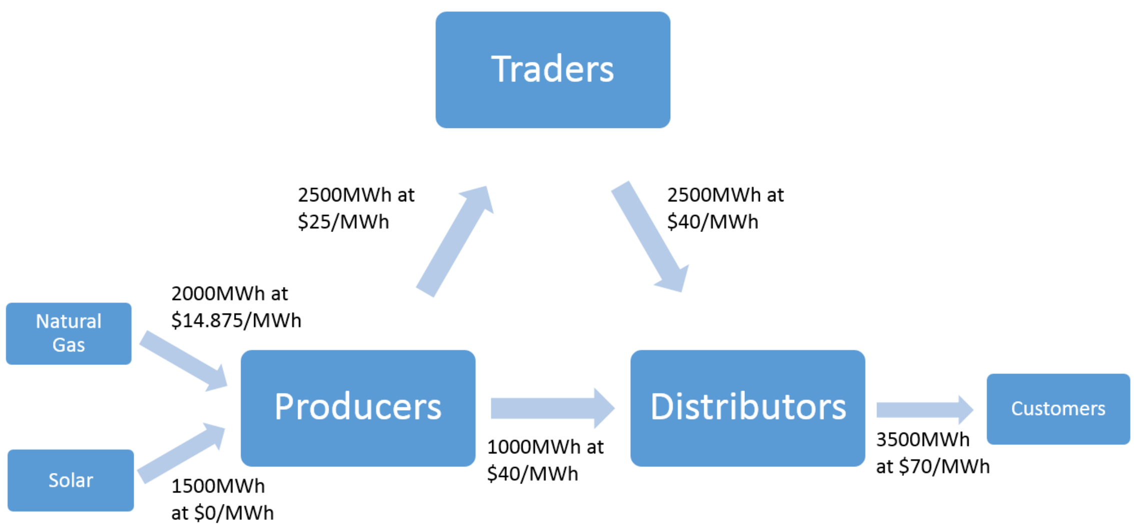
Profit = Average Selling Price per MWh – average cost per MWh = $\$29.286 - \$8.50 = \$20.786$

Distributors:

Profit = Selling price to customers – cost of buying electricity = $\$70 - \$40 = \$30$

Traders:

Profit = Selling price to Distributors – cost of buying electricity = $\$40 - \$25 = \$15$



In the example above, participants were able to trade electricity exclusively on the forward market and they did not need to do any spot transactions. If any of them had an open position of ELEC-day2 at the beginning of day 2, they could trade ELEC-day2 spot in order to close their position. The price at which they could trade will be imposed by the Regulatory Authority for Electricity as explained above.

The following is an example with a spot transaction.

Assume that on day 1 Producers knew that they would produce 1,500 MWh (15 contracts) of electricity for day 2 using the solar power plant (there is no cost for producing electricity using the solar power plant) and also decided to produce 2,000MWh (20 contracts) of electricity using the natural gas power plant at a cost of $14.875/MWh. The average cost for the 3,500 MWh of electricity produced is $8.5/MWh [=(1,500MWh x $0 + 2,000MWh x $14.875)/(1,500MWh + 2,000MWh)].

On day 1, Distributors bought 2 contracts of ELEC-F (each contract is for 500MWh so Distributors bought 1,000 MWh of electricity) from the Producers at a price of $40/MWh. Traders did not buy or sell any ELEC-F contract.

At the end of day 1, Producers will have 2,500MWh of unsold electricity (3,500 MWh produced – 1,000MWh sold to Distributors). At the beginning of day 2, the Regulatory Authority for Electricity declares that the price for ELEC-day2 for the day will be $20/MWh. To avoid penalties, the Producers will sell the remaining 2500MWh of ELEC-day2 at the spot price of $20/MWh.

Profit generated by each member (per MWh).

Producers:

Average Selling Price per MWh = $\frac{1000\text{MWh} \times \$40 + 2500\text{MWh} \times \$20}{3500\text{MWh}} \approx \$25.71$

Profit = Average Selling Price per MWh – average cost per MWh = $\$25.71 - \$8.50 = \$17.21$

Distributors:

Profit = Selling price to customers – cost of buying electricity = $\$70 - \$40 = \$30$

Traders' profits are zero because they did not trade.

TRADING/POSITION LIMITS AND TRANSACTION COSTS

The maximum trade size will be 10 contracts for the security ELEC-F and 80 contracts for the security NG. Producers, Distributors and Traders will be allowed to have at maximum a net position of 300 contracts of ELEC-dayX. Producers will be allowed to have at maximum a net position of 80 contracts of NG. Producers, Distributors and Traders will be allowed to have at maximum a net position of 60 contracts of ELEC-F.

There are no transaction costs to trade ELEC-F and NG. The ELEC-F market will allow participants to submit only rounded integer quotes.

POSITION CLOSE OUT

Each outstanding position of ELEC-day2 through ELEC-day5 will be closed out at a distressed price of $0 at the end of days 2 through 5 respectively. The fee of $20,000/contract from the Ministry of the Environment and Climate Change will be applied to all long positions of ELEC-day2 through ELEC-day5 at the end of days 2 through 5 respectively. A penalty of $20,000/contract will also be applied to all short positions of ELEC-day2 through ELEC-day5 at the end of days 2 through 5 respectively.

At the end of the case (end of day 5), any outstanding positions in ELEC-day6 will be closed at the final RAE price announced during day 5. No fines will be applied to long or short positions of ELEC-day6.

KEY OBJECTIVES

Objective 1

Design a model to calculate the effect of news releases on the supply and demand for electricity. Use this information to make a decision on the optimal level of production of electricity (for Producers' role), the optimal quantity to be delivered to customers (for Distributors' role) and the optimal trader activity to fill the tender offers from factories (for Traders' role).

Objective 2

Maximize profits as a team of Producers, Distributors, and Traders by communicating and sharing private news information with each other.

Note: Since this simulation requires a large number of participants in order to establish supply/demand, practice sessions for this case will be organized and held at specified times (please refer to the "Important Information" section above). After organized practice sessions are completed, cases will be run iteratively for model calibration purposes ("trading skillfully" cannot be practiced unless there are 20+ users online).

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Algorithmic Trading Case

Rotman International Trading Competition 2023

OVERVIEW

The Algorithmic Trading Case is designed to challenge participants' programming skills by developing algorithms using the RIT API to automate trading strategies and react to changing market conditions. Throughout the case, these algorithms will submit orders to profit from arbitrage opportunities and private tender offers. Due to the high-frequency nature of the case, participants are encouraged to develop algorithms that can adapt to rapid changes in market dynamics using their selected programming languages.

DESCRIPTION

There will be 10 heats with 1 team member competing in each heat. Only one team member shall trade to represent the team for all heats. Each heat will be 5 minutes long and represent one month of trading.

Parameter	Value
Number of trading heats	10
Trading time per heat	5 minutes (300 seconds)
Calendar time per heat	one month of trading

Order submission using the RIT API will be enabled. Data retrieval via Real-time Data (RTD) Links and the RIT API will also be enabled. **All trades must be executed by a trading algorithm**. Participants will not be allowed to trade manually through the RIT Client once the heat begins (but they will be allowed to manually use the RIT Client to use Converters – see "Market Dynamics" section below). Participants are allowed to modify their algorithms in response to prevailing market conditions and competition from the algorithms of other teams. They will have 2 minutes between each heat to re-load their algorithms. A base template algorithm will be provided[5] to participants and can be directly modified for use in the competition. However, participants are encouraged to create their own algorithms.

[5] The "Base Algorithm" will be released on the RITC webpage as outlined in the "Important Information" section above.

MARKET DYNAMICS

This case involves five securities with the following details.

Ticker	CAD	USD	BULL	BEAR	RITC
Security type	Currency	Currency	Stock	Stock	ETF
Quote currency	CAD	CAD	CAD	CAD	USD
Starting Price	n/a	n/a	$10	$15	$25
Fee/share (Market orders)	n/a	n/a	$0.02	$0.02	$0.02
Rebate/share (Limit/Passive orders)	n/a	n/a	$0.01	$0.01	$0.01
Max order size	2,500,000	2,500,000	10,000	10,000	10,000

The base currency in this case will be CAD. Therefore, USD will be quoted in a direct exchange rate as the number of CAD required to buy 1 USD.

Participants will be able to trade two stocks denominated in CAD and one ETF denominated in USD with varying levels of volatility and liquidity. This dynamic exposes participants to the basics of market microstructure in the context of algorithmic trading. In equilibrium, the ETF pricing will reflect the following sum of the two stocks traded, subject to periodic shocks to its price. In other words, in equilibrium, the CAD-converted price of the RITC ETF will be the sum of prices of both BULL and BEAR stocks since the ETF is equally weighted.

$$P_{RITC,USD} * USD = P_{BULL,CAD} + P_{BEAR,CAD}$$

Participants will also receive private tender offers for the ETF. Since the decision time to accept or reject a tender offer is very short, participants should build an algorithm to evaluate the profitability of a tender offer to make a decision to accept it or not. Once a tender offer is accepted, a participant's algorithm should also unwind the positions at a profit while managing the market price impact of trades.

In addition, there will be two Converters[6] available to facilitate a conversion between the underlying stocks and the ETF. Participants should consider using these Converters as an alternative approach to manage the liquidity risk associated with submitting orders directly to the market. Please note that these Converters can only be used by human traders: you will be able to use them from the RIT Client manually but your algorithm will not be able to use them automatically through the API.

[6] The two Converters are available from the "Assets" tab on the RIT Client.

Converters	Description	Convert From	Convert To	Cost
ETF-Creation	ETF creation from underlying stocks	10,000 BULL stocks and 10,000 BEAR stocks	10,000 units of RITC	$1,500 USD/use
ETF-Redemption	ETF redemption to underlying stocks	10,000 units of RITC	10,000 BULL stocks and 10,000 BEAR stocks	$1,500 USD/use

TRADING/POSITION LIMITS AND TRANSACTION COSTS

Each trader will be subject to gross and net trading/position limits during trading in each heat. The gross limit reflects the sum of the absolute values of the long and short positions across all securities, and the net limit reflects the sum of long and short positions such that short positions negate any long positions. Trading/position limits will be strictly enforced and participants will not be able to exceed them. Each position in the stocks will be counted towards trading/position limits with a multiplier of one, while each position in the ETF will be counted with a multiplier of two. For example, if you long 100 shares of any stocks, your gross and the net limits will increase by 100. If you buy 100 shares of RITC, your gross and net limits will increase by 200 (100 shares * multiplier of two).

The maximum trade size will be 10,000 shares per order for both stocks and the ETF. Transaction fees will be set at $0.02 per share for each stock and the ETF on all market orders filled. A rebate of $0.01 per share for each stock and the ETF will be provided for all submitted limit orders that are filled.

POSITION CLOSE-OUT

Any non-zero position of stocks will be closed out at the end of trading based on the last traded price while the ETF will be closed out at the fair value which is the sum of the component stock prices converted to CAD.

KEY OBJECTIVES

Objective 1

Create an algo model using the provided template to identify the profitability of private tender offers and execute trades accordingly while managing liquidity risk and market risk. Consider utilizing ETF-Creation and ETF-Redemption Converters as an alternative approach to mitigate liquidity risk when working a private tender offer.

Objective 2

Build a trading algorithm that identifies arbitrage opportunities between underlying stocks and the ETF. Consider trading CAD and USD in order to hedge the currency exchange rate exposure.

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Liquidity Risk Case

Rotman International Trading Competition 2023

OVERVIEW

The Liquidity Risk Case challenges participants to put their critical thinking and analytical abilities to test in an environment that requires them to evaluate the liquidity risk associated with tender offers. Participants will be faced with multiple tender offers throughout the case. This will require participants to make rapid judgments on the profitability, subsequent acceptance and execution, or rejection, of each offer. Profits can be generated by taking advantage of price differentials between market prices and prices offered in the private tenders. Once any tender has been accepted, participants should aim to efficiently close out their large positions to maximize returns and minimize liquidity and market risks.

DESCRIPTION

There will be 5 independent heats with all four team members participating in each heat. All team members have the same role. Each heat will be 10 minutes long and represent one month of calendar time. Each heat will may involve up to four stocks with different volatility and liquidity characteristics.

Parameter	Value
Number of heats	5
Trading time per heat	10 minutes (600 seconds)
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. Participants must subsequently evaluate the profitability of these tenders when accepting or bidding on them. Order submission using the RIT API will be disabled. Data retrieval via Real-time Data (RTD) Links and the RIT API will be enabled.

MARKET DYNAMICS

There are five heats, each with unique market dynamics and parameters as shown below.

HEAT 1		
Securities	**RITC**	**COMP**
Start Price	$50	$40
Commissions	$0.02	$0.02
Tender Offer Window	30 Seconds	30 Seconds
Volatility	Low	Medium
Liquidity	Medium	High

HEAT 2		
Securities	**CLBR**	**EDTN**
Start Price	$15	$30
Commissions	$0.01	$0.01
Tender Offer Window	30 Seconds	30 Seconds
Volatility	High	Low
Liquidity	Medium	Low

HEAT 3			
Securities	**BLU**	**RED**	**GRN**
Start Price	$10	$25	$30
Commissions	$0.04	$0.03	$0.02
Tender Offer Window	30 Seconds	30 Seconds	30 Seconds
Volatility	High	Low	Medium
Liquidity	High	Medium	Medium

HEAT 4			
Securities	**WDY**	**BZZ**	**BNN**
Start Price	$12	$18	$24
Commissions	$0.02	$0.02	$0.03
Tender Offer Window	20 Seconds	20 Seconds	20 Seconds
Volatility	Medium	High	Medium
Liquidity	High	Medium	Medium

HEAT 5				
Securities	**VNS**	**MRS**	**JPTR**	**STRN**
Start Price	$20	$75	$35	$50
Commissions	$0.02	$0.02	$0.02	$0.02
Tender Offer Window	20 Seconds	20 Seconds	20 Seconds	20 Seconds
Volatility	High	Medium	Low	High
Liquidity	Medium	High	Medium	Medium

During each heat, participants will occasionally receive one of three different types of tender offers: private tenders, competitive auctions, and winner-take-all tenders. Tender offers are generated by the server and randomly distributed to random participants at different times. Each participant will get the same number of tender offers with variations in price and quantity. No trading commission will be paid on tender offers.

Private Tenders are routed to individual participants and are offers to purchase or sell a fixed volume of stocks at a fixed price. The tender price is influenced by the current market price.

Competitive Auction offers are sent to all participants at the same time. Participants will be required to determine a competitive, yet profitable, price to submit for a given volume of stocks from the auction. Any participant that submits an order that is better than the base-line reserve price (hidden from participants) will automatically have his/her order filled, regardless of other participants' bids or offers. If accepted, the transactions will occur at the price that the participant submitted.

Winner-Take-All Tenders request participants to submit bids or offers to buy or sell a fixed volume of stocks. After all prices have been received, the tender is awarded to the participant with the single highest bid or single lowest offer. The winning price, however, must meet a base-line reserve price (hidden from participants). If no bid or offer meets the reserve price, then the trade will not be awarded to anyone (e.g. if all participants bid $2.00 for a $10.00 reserve price stock, nobody will win).

CALCULATION OF THE PROFIT OR LOSS OF TRADERS

The prices generated by 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 case 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 stocks without "taking a bet". Therefore, the RITC-CE scoring committee will consider trading stocks 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 flagged as "speculative trades".

Participants will have time to think about the tender offer before they choose to accept it or decline it and the time may be different for each security. For example, one may receive a tender offer at time $t = 0$ and will have until $t = 30$ to decide whether to accept or decline. Any trades for that security made by a participant during this time without accepting or declining the tender offer will be considered as "*front-running*"[7] since the participant had the advance knowledge of a pending institutional order. The RITC-CE scoring committee will flag these trades as "front-running trades".

This case is designed to only reward participants for identifying, accepting, and closing out[8] tender offer positions at a profit, while managing liquidity risk and execution risk. Any other strategy will not be considered. In particular, the total profit of each participant[9] 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 speculative trades and/or front-running trades.

[7] 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.
[8] "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.
[9] Total profit of each participant is the profit (or loss) that you can observe in the RIT Client at the end of a heat.

Profits from tender offers 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:

$$Adjusted\ P\&L\ =\ P/L\ From\ Tenders\ +\ Min(0, P/L\ From\ Speculation)$$

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 only be $\$10{,}000$ [$= \$10{,}000\ +\ min(0, \$50{,}000)$]. In 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 equal to the $Adjusted\ P\&L$ [$\$15{,}000\ =\ \$35{,}000\ +\ min(0, -\$20{,}000)$]. Any losses from speculation <u>will be included</u> while profits from speculation <u>will **not** be included</u>.

The $Adjusted\ P\&L$ will be calculated by the RITC-CE scoring committee at the end each heat and <u>will **not** be included</u> in the P&L calculation in RIT. However, participants will be provided with an Excel tool [10], the "Performance Evaluation Tool", that will allow them to calculate their $Adjusted\ P\&L$ while practicing.

TRADING LIMITS AND TRANSACTION COSTS

Each participant will be subject to gross and net trading limits of 250,000 and 150,000 shares, respectively. The gross trading limit reflects the sum of the absolute values of the long and short positions across all stocks, 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.

The maximum order size is 10,000 shares and commissions are specified in the table above.

POSITION CLOSE-OUT

Any open position will be closed out at the end of each heat 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.

[10] The "Performance Evaluation Tool" will be released on the RITC webpage as outlined in the "Important Information" section above.

KEY OBJECTIVES

Objective 1
Evaluate the profitability of tender offers by analyzing market liquidity. Participants should accept tenders that are expected to generate positive profits while rejecting unattractive tender offers.

Objective 2
Submit competitive, yet profitable, bids and offers for competitive auction and winner-take-all tenders to maximize potential profits while managing liquidity and market risk.

Objective 3
Use a combination of limit orders, market orders, and marketable limit orders to mitigate liquidity and price risks from holding open positions. There is a chance that the market may move away from your transaction prices, so maintaining large open positions may result in losses.

Scoring Methodology

Rotman International Trading Competition 2023

OVERVIEW

The scoring and ranking methodology is designed to translate absolute performance into relative performance by the use of a ranking system. This ranking system is designed to discourage participants from "betting the house" in one heat and generating very large absolute profits that will result in a clear win of the entire competition. Instead, participants' absolute performance in each heat is converted into a series of ordinal ranks which are subsequently converted into a final case ranking. These case rankings are mapped to case scores and then combined under the following weights:

Case	Weight
Volatility Trading Case	25%
Electricity Trading Case	25%
Liquidity Risk Case	25%
Algorithmic Trading Case	25%

The scoring system is not intended to be extremely complex. However, throughout the trading competition there will be over 2,000 separate trading results. These results must then be averaged and ranked over several iterations to compute a final ranking and score. This document describes that process.

The purpose of the system is to reward consistently high performance (i.e. a team that places 8th, 5th, and 10th will have a higher final score than a team that places 1st, 10th, and 35th).

Volatility Trading Case and Liquidity Risk Case

For each heat, the final profits and losses (P&L)[11] of all participating members[12] of a team are summed to form a dollar value of the team P&L. The teams are then ranked for each heat by the dollar values of the team P&L with 1st place given to the team with the highest dollar value. In the event of a tie, the teams that have tied will be given the same rank. The teams below the tie will be given a rank based on the number of teams that have scored better than them. Therefore, if three teams tied for 2nd place, the ranking for the top five teams would be 1st, 2nd, 2nd, 2nd, and 5th.

Each team's heat ranks are then averaged. Teams are then ranked based on their average heat rank to determine their final case rank. The team with the lowest average will be ranked first.

This case ranking is then mapped to a point score where the lowest rank (best score) is given a score of n+1, where n is the number of teams below you plus the teams that tied with you (i.e. the first place team out of 52 teams will get a score of 52, the last place team will get a score of 1). To continue the above example, if you are tied for 2nd place with three other teams, you will get a score of 51.

[11] For the Liquidity Risk Case, the **Adjusted P&L** (as described in this Case Package) will be used.
For the Volatility Trading Case, the P&L (as shown in the RIT) will **be decreased by the sum of penalties** received by each team member as described in this Case Package.

[12] **Two** team members for the Volatility Trading Case and **four** team members for the Liquidity Risk Case

Electricity Trading Case

The final P&L of each team member will be summed to form a dollar value of the team P&L. The teams are then ranked for each heat by the dollar values of the team P&L, with first place awarded to the team with the highest dollar value. In the event of a tie, the teams that have tied will be given the same rank. The teams below the tie will be given a rank based on the number of teams that have scored better than them. Therefore, if three teams tied for 2nd place, the ranking would be 1st, 2nd, 2nd, 2nd, and 5th.

Based on the above, each team's heat ranks will be averaged and then the resulting averages will be ranked to determine their overall case rank. The team with the lowest average will be ranked first. This case ranking is then mapped to a point score where the lowest rank is given a score of n+1, where n is the number of teams below you plus the teams that tied with you.

Algorithmic Trading Case

Only one member from each team will be required to participate in the Algorithmic Trading Case. The final P&L of the participating team member will become the team P&L, which will be then ranked for each heat with first place awarded to the team with the highest dollar value. In the event of a tie, the teams that have tied will be given the same rank. The teams below the tie will be given a rank based on the number of teams that have scored better than them. Therefore, if three teams tied for 2nd place, the ranking would be 1st, 2nd, 2nd, 2nd, and 5th.

Based on the above, each team's heat ranks will be averaged and then the resulting averages will be ranked to determine the final case rank. The team with the lowest average will be ranked first. This case ranking is then mapped to a point score where the lowest rank is given a score of n+1, where n is the number of teams below you plus the teams that tied with you.

Final Score

The final case scores are then multiplied by their case-weights to form a final weighted score. This final weighted score is used to rank teams, where the highest score is the best score. In the case of two or more teams having the same final weighted score, those teams will be ranked based on the variance of their final case scores. The team with the lowest variance will be ranked ahead of the others. For example, if the top 3 teams have the following scores:

	Final Case Scores				
Team	**MATLAB Volatility**	**Electricity**	**Liquidity Risk**	**Algo**	**Final Weighted Score**
Team 1	52	48	50	50	**50.0**
Team 2	50	47	46	50	**48.3**
Team 3	49	48	50	46	**48.3**

Team 1 will be ranked first as it has the highest weighted score. Team 2 and Team 3 have the same final weighted score and will be ranked based on the variance of their case scores. The variance for Team 2 is 4.3 while the variance for Team 3 is 2.9, therefore Team 3 will be ranked second while Team 2 will be ranked third.

Final Rank	Team
1	Team 1
2	Team 3
3	Team 2

Two (or more) teams that have the same score and the same variance will tie. In the event of a tie, the teams that have tied will be given the same rank. The teams below the tie will be given a rank based on the number of teams that have scored better than them. Therefore, if three teams tied for 2nd place, the ranking would be 1st, 2nd, 2nd, 2nd, and 5th.

Awards

The top three ranking teams will receive the following cash prizes:

- 1st place team: $5,000 CAD
- 2nd place team: $2,500 CAD
- 3rd place team: $1,000 CAD