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Rotman EUROPEAN TRADING COMPETITION 2018

Case Package

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About RETC

The Rotman European Trading Competition (RETC) is a two and a half day event that allows teams from universities across Europe to participate in a simulated market. Its structure is similar to the very successful Rotman International Trading Competition (RITC) held annually in Toronto, where 52 schools from around the world meet and compete in simulated markets.

The competition is predominantly structured around the Rotman Interactive Trader (RIT) platform that creates a simulated electronic market where participants trade with one another. The competition cases, designed by the Rotman RIT development team, test the participants' ability to model risks and opportunities and make effective real-time decisions when confronted with a range of market scenarios.

The following case package provides an overview of the content to be presented at the 2018 Rotman European Trading Competition. Each case has been specifically tailored to tackle topics in university level classes and real-life trading situations. We hope you enjoy your experience at the competition.



SEE YOU IN ROME!

Important Information

PRACTICE SERVERS

Practice servers will be made available starting from July 27th. We will introduce the actual cases in a staggered manner - not all cases will be available on July 27th. Further information on release dates can be found below and more information will be posted on the RETC website.

Case	Release date
Intesa Sanpaolo Liquidity Risk Case	Friday, July 27th – 5:59am CET
EIB Interest Rate Case	Saturday, July 28th – 5:59am CET
Credit Risk Case	Saturday, July 28th – 5:59am CET
Quantitative Outcry Case	Monday, July 30th – 5:59am CET
Enel Electricity Case	Tuesday, July 31st – 5:59am CET

Practice servers will operate 24 hours a day 7 days a week until 11:00pm CET on Thursday, August 23rd. Information on how to download and install the RIT Client is available on the RIT website at http://rit.rotman.utoronto.ca/software.asp.

The following table lists the server IP and ports available for RETC practice environments:

Case	Server IP	Port
Intesa Sanpaolo Liquidity Risk Case	flserver.rotman.utoronto.ca	16500
EIB Interest Rate Case	flserver.rotman.utoronto.ca	16510
Credit Risk Case	flserver.rotman.utoronto.ca	16520
Quantitative Outcry Case	flserver.rotman.utoronto.ca	16530
Enel Electricity Case	flserver.rotman.utoronto.ca	16540

To log in to any server port, 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.

Please note that the market dynamics in practice and in the competition cases will be the same. Price paths will be different during the competition. In addition, market parameters during the competition may be adjusted to better account for over 100 live traders.

The Credit Risk Case and the EIB Interest Rate Case will have three different scenarios of news and price paths running on the practice server, which will be randomly loaded each time they are run on the practice server. The Intesa Sanpaolo Liquidity Risk Case has no news drivers but is comprised of new, randomized sets of security paths each time it is run.

We will be running four "special" practice sessions for the cases. On August 7th at 11:59am CET, we will run a single iteration of the Enel Electricity Case. On August 14th at 4:00pm CET, August 16th at 4:00pm CET, and August 21st at 4:00pm CET, we will run the practice sessions for all competition cases (except for the Quantitative Outcry Case), so all teams are invited and encouraged to connect at the same time as the results will be released from each practice case. The instructions to connect to these special practice sessions will be sent via e-mail to the participants individually along with login credentials prior to the practice sessions.

SCORING AND RANKING METHODOLOGY

The Scoring and Ranking Methodology document will be released prior to the start of the competition on the RETC website. An announcement will be sent out to participants when the document is available.

COMPETITION SCHEDULE

This schedule is subject to change prior to the competition. Participants can check on the RETC website for the most up-to-date schedule. Each participant will also receive a personalized schedule when s/he arrives at the competition.

TEAM SCHEDULE

Participants must submit a team-schedule by Wednesday, August 8th at 11:59pm CET. This schedule will specify which team members will participate in certain RETC events and will specify each team member's role in the Enel Electricity Case. It is the team's responsibility to organize and schedule appropriately so that conflicts (for example, simultaneously trading for multiple roles) are avoided. Schedules submitted by Wednesday, August 8th are considered final and substitutions following that date will not be permitted except under extenuating circumstances. Further instructions on how to submit your team schedule will be sent via email.

COMPETITION WAIVERS

Each participant is required to sign a competition waiver prior to his/her participation at RETC. These will be e-mailed to you (to be signed and returned by Wednesday, August 15th).

Case Summaries

SOCIAL OUTCRY CASE

The opening event of the competition gives participants their first opportunity to make an impression on sponsors, faculty members, and other teams in this fun introduction to the Rotman European Trading Competition. Each participant trades against one another as well as faculty and experienced professionals from industry, trying to make his/her case and showcasing his/her outcry skills by making fast and loud trading decisions.

QUANTITATIVE OUTCRY CASE

Building on the experience of the frantic Social Outcry Case market, this case requires teams to optimize their trading, analytical, and risk management skills. Participants will use news releases that provide quantitative economic forecasts, as well as qualitative micro and macro data, to predict the futures market on the RT100 index. Analyzing macroeconomic indicators, participants should be able to gain an understanding of the impact of the factors on the index and generate profitable trades.

Enel ELECTRICITY CASE

The Enel Electricity Case challenges the ability of participants to interact with one another in a closed supply and demand market for electricity. Electricity production and its consumption will form the framework for participants to engage in direct trade to meet one another's objectives. The case will test each individual's ability to understand sophisticated market dynamics and optimally perform his/her role, while stressing teamwork and communication.

INTESA SANPAOLO LIQUIDITY RISK CASE

The Intesa Sanpaolo Liquidity Risk Case challenges participants to put their critical thinking and analytical abilities to the test in an environment that requires them to evaluate the liquidity risk associated with different tender offers. Participants 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 price premiums and discounts associated with large tender offers compared to the market.

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 companies' credit ratings. Periodic news updates will compel participants to make appropriate adjustments to the assumptions in their models and rebalance their portfolios accordingly. This case tests participants' abilities 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.

EIB INTEREST RATE CASE

The EIB Interest Rate Case challenges traders' understanding of bond pricing based on news and benchmark interest rates derived from 4 non-tradable EIB zero-coupon bonds. Traders have to price 3 tradable coupon bonds based on the benchmark rates and news. The news, released throughout the case, may have an impact on the benchmark rates, and thus also have an impact on the fair prices of the tradable coupon bonds. Traders should forecast the impact of news on the benchmark rates and exploit any bond mispricing opportunities to generate profits.

Social Outcry Case

OVERVIEW

The objective of the Social Outcry Case is to allow participants to interact ("break the ice") and to recognize how far financial markets have evolved technologically. The Social Outcry will be an exciting way for participants, professors and sponsors to interact with one another as well as a great preparation for the Quantitative Outcry Case. Participants will trade individually and not as a team. Participants will be ranked based on their individual profits at the end of the case. Participants' performance in the Social Outcry Case will not count towards their final scoring of RETC.

DESCRIPTION

Each participant will start the session with a neutral futures position. Participants are allowed to go long (buy) or go short (sell). All trades will be settled at the closing spot price.

MARKET DYNAMICS

Participants will trade futures contracts on an index, the RT100. The futures price will be determined by the market's transactions while the spot price will follow a stochastic path subject to influence from qualitative news announcements that will be displayed on a screen. News announcements will be displayed one at a time, and each news release will have an effect with uncertain direction and length (favourable news will result in an increase in the spot price while unfavourable news will cause a decrease in the spot price, and these reactions may occur instantly or with lags). Participants are expected to trade based on their interpretation of the news and on their expectations of market reactions.

TRADING LIMITS AND TRANSACTION COSTS

There are no trading commissions or fines for the Social Outcry Case. Participants are allowed to trade a maximum of 5 contracts per trade/ticket. The contract multiplier of RT100 futures is $10. There are no limits to the net position that participants can have.

RULES AND RESPONSIBILITIES

The following rules apply throughout the Social Outcry Case:

- Market agents are RETC staff members at the front of the outcry pit collecting tickets.
- Once parties have verbally committed to a trade, they are required to transact.
- All tickets must be filled out completely and legibly, and verified by both parties. Illegible tickets will be ignored by the market agents!

- Both transacting parties are responsible for making sure that the white portion of the ticket is received by the market agent. The transaction will **not** be processed if the white portion is not submitted or is damaged. Both trading parties must walk the ticket up to the market agent for the ticket to be accepted.
- Only the white portion of the ticket will be accepted by the market agent; trading receipts (pink and yellow portions) are for the participants' records only.
- RETC staff reserve the right to break any unreasonable trades.
- Any breaches of the above stated rules and responsibilities are to be reported to the market agent or floor governors immediately.
- All communications must be in English.

POSITION CLOSE OUT AND CASE SCORING

Each person's trades will be settled at the close of trading based on the final spot price. The ranking is based on the total profit and loss (P&L) from the trading session. There are no commissions or fines in the Social Outcry Case.

Example:
Throughout the trading session, one participant has made the following trades:

Buy 2 contracts @ 998
Sell 5 contracts @ 1007
Buy 1 contract @ 1004

The market closed out @ 1000. The P&L for the participant is then calculated as follows:

2 long contracts @ 998
$P\&L: (1000 - 998) * 2 * \$10 \; = \; \$40$

5 short contracts @ 1007
$P\&L: (1000 - 1007) * (-5) * \$10 \; = \; \$350$

1 long contract @ 1004
$P\&L: (1000 - 1004) * 1 * \$10 \; = \; -\$40$

The participant has made a total P&L of $350.

COMPLETE TRANSACTION AND SOCIAL OUTCRY LANGUAGE EXAMPLE

To find the market, participants simply yell "What's the market?" If someone wants to make the market on the bid side, s/he can answer "bid 50" meaning s/he wants to buy at a price ending with

50 (e.g. 950 or 1050), whichever is closest to the last price. If someone wants to make the market on the ask side, s/he will yell “at 51” meaning s/he wants to sell at a price ending with 51 (e.g. 951 or 1051), whichever is closest to the last price. Note that so far, no quantity has been declared, only two digits are required when calling the bid or ask. To complete a trade, for example, someone willing to take the ask can simply say “bought two” to the person selling. The seller’s response must then be: “sold two” (or any other quantity below 2, but not 0, at the seller’s discretion). After the seller and the buyer fill out the trade ticket and submit the white part to our competition staff whose role is a ticket taker, the trade is complete. Please note that the “market maker” (participant announcing the bid or ask price) gets to decide the quantity traded up to a maximum of the quantity requested by the “market taker” (participant taking the price).

A complete transaction could run as follows:

Trader 1	“What’s the market?”
Trader 2	“bid 70, at 72” or “70 at 72”, (bid 1070, ask 1072, this trader wants to buy and sell)
Trader 3	“at 71” (the new market is 1070 to 1071)
Trader 1 to Trader 3	“Bought 5” (he/she wants to buy 5 contracts at 1071)
Trader 3 to Trader 1	“Sold 3” (Although trader 1 wanted to buy 5 contracts, trader 3 only wants to sell 3 contracts so trader 1 must accept the three contracts).
Trader 1 or Trader 3	S/he fills out the trade ticket with initials from both trader 1 and trader 3. The white portion of the ticket is submitted to the market agent by **both** traders (both traders walk the ticket up to the front of the trading floor to the market agent). Trader 1 (Buyer) keeps the yellow portion of the ticket and trader 3 (Seller) keeps the pink portion of the ticket.

There will be a brief outcry practice and demonstration before the Social Outcry on the first day of the competition.

Quantitative Outcry Case

Overview

The Quantitative Outcry Case challenges participants to apply their understanding of macroeconomics to determine the effect of news releases on the world economy as captured by the Rotman Index ("RT100"). The RT100 Index is a composite index reflective of global political, economic, and market conditions. Participants will be required to interpret and react to both quantitative and qualitative news releases based on their analysis of the news' impact on the index by trading futures.

Description

There will be 2 heats with 4 team members competing for each entire heat. A team will comprise of 2 analysts and 2 traders who will rotate positions for the second heat. Team members acting as traders in the first heat must act as analysts in the second heat and vice versa. Each heat will last 30 minutes and represents six months of calendar time. Traders will be trading futures contracts on the RT100 Index.

Parameter	Value
Number of trading heats	2
Trading time per heat	30 minutes
Calendar time per heat	6 months (2 quarters)

Two traders will be located in the trading pit while two analysts will be located in the Matroneo (2nd floor). Analysts will have access to detailed news releases via RIT Client, while traders in the pit will have access only to news headlines displayed on a screen. It will be the role of the analysts to quantify the impact of news releases on the RT100 Index, while traders will be required to react and trade according to the analysts' instructions.

As analysts and traders will be on separate floors, it is essential for teams to develop non-verbal communication strategies. **Electronic devices are not permitted during this case.**

Market Dynamics

The value of the RT100 Index is determined by the quarterly GDP growth, in billions, of the following 4 economies**: Germany, France, Italy, and Spain.** Each country's GDP contributes to a percentage of the RT100 Index.

The initial level of RT100 is 1,000 at t=0. The RT100 Index is quoted in units and the futures contracts are written on the RT100 Index. The contract multiplier for RT100 futures is $10. Therefore, 1 futures contract is worth $10*RT100 Index. If the RT100 Index is at 995 and a trader owns 1 future contract, his/her position will be worth $9,950 (= $10*995).

Economic statistics for each of the countries are released throughout the case, and will determine the exact trading level of the RT100 Index at the midpoint and at the end of each heat (15-minute and 30-minute of each heat, equivalent to 3 months and 6 months in calendar time). There is no exchange rate risk (all values are expressed in the same currency).

The value of the RT100 Index at t=15 minutes is calculated by the following formula:

$$RT100_{Value\ at\ t=15} = 1000 + Germany_{(Actual\ Q1\ GDP - Previous\ Q1\ GDP)} + France_{(Actual\ Q1\ GDP - Previous\ Q1\ GDP)} + Italy_{(Actual\ Q1\ GDP - Previous\ Q1\ GDP)} + Spain_{(Actual\ Q1\ GDP - Previous\ Q1\ GDP)}$$

In other words, every $1 billion of actual year-over-year GDP increase will cause a 1 point increase in the RT100 Index. Consequently, every $1 billion of actual GDP shortfall will cause a 1 point decrease in the RT100 Index.

The quarterly GDP for each country is comprised of aggregate production in three independent sectors: Manufactured Goods, Services, and Raw Materials. At the beginning of the case, estimates for the quarterly GDP of each country and sector will be released. Throughout each quarter, news releases will provide estimates and information that will allow analysts to construct expectations for each country and each sector.

The following is a sample series of data for Q1 Italy:

- Italian Q1 GDP last year was $100 billion. This year in Q1, the market expects manufactured goods of $30 billion, services of $60 billion, and raw materials of $10 billion.
- General workers protest hits Italy manufacturing sector, causing minor production delays.
- Strong global commodities prices lift raw materials output across the globe by as much as 10%.
- New policies cause $7 billion increase in services spending.
- RELEASE –Italian Manufacturing for Q1: $28 billion
- RELEASE – Italian Services for Q1: $67 billion
- RELEASE – Italian Raw Materials for Q1: $11 billion

The sum of the independent sectors, and thus the resulting Q1 Italian GDP, is $106 billion. This is $6 billion above last year's Q1 GDP of $100 billion and would cause the RT100 Index to increase by 6 points. This, in addition to the effects of the other 3 countries, will determine the RT100 Index at the 15-minute mark (and then at the 30-minute mark).

TRADERS' ROLES

Traders are responsible for interpreting the signals from the analysts located in the Matroneo and for trading the RT100 index. Traders will have to find other teams who are willing to act as counterparties to complete their trades. Traders are also responsible for keeping track of their position and communicating it to analysts.

ANALYSTS' ROLES

Analysts are responsible for interpreting the detailed news they receive on the RIT Client and communicating their findings to the traders in the trading pit. Analysts are also responsible for submitting analyst estimate forms (refer to the Cash Bonuses section below for more details) and making spot trades.

<u>Spot Trades</u>

In addition to the transactions executed by traders in the trading pit, analysts in the Matroneo are allowed to make up to 2 spot trades per heat, with a maximum of 50 contracts in each trade. The spot trades will be executed at the current spot price of the RT100 Index posted on the screen. The spot contract has a contract multiplier of $10. Therefore, if an analyst owns 1 spot contract when the RT100 Index is at 1,023, his/her position will be worth $10,230 (= $10*1,023).

The spot trades allow each team to have an opportunity to close out their positions in a timely manner. Moreover, since the futures market will be driven by trader activity, while the spot market is based on the actual economic indicators realized, there may be arbitrage profit opportunities arising from inefficiencies in the two markets (the actual market and the spot market). These trades are added to the aggregate futures position of the team. The soft and hard trading restriction limits discussed below also apply to Spot Trades made by analysts in the Matroneo.

CASH BONUSES

<u>Analyst Estimates</u>

Throughout each heat, analysts will be required to submit a point estimate of where they believe the RT100 Index will settle at the 15 and 30 minute marks. These estimates are due by the 10 and 25 minute marks, respectively (i.e. 5 minutes before the end of the quarter). These time limits will be tracked solely based on the trading software. Participants should refrain from using external devices (online timers, cell phones, watches, etc.) to track the time limits. Analysts will be graded based on their prediction accuracy, and more bonus cash will be allocated to the teams with more accurate estimates.

<u>Counterparties</u>

At the end of trading, all submitted tickets will be reviewed and each team will be given a counterparty score based on the number of different trading counterparties they transacted with throughout the trading session. Teams will be awarded bonus cash based on the number of different counterparties with which they transacted, with more cash being allocated to teams that traded with more different counterparties.

Bonus Cash Calculations

Each team will be ranked based on its performance and split into quintiles for each of the 2 bonus calculations. The top quintile for each bonus pool will be assigned a 5% bonus, the second 4%, and so on until the last quintile, which is assigned a 1% bonus. Bonuses are never negative, and they are applied at the end of the heat based on the team's absolute performance throughout the heat.

TRADING LIMITS, TRANSACTION COSTS, AND FINES

Each team has a starting position of 0 contracts, a soft trading limit of 200 contracts per heat, and a fixed hard trading limit of 500 contracts on their net positions per heat. On a best-efforts basis, each team will be notified as it approaches its soft and hard limits. If a team exceeds its soft limit, it will be charged a fine proportional to how much they exceed the soft limit. The amount by which a team exceeds the initial soft limit of 200 will become their new soft limit. The fine per contract above the soft limit is $50.

For instance, if Team A's net position is at 220, they will be charged a fine of $50*20 = $1,000 (they have exceeded their soft limit of 200 by 20 contracts). For Team A, 220 is now the new soft limit. As long as Team A's position remains below 220, there will be no additional fines. If Team A bought more and had a new net position of 280, then they would be charged an additional fine of $50*60 = $3,000 which is the difference between the new net position and new soft limit. If a team does not exceed its soft limit, it will not be charged any fines.

Any team that exceeds the hard limit of 500 will be automatically disqualified from the outcry. They will be given a rank equal to that of last place for that heat. In addition, there is a zero tolerance policy with regards to electronic communication. Any trader or analyst seen by an RETC staff member using or holding a cell phone or any other electronic device during the trading heats will be immediately disqualified. RETC staff will be positioned throughout the pit and the Matroneo to monitor this.

Each transaction on futures has a **maximum volume of 20 contracts** per trade. Once again, analysts in the Matroneo are allowed to make up to 2 spot trades during each heat, with up to 50 contracts in each trade.

Each contract will be charged a brokerage commission of $1 per contract.

Position Close Out

Each team's position will be settled at the end of each heat by closing out their remaining positions at the final spot price.

TRADING P&L CALCULATION EXAMPLE

Trading P&L will be calculated in a similar fashion to the Social Outcry Case (with the addition of trading fines as described above). Trading P&L will then be modified by all cash bonuses (Analyst Estimates and Counterparties).

The following is an example of a P&L calculation:

- Bought 5 RT100 Index futures at 1,000
- Sold 5 RT100 Index spot contracts at 1,100

The team is ranked at the top quintile for the bonus pool of Analyst Estimates and the third quintile for Counterparties

$$\begin{aligned} Profit\ Before\ Bonuses &= (1{,}100 - 1{,}000) \times \$10 \times 5 - \$1^{1} \times 10 \\ &= \$4{,}990 \\ Bonuses &= |\$4{,}990| \times 5\% + |\$4{,}990| \times 3\% \\ &= \$399.20 \\ Total\ P\&L &= \$4{,}990.00 + \$399.20 \\ &= \$5{,}389.20 \end{aligned}$$

The following is an example when a trader has a negative P&L:

- Bought 5 RT100 Index futures at 1,000
- Sold 5 RT100 Index spot contracts at 900
- The team is ranked at the top quintile for the bonus pool of Analyst Estimates and the third quintile for Counterparties

$$\begin{aligned} Profit\ Before\ Bonuses &= (900 - 1000) \times \$10 \times 5 - \$1 \times 10 \\ &= -\$5{,}010 \\ Bonuses &= |-\$5{,}010| \times 5\% + |-\$5{,}010| \times 3\% \\ &= \$400.80 \\ Total\ P\&L &= -\$5{,}010.00 + \$400.80 \\ &= -\$4{,}609.20 \end{aligned}$$

KEY OBJECTIVES

Objective 1

Traders can generate profits by interpreting news headlines and going long on positive news and short on negative news. Traders are also encouraged to trade with as many different counterparties as possible to capitalize on the cash bonus structure.

[1] Brokerage commission of $1 per contract traded – explained in Trading Limits and Transaction Costs – there have been 10 contracts traded in this example, 5 to buy and 5 to sell.

Objective 2

Analysts should track news releases and attempt to accurately estimate the value of the RT100 Index in order to develop a profitable trading strategy and communicate it efficiently to the traders. Additionally, analysts should submit their index estimates in a timely manner and develop effective non-verbal communication methods with their traders to quickly communicate trading strategies.

Enel Electricity Case

OVERVIEW

The Enel Electricity Case challenges the ability of participants to interact with one another in a closed supply and demand market for electricity. Electricity production and its consumption form the framework for participants to engage in direct trade to meet one another's objectives. The case tests each individual's ability to understand sophisticated market dynamics and optimally perform his/her role, while stressing teamwork and communication.

DESCRIPTION

The Enel Electricity Case will comprise 5 heats. Each heat will be independent from the others and will consist of 15 minutes of trading representing 5 trading days. Order submission using the RIT API will be disabled. Only data retrieval via Real Time Data (RTD) links or the RIT API will be enabled.

Parameter	Value
Number of trading heats	5
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 one of three specific roles:

1. Producer
2. Distributor
3. Trader

Each team will have 1 Producer, 1 Distributor, and 2 Traders. The team will determine the role of each member.
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	Traders

Please remember to submit each member's role in the team schedule by Wednesday August 8th, as specified in the "Important Information" section above. If a team misses this deadline, the roles will be randomly assigned between the team members by competition staff.

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 either with a forward contract or on the spot market

[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.

the following day. For example, if on day 1 the Producers decide to produce 2000 MWh of ELEC-day2, they will have to deliver 2000 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 1500 MWh of ELEC-day2 (each contract is for 500 MWh). On day 2, Producers can also sell 500 MWh of ELEC-day2 spot (which is 5 contracts of ELEC-day2). Combining the 1500 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 1500 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 ELEC-day2 (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:

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

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 forward market 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 (2000 MWh) of ELEC-day2 (by combining the solar and natural gas power plants production) but only 3 contracts (1500 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 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 expected 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 3000 MWh (30 contracts) and the Distributors are only able to buy 2500 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.

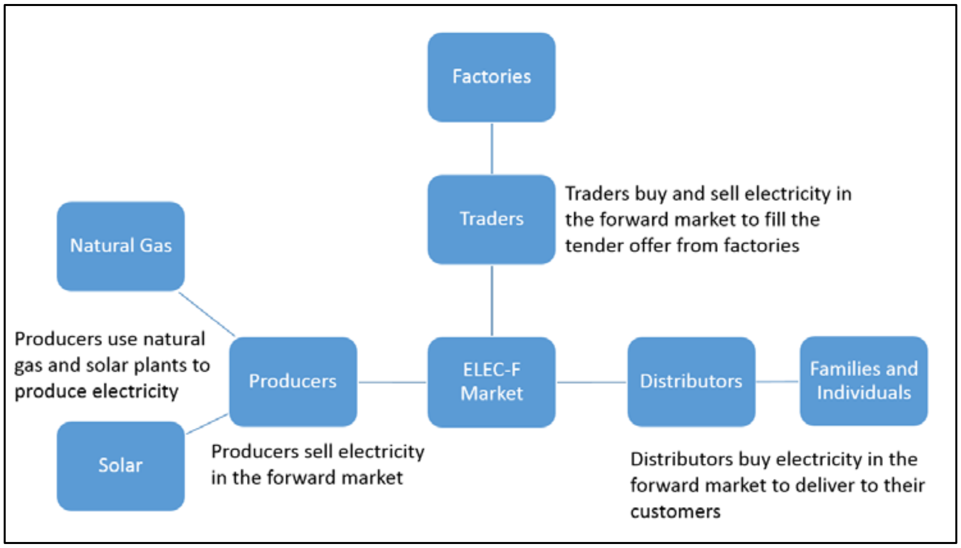
Traders

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.

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	No
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

[4] Please note that the solar power plant will produce electricity every day, which will be distributed as an 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".

Producers will be limited to using 10 natural gas power plants at a time. The natural gas power plant can convert, at 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 defines 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 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 is supposed to 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.

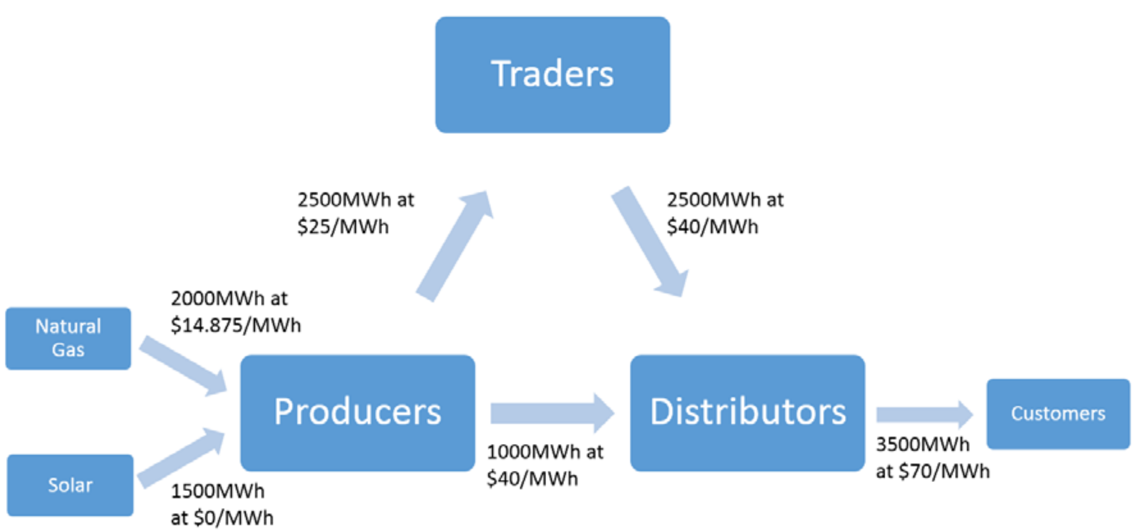
The following is a simplified example of the case:
Assume that on day 1 Producers knew that they would produce 1500MWh (15 contracts) of electricity for day 2 using the solar power plant (there is no cost for producing electricity using the solar power plant) and also decided to produce 2000 MWh (20 contracts) of electricity using the natural gas power plant at a cost of $14.875/MWh. The average cost for the 3500 MWh (35 contracts) of electricity produced is $8.5/MWh [=(1500MWh x $0 + 2000MWh x $14.875)/(1500MWh + 2000MWh)].

On day 1, Distributors have bought 2 contracts (1000 MWh) of ELEC-F from the Producers and 5 contracts (2500 MWh) of ELEC-F from the Traders at a price of $40/MWh. Traders initially bought 5 contracts (2500 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 1500 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 2000MWh (20 contracts) of electricity using the natural gas power plant at a cost of $14.875/MWh. The average cost for the 3500 MWh of electricity produced is $8.5/MWh [=(1500MWh x $0 + 2000MWh x $14.875)/(1500MWh + 2000MWh)].

On day 1, Distributors bought 2 contracts of ELEC-F (each contract is for 500MWh so Distributors bought 1000 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 2500MWh of unsold electricity (3500 MWh produced – 1000MWh 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 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. 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).

Intesa Sanpaolo Liquidity Risk Case

OVERVIEW

The Intesa Sanpaolo Liquidity Risk Case challenges participants to put their critical thinking and analytical abilities to the test in an environment that requires them to evaluate the liquidity risk associated with different tender offers. Participants will be faced with multiple tender offers throughout the case. This will require participants to make rapid judgments on the profitability and subsequent 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 the large positions to maximize returns.

DESCRIPTION

The Intesa Sanpaolo Liquidity Risk Case will comprise 8 traded heats. Each heat will be independent from the others. Each heat will be 10 minutes long and will represent one month of calendar time. Each heat will have a unique objective and could involve up to 4 stocks with different volatility and liquidity characteristics.

Parameter	Value
Number of trading heats	8
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. Participants must subsequently evaluate the profitability of these tenders when accepting or bidding on them. Order submission using the RIT API will be disabled. Only data retrieval via Real Time Data (RTD) links or the RIT API will be enabled.

MARKET DYNAMICS

There are eight heats, each with unique market dynamics and parameters. Potential parameter changes include factors such as spread of tender orders, liquidity, and volatility. Market dynamics and parameter details regarding each heat will be shown on the Case Description distributed prior to the beginning of the Case, allowing participants to formulate trading strategies. An example of heat details with two stocks, RETC and COMP, is shown below.

	RETC	**COMP**
Starting Price	$10	$25
Commission/stock	$0.01	$0.02
Max Order Size	10,000	15,000
Trading Limit (Gross/Net)	250,000/150,000	250,000/150,000
Liquidity	High	Medium
Volatility	Medium	High
Tender Frequency	Medium	Low
Tender Offer Window	30 seconds	15 seconds

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 only in price and quantity. No trading commission will be paid on tenders.

<u>Private Tenders</u> 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.

<u>Competitive Auction</u> 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 stock from the auction. Any participant that submits an order that is better than the base-line reserve price (hidden from participants) will automatically have their orders filled, regardless of other participants' bids or offers. If accepted, the transactions will occur at the price that the participant submitted.

<u>Winner-take-all Tenders</u> 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 (i.e. if all participants bid $2.00 for a $10.00 reserve price stock, nobody will win the tender).

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 stocks without "taking a bet". Therefore, the RETC 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 marked as "speculative trades".

Participants will have time to think about the offer before they choose to accept it or decline 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*"[5] since the participant had the advance knowledge of a pending institutional order. The RETC Scoring Committee will mark these trades as "front-running trades".

This case is designed to only reward the participants for identifying, accepting, and closing out[6] 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[7] 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.

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:

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

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 only

[5] 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.
[6] "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.
[7] Total profit of each participant is the profit (or loss) that you can observe in the RIT at the end of a heat/iteration.

be $\$10{,}000$ $[= \$10{,}000 + min(0, \$50{,}000)]$. 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 $Adjusted\ P\&L$ $[\$15{,}000 = \$35{,}000 + min(0, -\$20{,}000)]$. 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 RETC Scoring Committee at the end of each heat and it will **not be included** in the P&L calculation in the RIT Client. However, participants will be provided with an Excel tool[8], the "Performance Evaluation Tool", that will allow them to calculate their $Adjusted\ P\&L$.

TRADING LIMITS AND TRANSACTION COSTS

Each participant will be subject to gross and net trading limits to be specified in the Case Description distributed prior to the beginning of the Case. 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 and commissions will be specified in the Case Description distributed prior to the beginning of the Case. See the table above for an example.

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.

KEY OBJECTIVE

Evaluate the profitability of tender offers by analyzing the market liquidity. Participants should accept the tenders that will generate positive profits while rejecting the others. Submit competitive, yet profitable, bids and offers on above reserve and winner-take-all tenders to maximize potential profits while managing liquidity and market risk. There is a chance that the market may move away from your transaction prices, so maintaining large short or long positions may result in losses. Use a combination of limit, market orders and marketable limit orders to mitigate any liquidity and price risks from holding open positions.

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[8] The "Performance Evaluation Tool" will be uploaded on the RETC website on July 25th.

Credit Risk Case

OVERVIEW

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 companies' credit ratings. Periodic news updates will compel participants to make appropriate adjustments to the assumptions in their models and rebalance their portfolios accordingly. This case tests participants' abilities 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

The Credit Risk Case will comprise 5 heats. Each heat will span 16 minutes, representing two calendar years. Each heat will involve 5 tradable securities. Order submission using the RIT API will be disabled. Only data retrieval via Real Time Data (RTD) links and the RIT API will be enabled.

Parameter	Value
Number of trading heats	5
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 junior analysts. 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 (D)	100	100	100	100	100
Coupon	0	0	0	0	0
Maturity (T)	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	Anaheim Manufacturing	BaseData	Calyx Asset Management	Dayaria Milk Products	Ellen Cosmetics
Volatility of Company's Assets (σ_A)	36%	35%	54%	35%	46%
Total Asset Value *(in 100 millions)* (A_0)	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 *(in 100 millions)*	100	160	35	60	60
EBIT (Earnings Before Interest and Taxes) *(in 100 millions)*	20	60	10	40	35
Retained Earnings *(in 100 millions)*	15	30	5	10	25
Working Capital *(in 100 millions)*	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 release the updated credit ratings for each company on a quarterly basis. A company can be upgraded or downgraded by the credit rating agency only by one level. For example, if a company has a current rating of A, its rating will be A+ in case of upgrade and A- in case of downgrade.

Senior fixed income fund managers understand that the change of the financial situation of a company will not be reflected immediately by these ratings since they are only updated quarterly. Therefore, they have suggested that you can also calculate an implied credit spread (s_m) using real-time market data through a Structural Model, 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. In 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_t) 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 model[9] for the implied credit spread: let L be the measure for the company's leverage and defined as:

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

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:

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

[9] This model is known in the literature as the Merton Model.

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.

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.

	Probability of Downgrade			**Probability of Upgrade**		
Difference ($s_m - s_r$)	**Safe**	**Grey**	**Distressed**	**Safe**	**Grey**	**Distressed**
$s_m - s_r < -2\%$	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 is 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:

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

News releases

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 their 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 per heat. 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.

The maximum order size will be 500 bonds, and transaction fees will be set to 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 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).

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

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:

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

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):

$$B_0 = De^{-yT} = D^{-rT}e^{(r-y)T} = A_0Le^{(r-y)T}$$

It follows that:

$$A_0Le^{(r-y)T} = A_0[N(-d_1) + LN(d_2)]$$

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:

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

EIB Interest Rate Case

Overview

The EIB Interest Rate Case challenges traders' understanding of bond pricing based on news and benchmark interest rates derived from 4 non-tradable EIB zero-coupon bonds. Traders have to price 3 tradable coupon bonds based on the benchmark rates and news. The news, which will be released throughout the case, may have an impact on the benchmark rates, and thus on the fair prices of the tradable coupon bonds. Traders should forecast the impact of the news on the benchmark rates and exploit any bond mispricing opportunities to generate profits.

Description

The EIB Interest Rate Case will comprise 8 heats. The case represents one year of calendar time and involves 3 tradable coupon bonds and 4 non-tradable EIB zero-coupon bonds. Order submission using the RIT API will be disabled. Only data retrieval via Real Time Data (RTD) links and the RIT API will be enabled.

Parameter	Value
Trading time	624 seconds (approximately 10 minutes)
Calendar time	1 year (52 weeks) Assumed to be December 31st 2015 to December 31st 2016
Number of periods	2
Trading time per period	312 seconds (approx.. 5 minutes)
Calendar time per period	6 months (126 days, 26 weeks)
Number of trading heats	8

During the case, news will be released and traders will be able to trade the coupon bonds.

Securities

At the beginning of the case (December 31st, 2015), EIB will issue 4 zero-coupon bonds for which the maturity dates are specified below:

Security	Maturity Date
ZC_EIB2016	December 31st 2016
ZC_EIB2017	December 31st 2017
ZC_EIB2020	December 31st 2020
ZC_EIB2025	December 31st 2025

The annualized yields to maturity for the zero-coupon bonds (compounded on a weekly basis) will be quoted. We assume that the EIB zero-coupon bonds are not tradable; their yields to maturity constitute a zero-coupon benchmark curve for the pricing of the coupon bonds. These benchmark rates are exogenous and should be considered risk-free rates.

For the purposes of this case, the 4 bonds described above are the only zero-coupon securities issued by the EIB. It is possible to infer the zero-coupon yield curve (henceforth zero-coupon curve) by linearly interpolating the 4 benchmark rates.

At the beginning of the case, the EIB will also issue 3 coupon bonds with different maturity dates. Each bond has a 5% coupon rate paid out semi-annually (at the end of June and December), and a face value of € 100.00. Details of these securities are presented below.

Security	Maturity Date	Coupon Rate	Face Value
EIB2017	December 31st 2017	5% (paid semi-annually)	€ 100.00
EIB2020	December 31st 2020	5% (paid semi-annually)	€ 100.00
EIB2025	December 31st 2025	5% (paid semi-annually)	€ 100.00

The coupon bonds are tradable and short selling is allowed.

Market Dynamics

Trading will occur over 2 periods, each lasting 312 seconds. Each period simulates 26 weeks of calendar time, or 12 seconds per week. Interest will not be earned on cash sitting in the traders' accounts because the overnight rate is assumed to be zero.

Traders begin the case with an endowment of € 10,000,000 and will have to price the 3 tradable coupon bonds (with the maturity dates indicated above) according to the benchmark rates.

News will be distributed throughout the case, which may or may not affect the slope, level, and/or the curvature of the zero-coupon curve. The effect of the news might not be reflected in the zero-coupon curve immediately, allowing the traders to buy/sell the bonds whose prices they think will increase/decrease (according to their forecasts of the future movements of the zero-coupon curve). When the zero-coupon curve incorporates the effect of the news, the fair price of the tradable coupon bonds will change accordingly. If the traders' forecasts of the future movements of the zero-coupon curve were correct, they would make profits by selling (at a higher price) the bonds that they previously bought and buying (at a lower price) the bonds that they previously shorted.

Traders are encouraged to use Excel as a support tool to help make decisions given the uncertainty. They should build a pricing model to identify mispriced coupon bonds.

Parameter	Value
Starting Endowment	€ 10,000,000
Compounding Period	Weekly (12 seconds)

Valuation

Valuation of a bond involves calculating the present value of the future cash flows: the periodic coupon payments and the face value. Summing the present values of the cash flows, traders will calculate the fair price of the coupon bonds as shown below:

$$Bond\ Price = \frac{C}{(1+y_{6m})} + \frac{C}{(1+y_{1yr})} + \cdots + \frac{C}{(1+y_{n^{th}yr})} + \frac{M}{(1+y_{n^{th}yr})}$$

Where
C = coupon payment;
M = face value;
y_x = discount rate for the cash flow paid in x.

The discount rates for the different cash flows' maturities will be derived from the zero-coupon curve using linear interpolation. For example, given the benchmark rates provided below:

Security	Annualized YTM
EIB2016	2.00%
EIB2017	3.00%
EIB2020	4.50%
EIB2025	5.00%

The interpolated zero-coupon rate for December 31st 2018 would be 3.50% [=3.00% + (2018-2017)/(2020 - 2017)*(4.50%-3.00%)]. The interpolated zero-coupon rate for December 31st 2019 would be 4.00% and so forth. Assuming that the overnight rate is zero, the interpolated zero-coupon rate for June 2016 would be 1.00%.

Using the table above, at the start of the case with 52 weeks remaining, the discount rate for the cash flow paid for December 31st 2016 will be equal to 2.00% [=(1+2.00%)^(52/52)-1]. At tick 132, when there are 41 weeks remaining until the December 2016 coupon, the discount rate for the cash flow paid in December 31st 2016 will be equal to 1.5736...% [=(1+2.00%)^(41/52)-1]. Given the interpolated 6-month zero-coupon rate of 1%, the discount rate for the coupon to be paid at the end of June 2016 would be .2874%.

The following table provides details on the present value, at tick 132, for each of the cash flows associated with the coupon bond that matures in Dec. 2017. Note that, at tick 132, the fair value price for EIB2017 will be €104.60.

Date of payment	Weeks remaining before payment	Annualized YTM zero-coupon rate	Discount rate	Cash Flow	PV of Cash Flow
Jun 2016	15	1.00%	0.2874%	€ 2.50	€ 2.49
Dec 2016	41	2.00%	1.5736%	€ 2.50	€ 2.46
Jun 2017	67	2.50%	3.2327%	€ 2.50	€ 2.42
Dec 2017	93	3.00%	5.4287%	€ 102.50	€ 97.22
Total					€ 104.60

Between two coupon payment periods, the buyer needs to pay accrued interest[10] to the seller in addition to the 'clean' price of the bond. Accrued interest is calculated using the following formula:

$$Accrued\ Interest = C * \frac{Ticks\ between\ settlement\ and\ last\ coupon\ payment}{Total\ ticks\ in\ payment\ period}$$

where C = coupon payment and $Ticks$ refers to seconds in the RIT case.

For example, if a trader purchased the bond described in the table above 132 seconds after the start of the case for € 103.54 (clean price), the accrued interest would be € 1.06 [= (132/312) * € 2.5]. The total amount that the trader will pay per bond is € 103.54 + € 1.06 = € 104.60. Please note that the trader paid the fair price for the bond but there might be occasions where the bond is mispriced making it more attractive for a trader seeking extra returns.

The contract size is 10. If a trader wished to purchase this bond, s/he would have to pay € 1,046 (=€ 104.60 × 10).

[10] Accrued interest is the fraction of the coupon payment that the original holder has earned prior to the settlement of the bond.

The dirty price of the bond is obtained as the sum of the accrued interest and the clean price. The transaction log will display two entries for every purchase or sale of a bond: the transaction amount (clean price * quantity), and the accrued interest amount.

Trading Limits and Transaction Costs

Each trader 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 traders will not be able to exceed them.

A commission of 2 cents per contract (each contract is written for 10 bonds) is charged on every transaction. There is a maximum order size of 1,000 contracts per order.

Liquidity Traders

Liquidity traders are labelled ANON in the order book. They actively trade the coupon bonds by continuously submitting market and limit orders to cause price fluctuations.

Settlement and Position Close Out

Any non-zero position in the coupon bonds will result in coupon receipts or payouts at the end of the first period.

All the non-zero positions at the end of the second period will result in settlement at the last traded price, and will result in the coupon receipts or payouts. 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:

Students will be able to observe the yield to maturity of 4 EIB zero-coupon bonds with maturities of 1, 2, 5, and 10 years. Based on these yields, they will be able to calculate the fair price for each of the 3 tradable EIB coupon bonds and profit from any mispricing that they observe on the market.

Objective 2:

Qualitative news will be distributed to students throughout the case. Students are required to analyze the news, and determine how they will affect the slope, level, and/or the curvature of the zero-coupon curve, and thus, the price of the tradable bonds.

Appendix

Supplementary files will be released prior to the competition as they become available. Announcements will be made on the RETC website when these files are released.

Please refer to the RETC website for more information on the release dates for cases. The website will be updated periodically to reflect estimated upload dates.

Please send any questions to retc@luiss.it. If applicable, case-related questions will be forwarded to the Rotman RIT development team. To ensure the fair dissemination of information, responses to your questions will be posted online for all participants to see.

Good luck and see you in Rome!