A Simulation-Based Approach to Learning Finance

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Founding Director, Rotman Financial Research and Trading Lab

Rotman European Trading Competition Workshop

LUISS Guido Carli University, Rome

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Learning Goals: Preparing Students For Careers

Practitioners need to operate in uncertain, complex, real-time environments:

• Learning goals: develop skills in making decisions in real time in realistic environments which make uncertainty explicit

On-going innovation is a necessity in a competitive global environment:

• Learning goals: integrating research and practice and learning how to learn promotes learning on the job which is a critical ingredient of innovation

Practitioners rarely have well-defined problems:

• Learning goals: go beyond cookbook approaches by designing interactive simulations that allow participants to experience implications of their actions and discover the main issues and optimal solutions
Some Challenges

Diverse backgrounds:
- Prior knowledge about institutional detail of markets and securities
- Adeptness with tools such as Excel
- Dealing with uncertainty in a quantitative way

Diverse aspirations:
- Learning about different types of securities
- Learning how to identify, quantify and manage risks and opportunities
- Learning how to learn and find new solutions to new problems

Learning how to use dynamic learning strategies
- Dealing with complexity and potential informational overload
- Coping with integrative exercises
- Allocating time to practice and make efficient use of feedback
Meeting the Challenges*

Interactive simulation methods:

- Involve learning-by-doing which is active learning that engages participants
- Enhance individualized learning by allowing participants with different backgrounds to interact and learn from their own level
- Provide immediate feedback which contributes to a self-reinforcing cycle of learning
- Contribute to deep as opposed to surface learning
- Facilitate learning how-to-learn which promotes life-long learning

Critical inputs for innovation and the knowledge economy

*For more details see ‘Measuring the challenge of innovation in management education: the case for interactive simulations’ by Woodhouse and McCurdy, 2012
Examples: Applications developed in the FRTL

1. Rotman Interactive Trader (RIT) platform plus RIT cases
   Analogous to a flight simulator in our case learning how to make effective financial decisions in an uncertain world
   
   http://inside.rotman.utoronto.ca/rit

2. Rotman Portfolio Manager (RPM) platform
   Applying the strategies derived and tested using RIT incorporating the institutional details involved with trading real securities
   
   http://rpm.rotman.utoronto.ca
What is the RIT (Rotman Interactive Trader) application?

- **RIT platform**: a flexible & robust order-driven market platform designed to facilitate learning objectives in innovative ways
  - For example, ANON traders may be turned on to provide liquidity – can be programmed to be informed or uninformed and can be adjusted during trading

- **RIT cases** focusing on particular learning objectives in a stochastic environment
  - Cases simulate risks and opportunities associated with securities/strategies
  - Learning objectives for each case are designed such that students can explore, learn, and practice strategies that achieve their desired goals
  - Also sequence from introductory (generally 1 source of risk) to richer cases for which the decision maker has to manage several risks
  - Real-time interface to Excel applications applying relevant finance theory --integration of research and practice

- Note that the RIT cases are not just about trading; rather they cover wide variety of securities and objectives
  - Learning to make effective decisions when one cannot predict outcomes with certainty
RIT Features: RTD Links to Simulated Market

Excel Support for Fixed Income 3 - Interest Rate Risk
File Version 1.0

<table>
<thead>
<tr>
<th>Case Data</th>
<th>Purpose: This support file will show the valuation of the Treasury Bills and Bonds at each time point and allow you to calculate a probability weighted value 1 year bonds.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash:</td>
<td>$1,007,837.32</td>
</tr>
<tr>
<td>Time Remaining:</td>
<td>235</td>
</tr>
<tr>
<td>Time in a Week:</td>
<td>12</td>
</tr>
<tr>
<td>Weeks Remaining:</td>
<td>46</td>
</tr>
<tr>
<td>Current Risk Free Rate:</td>
<td>7%</td>
</tr>
<tr>
<td>Current Period:</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>Securit2.ertd Position</td>
</tr>
<tr>
<td>17</td>
<td>TB6M</td>
</tr>
<tr>
<td>16</td>
<td>TB12M</td>
</tr>
<tr>
<td>15</td>
<td>1YCP</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Performance Assessment</th>
<th>Your NLV</th>
<th>$1,007,837.32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk-Free Portfolio</td>
<td>$1,007,837.32</td>
<td></td>
</tr>
</tbody>
</table>

| Excess Return ($) | $0.00 |
| Excess Return (%) | 0.00% |

Note: Once period 2 has begun, the rate is established so probabilities are ignored.
RIT Features: RTD Links to Simulated Market

![Excel Support Sheet Template for Commodities 5 Case (Commodities Capstone)](image)

**Current Market Monitor**

<table>
<thead>
<tr>
<th>Position</th>
<th>Last</th>
<th>Bid Size</th>
<th>Bid</th>
<th>Ask</th>
<th>Ask Size</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL</td>
<td>99.92</td>
<td>3,000</td>
<td>99.31</td>
<td>99.33</td>
<td>3,000</td>
<td>0</td>
</tr>
<tr>
<td>CL-1F</td>
<td>99.99</td>
<td>3,000</td>
<td>99.98</td>
<td>100.00</td>
<td>3,000</td>
<td>0</td>
</tr>
<tr>
<td>CL-2F</td>
<td>100.81</td>
<td>3,000</td>
<td>100.80</td>
<td>100.82</td>
<td>3,000</td>
<td>0</td>
</tr>
</tbody>
</table>

**News Monitor ( Displays the Most Recent 4 News Items)**

<table>
<thead>
<tr>
<th>Recent #</th>
<th>MONTH</th>
<th>News</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>1</td>
<td>CL HOPE RISES AS NEW PETROLEUM INDUSTRY BILL IS PASSED A bill clarifying regulations on the Oil industry in Nigeria has been passed. It is h</td>
</tr>
<tr>
<td>2nd</td>
<td>1</td>
<td>CL WEEK 2 CL ACTUAL DRAW 2 MLN BBLS VS FORECAST BUILD 1 MLN BBLS. WEEK 2 CL ACTUAL DRAW 2 MLN BBLS VS FORECAST BUILD 1</td>
</tr>
<tr>
<td>3rd</td>
<td>1</td>
<td>AK-CS-PIPE, PIPELINE COST FOR ALASKA TO CUSHING GOING DOWN TO $4,000 PER LEASE. PIPELINE COST FOR ALASKA TO CUSHING GO</td>
</tr>
<tr>
<td>4th</td>
<td>1</td>
<td>CL WEEK 1 CL ACTUAL BUILD 9 MLN BBLS VS FORECAST DRAW 1 MLN BBLS. WEEK 1 CL ACTUAL BUILD 9 MLN BBLS VS FORECAST DRAW 1</td>
</tr>
</tbody>
</table>

**Crude Oil (CL) Fundamental Model**

**EIA Statistics Month 1**

<table>
<thead>
<tr>
<th>Actual</th>
<th>Expected</th>
<th>Differential</th>
<th>Net Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>7</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Week 2</td>
<td>6</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Week 3</td>
<td>6</td>
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<tr>
<td>Week 4</td>
<td>6</td>
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<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>24</td>
<td>0</td>
</tr>
</tbody>
</table>

**News Report Effects**

<table>
<thead>
<tr>
<th>News Item</th>
<th>Month 1</th>
<th>Month 2</th>
<th>Starting Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>-0.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>-1.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Forecasted Price**

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RIT Features: API from Excel to the RIT Platform

- Allows algorithmic trading, for example:
  - To implement an arbitrage strategy across alternative markets
  - To implement a market-making strategy
  - Etc.

- Writing a VBA script can clarify participants’ thinking about a strategy

- Running their algorithm by linking it to the relevant RIT ALGO case:
  - Allows testing of the algorithm design
  - Promotes better understanding of the relevant theory
  - Provides immediate feedback about the effectiveness of their strategy
  - Assesses competitiveness of their strategy relative to their cohort
  - Promotes ongoing learning

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Example from RIT ALGO1 Case

```
Function arb(timeremaining)
    Dim API As RIT2.API
    Set API = New RIT2.API
    If timeremaining < 295 And timeremaining > 5 Then
        If Range("CRZY_A_BID") > Range("CRZY_M_ASK") Then
            OrderID = API.AddOrder("CRZY_M", 1000, 0, API.BUY, API.MKT)
            OrderID = API.AddOrder("CRZY_A", 1000, 0, API.SELL, API.MKT)
        End If
        If Range("CRZY_M_BID") > Range("CRZY_A_ASK") Then
            OrderID = API.AddOrder("CRZY_A", 1000, 0, API.BUY, API.MKT)
            OrderID = API.AddOrder("CRZY_M", 1000, 0, API.SELL, API.MKT)
        End If
    End If
End Function
```

```
<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
</tr>
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<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Time Remaining</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>CRZY_A</td>
<td>10.15</td>
<td>10.16</td>
<td></td>
<td><a href="156">156 &lt;--RTD(&quot;ril2.rtl&quot;,&quot;TIMEREMAINING&quot;)</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CRZY_M</td>
<td>10.1</td>
<td>10.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 &lt;--=ARB(E2)</td>
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<tr>
<td>6</td>
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<td></td>
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<td>7</td>
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<td></td>
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<td>8</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
```
Some auxiliary learning facilitated by RIT cases

- How markets work: types of markets and market microstructure details
- The role of market participants (market makers, buy side, etc.)
- How security prices get determined reflecting
  - Fundamentals, information & news, market structure, trader behaviour, etc.
- Motivations for trading (arbitrage, speculation, hedging, etc.)
- Learn effective trading/investment/risk management strategies by applying finance theory
- How participants generate liquidity, volatility, profits/losses, informational & allocative efficiency
- The ‘business of trading’ is not just trading but is involved with every step:
  - trade idea generation & structuring
  - executing the trade
  - managing the position or rebalancing; etc.
  - identifying, quantifying & managing risks at each step, including:
    - liquidity risk, market risk, interest rate risk, FX risk, model risk, operational risks, etc.
- Our suite of RIT cases focus on many of these issues

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RIT2 Case Topics

- Our RIT 2.0 (RIT2) cases cover three broad topic areas
  - Market Microstructure
  - Asset Pricing
  - Portfolio and Risk Management

- For a list of cases currently available see
  http://inside.rotman.utoronto.ca/rit/cases/

- I will summarize some details for a few sample cases
Sample Market Microstructure Case: Liquidity Risk

RIT2 LT2 – Orders in Illiquid Markets

- Having already learned about how order-driven markets work using the agency trading cases, one can then add the issue of liquidity risk.

- In this case, the liability desk uses the firm's capital to buy or short securities and generates profits and losses depending on the skill of the liability trader.

- Facilitating buy side institutions that want to accumulate or dispose of a position with expediency by offering to buy a block of shares at a premium, or sell shares at a discount, immediately, rather than waiting for a typical agency-type execution (VWAP/TWAP accumulation, dark pool, or block trades).

- Traders are introduced to marketable limit orders to control price impact and liquidity risk management strategies.

- Case brief, teaching notes, discussion questions, and solution hints:

- Reports:
Sample Risk Management Case: Price & Production Risks

RIT2 Crop Hedging (AH1) Case:

- Students may have already practiced how futures contracts are valued and traded using the F1 and F2 cases.

- The AH1 case introduces the problem of hedging price risk for wheat when there is also production risk which will influence the optimal number of futures contracts.

- Case brief:

- Case solution:
Sample Commodities Case: NG Futures

RIT2 COM2 – NG Futs Case

- Analyze news affecting supply & demand for natural gas and transact NG futures contracts for alternative delivery months

- Case brief:

- Case tutorial:

- Excel support: see next slide
Example Excel Support for the Commodities 2 Case

[Excel spreadsheet screenshot]

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Sample Commodities Case: Commodities Capstone

RIT2 Commodities Capstone Case:

- Buy and sell crude oil and related products
  - In response to their analysis of various news releases affecting the price of oil
  - Introduces asset technologies: storage, ships, pipelines, refineries, etc.
  - Identify and exploit arbitrage opportunities occurring in the spot and futures markets as well as across different location and crude oil products

- Case brief and solution discussion

- Example Excel support: see next slide
**Example Excel Support for Commodities 5 Case**

Excel Support Sheet Template for Commodities 5 Case (Commodities Capstone)

### Current Market Monitor

<table>
<thead>
<tr>
<th>Position</th>
<th>Last</th>
<th>Bid Size</th>
<th>Bid</th>
<th>Ask</th>
<th>Ask Size</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL</td>
<td>0</td>
<td>99.62</td>
<td>3,000</td>
<td>99.61</td>
<td>3,000</td>
<td>0</td>
</tr>
<tr>
<td>CL-1F</td>
<td>0</td>
<td>100.62</td>
<td>3,000</td>
<td>100.61</td>
<td>3,000</td>
<td>0</td>
</tr>
<tr>
<td>CL-2F</td>
<td>0</td>
<td>101.63</td>
<td>3,000</td>
<td>101.55</td>
<td>3,000</td>
<td>0</td>
</tr>
</tbody>
</table>

### News Monitor (Displays the Most Recent 4 News Items)

1. Welcome to the Commodities Trading 5 Case,

### Crude Oil (CL) Fundamental Model

#### EIA Statistics Month 1

<table>
<thead>
<tr>
<th>Week</th>
<th>Actual</th>
<th>Expected</th>
<th>Differential</th>
<th>Net Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>2</td>
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<td>-0.2</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total**

|          | 17 | 16 | -1 | -0.10 |

#### EIA Statistics Month 2

<table>
<thead>
<tr>
<th>Week</th>
<th>Actual</th>
<th>Expected</th>
<th>Differential</th>
<th>Net Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
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</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total**

|          | 0  | 0  | 0  | 0    |

### News Report Effects

<table>
<thead>
<tr>
<th>News Item</th>
<th>Month 1</th>
<th>Month 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$0.20</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>$0.24</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>$0.69</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>$0.75</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>-$0.23</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>-$0.10</td>
<td></td>
</tr>
</tbody>
</table>

#### Starting Price

- Month 1 EIA Report Effect: ($6.10)
- Month 2 EIA Report Effect: $6.00
- Total Effects from EIA Reports: ($6.10)

- Month 1 News Report Effect: $1.96
- Month 2 News Report Effect: $6.00
- Total Effects from News Reports: $1.96

**Commission**

- $1.00

**Forecasted Price**

- $101.76

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Example Excel Support for Portfolio Insurance (H2) Case
Sample Options Case: Trading Volatility

RIT2 OP2 Compound Options Case

- Having practiced how options are priced (OP1) and used for portfolio insurance (H2), this case allows participants to practice building compound option positions (such as, straddles, strangles, butterflies, condors), in order to speculate on volatility.

- Case brief
Evaluation of RIT Case Performance

- Due to stochastic outcomes, have to be careful to not base marks on outcomes from a small number of replications.

- Average of rank across replications is often better than average profits/losses across replications.

- Some cases have a reliable mapping between rank and ability for two or three replications -- other cases require more replications due to a greater impact of stochastic realizations.

- In all cases, thinking about the learning objective, one can come up with a reward scheme that reflects and reinforces the learning objectives.
Evaluation of RIT Case Performance, continued

- Evaluating performance based on profits is not appropriate in all cases
  - Example: H2 Case – hedging effectiveness is the objective

- Case reports summarizing case objectives, appropriate strategies, and outcomes
  For example:
  - Executive summary including an explicit summary of the strategy
  - A comprehensive but succinct summary of results in the context of the strategy
  - Tables and Figures supporting results integrated into the text of the report
  - Supporting Appendices: trading history (must be output from the RIT case) and
    Excel support application used to apply finance theory for deriving the strategy

- Complementary RPM Case
  - Apply what you learned with the simulated RIT Case to real-time quotes for actual securities
What is RPM (Rotman Portfolio Manager)?

- **RPM platform**: allows participants to construct, track and analyze a portfolio of stocks, bonds, options and futures in real time
  - Excel applications are linked to real-time quotes for actual securities
  - Designed to maximize educational value by providing simple, relevant and realistic portfolio management tools
  - Instructors have access to customizable monitoring and evaluation tools that generate meaningful data about student performance

- **RPM cases can be designed to complement RIT cases**
  - Reinforce the learning objectives of the RIT simulation cases by applying the strategies to real-time quotes for actual securities
  - Contributes to knowledge of institutional details

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