Finance & Real Estate

Personal and Professional Business Explorations in Finance and Real Estate

Financial Risk Management





Monte Carlo Simulation with Crystal Ball



CRYSTAL BALL

Crystal Ball Modeling

- Reduce complexity and increase standardization
- Increase forecast accuracy & consistency of data
- Gain insight to key drivers through sensitivity analysis
- Move from data manipulation to improving business processes



Launching Crystal Ball

- Launch automatically with MS Excel after Crystal Ball installation
 - Start>Programs>Oracle Crystal Ball >Application Manager
 - Check the Crystal Ball box
- Start Manually
 - Start menu
 - Crystal Ball

| P Crystal Ball Application Manager | _ 🗆 X |
|--|----------|
| Launching Crystal Ball When starting Microsoft Excel, automatically launch Crystal Ball When launching Crystal Ball from the Start menu, start | _ |
| Microsoft .NET Framework Version | |
| <u> </u> | ancel |

| Crystal Campbell | |
|---|---|
| Internet Internet Explorer | My Documents |
| Acrobat 6.0 | My Pictures |
| E-mail Microsoft Office Outlook | Wy Computer |
| Excel 2003 | 🧐 My Network Places |
| PowerPoint 2003 | Control Panel |
| Word 2003 | Connect To |
| Application Manager | 🕐 Help and Support |
| Crystal Ball | 🔎 Search |
| SnagIt SnagIt SnagIt Some items There is not enough To display them, ple items, or unpin some | cannot be shown I room to show all the items you have a ase choose smaller menu icons, choose e items. |
| All Programs | |
| Undock Compu | ter 💋 Log Off 🚺 Shut Down |

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Launching Crystal Ball



Basic Terminology

| Crystal Ball Term | Common Names |
|-------------------|---|
| Assumption | Input, X, independent variable, random variable, probability distribution |
| Decision Variable | Controlled variable |
| Forecast | Output, Y, f(X), dependent variable |

- 6 steps in a loan process
- The average cycle time is 91 hours

• Performance target is 96 hours



- Performance target is 96 hours what should we do?
- Choice 1: Nothing the average (91 hours) gives us all the information we need.
- Choice 2: Investigate the uncertainty around the inputs

(process steps) – and analyze the effect on the output (cycle

time)

- In this example, we have the average completion time for each process step. Instead of using the average, let's define a distribution of completion times.
- The distribution you choose can be based on the underlying nature of the process, historical information, expert opinion, or an educated estimate. In this example we are given the distribution and related parameters.









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Example: Create Crystal Ball assumption for Customer Inquiry 1. Select the cell that will be your assumption



Example: Create Crystal Ball assumption for Customer Inquiry

- Crystal Ball assumption for cell C14: lognormal (1,.25)



4. Enter a descriptive name and values for the distribution parameters suggestion: use cell referencing for the name and parameters Example: Create Crystal Ball assumption for Customer Inquiry

- Crystal Ball assumption for cell C14: lognormal (1,.25)
- When an assumption has been defined, Crystal Ball assigns the cell a green background



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Create Crystal Ball assumptions for remaining loan process steps

- Create assumptions for the remaining steps using the distributions and parameters listed in the
 - 'Assumptions Parameters' section of the spreadsheet



Create a Crystal Ball forecast for Cycle Time 1. Select the cell that will be your forecast



Defin

Define

Excel

Assumption • Decision

Define

Forecast Define



Create a Crystal Ball forecast for Cycle Time

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- Crystal Ball forecast for cell C26
- 3. Enter a descriptive name for the forecast. suggestion: use cell referencing for the name

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Define

Excel 2007

Assumption * Decision

Define

4. If you want to clear Crystal Ball information from a cell, use 'Clear Data'

Define

Forecast Define Copy 🕜

Define Forecast: Cell C26



Run the model!

Set the number of trials to 5000 in the 'Trials' tab of the Run Preferences dialog – on the toolbar or in the 'Run' menu.

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| No. of Concession, Name | | | | | | |
|-------------------------|----------|-----------------------|-----|--|--------------|-----------------------|
| | | | | Run Preferences | \mathbf{X} | |
| | | Continue Simulation | | Trials Sampling Speed Options Statistics | | |
| | - 44 | Reset Simulation | | Number of kinds to sup: | | |
| | | Single Step | | | | |
| | | OptQuest | | Stop on calculation errors | | Run Preference |
| | <u>~</u> | CB Predictor | | ☐ Stop when precision control limits are reached | | Trials: 5000 |
| | | Tools | | Confidence <u>l</u> evel: 95 % | | Start Stop Reset Step |
| | | Sa <u>v</u> e Results | | | | Run |
| | | Restore Results | | | | |
| | | Run Preferences | | OK Cancel Defaults Help | | |
| | | | | | | |
| | lic | k on the 'St | art | Simulation' button. | | |

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Start Stop Reset Step

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View the forecast results

- View the forecast output
- Are your results different? Why?
- How often did you exceed your target?
- What was the mean cycle time and standard deviation?

| 01 | Forecast: Cycle Time | | | | |
|--------------|---------------------------------|----------------|--------|-----------------------|-----------------|
| <u>E</u> dit | <u>View Forecast</u> Preference | s <u>H</u> elp | | | |
| 5,0 | 00 Trials | Split | t View | | 4,978 Displayed |
| | C | ycle Time | | Statistic | Forecast values |
| | | | | Trials | 5,000 |
| | 0.07 - | | | Mean | 89 |
| | | | | Median | 88 |
| | 0.06 - | | | Mode | |
| | 0.05 | | | Standard Deviation | 12 |
| ∣≧ | 0.05 | | | Variance | 140 |
| ja i | 0.04 | | | Skewness | 0.2239 |
| ļ | ě – | | | Kurtosis | 2.90 |
| 16 | 0.03 - | | | Coeff. of Variability | 0.1328 |
| | 0.02 | | | Minimum | 53 |
| | 0.02 | | | Maximum | 136 |
| | 0.01 | | _ | Mean Std. Error | 0 |
| | | | | | |
| | 0.00 | 100 110 | 420 | | |
| | 60 /0 80 | 90 100 110 | 120 | | |
| | 96 Certainty: | 26.51 % | nity | | |
| | , | , N) | | | |

View the forecast Statistics

| 1 | Runs | |
|--|-----------|--|
| 2 | Mean | |
| 3 | Median | |
| 4 | Mode | |
| 5 | Std. Dev. | |
| 6 | Variance | Define Forecast: Cell C7 |
| 7 | Skewness | |
| 8 | Kurtosis | Name: C7 💽 😒 🛞 |
| 9 | CV | Units: |
| 10 | Minimum | Forecast Window Precision Filter Auto Extract |
| 11 | Maximum | Extract forecast statistics automatically to your spreadsheet when the |
| 12 | Range | simulation stops |
| Method 1: Auto Extract | | □ Forecast Name ▲ □ Trials ▲ □ Mean ● □ Median ♥ □ Mode ♥ □ Std. Deviation ♥ □ Variance ■ □ Kurtosis ■ □ Coeff. of Variability ■ ■ Minimum ▼ ■ Maximum ▼ |
| | | OK Cancel Apply To Defaults Help |

• Method 2: CB.GetForeStatFN(Cell, Argument)

View the sensitivity results

- View the sensitivity chart (from the forecast window... Forecast menu > Sensitivity chart)
- Which of the six steps most affects the variation of Cycle Time?
 C Sensitivity: Cycle Time
- Is one assumption dominant?



View the sensitivity results

| Loan Process Solution.xls [Compatibility Mode] - | Specify target (step 1 of 3) | Specify input variables (step 2 of 3) | X |
|--|--|---|--|
| View Add-Ins Acrobat Risk Solver Platform Crystal Ball | Tornado Chart Measure the sensitivity of each assumption or variable individually to a specific target cell. | Tornado Chart Use the buttons to add or remove assumptions, decision variables, and precedents to the list; | |
| Solution roots Image: Solution Roots < | Please select the target forecast from the list | Input variables Step 1: Customer Inquiry Step 2: Loan Application Step 3: Document Verification Step 4: Loan Underwriting Step 5: Loan Closing Step 6: Loan Disburse Specify options (step 3 of 3) Tornado Input Testing range Input See For Base Case Use median values Image: Use median values | Add Assumptions Add Decision Variables Add Precedents Add Range Remove Remove All Cascel Ustree Casc |
| | | < <u>B</u> ack <u>S</u> tart | Cancel Help |

View the sensitivity results



Tornado Chart

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View the sensitivity results



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Summary

- Traditional spreadsheets, using estimates or averages, do not account for the variability that often occurs in problems we try to model.
- Monte Carlo simulation with Crystal Ball allows you to use ranges of inputs to explore the range of possible outcomes <u>and</u> the probability of their occurrence.



Cartoon

