



Market System Analyzer

Version 4

User's Guide

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Chapter 1

Quick Start

The following steps outline the basic process of using Market System Analyzer (MSA) 4:

1. Compile the trade data for the market system(s) you wish to analyze into one or more text files.
2. Select the file(s) of trade data compiled in step 1.
3. Enter basic settings, such as whether the input data represent stocks or futures, starting account equity, margin, commissions, etc.
4. Choose a position sizing method.
5. Explore optional methods and analyses, such as dependency rules and equity curve crossover rules.
6. Adjust the position sizing settings and rules to maximize trading performance.
7. Use the Trade Size command for real-time position sizing if desired.
8. Optionally create a portfolio by selecting two or more market-system files.

Step 1

MSA supports two basic text file formats: RINA xml files and text files in which the trades are arranged one trade per line with separate fields on each line for the different elements of each trade. RINA xml files can be saved from the performance reports of various trading programs, such as MultiCharts and TradeStation.

For all other text file formats, the trade data should be compiled into a spreadsheet or text file in column format with one trade per line. At a minimum, MSA requires the profit or loss amount in dollars for each trade or, alternatively, the entry and exit prices. The order of the columns does not matter. The formatting details are specified at the time the data are first read in via the Trades File Format window (see Step 2). A typical spreadsheet of trade data is shown below.

	A	B	C	D	E	F	G	H	I
1	7/23/2001 13:15	1324.25	8/8/2001 13:15	1312.75	1368.195	-1	545	1,701.00	1
2	8/10/2001 13:15	1324	8/16/2001 13:15	1297.5	1290.872	1	-1,355.00	1,656.38	1
3	8/28/2001 13:15	1293	8/30/2001 13:15	1255.25	1332.435	-1	1,857.50	1,971.75	1
4	9/17/2001 13:15	1166.25	9/21/2001 13:15	1065.5	1219.765	-1	5,007.50	2,675.75	1
5	10/10/2001 13:15	1195	10/19/2001 13:15	1189.25	1166.537	1	-317.5	2,213.75	1
6	10/22/2001 13:15	1209	10/29/2001 13:15	1198.75	1168.207	1	-542.5	2,407.13	1
7	10/29/2001 13:15	1198.75	10/30/2001 13:15	1182.5	1245.39	-1	782.5	2,441.25	1
8	10/31/2001 13:15	1195.75	11/6/2001 13:15	1241.25	1146.925	1	2,245.00	2,441.25	1
9	11/13/2001 13:15	1257.75	11/28/2001 13:15	1253	1233.068	1	-267.5	1,714.13	1
10	11/29/2001 13:15	1267.5	12/10/2001 13:15	1271	1238.193	1	145	1,950.38	1
11	12/17/2001 13:15	1259.25	12/18/2001 13:15	1269.25	1220.715	1	470	1,812.25	1
12	12/31/2001 13:15	1269	1/2/2002 13:15	1260.5	1294.135	-1	395	1,317.75	1
13	1/3/2002 13:15	1289.5	1/14/2002 13:15	1266.75	1238.63	1	-1,167.50	1,648.50	1
14	1/15/2002 13:15	1271.75	1/22/2002 13:15	1244.5	1238.78	1	-1,392.50	1,648.50	1
15	1/29/2002 13:15	1238.5	2/14/2002 13:15	1245.5	1256.75	-1	-380	1,925.00	1
16	3/15/2002 13:15	1285.75	3/20/2002 13:15	1279.5	1250.575	1	-342.5	1,611.50	1
17	3/20/2002 13:15	1279.5	3/21/2002 13:15	1269	1311.73	-1	495	1,538.25	1
18	3/26/2002 13:15	1269.5	3/28/2002 13:15	1271	1238.158	1	45	1,688.50	1

If all trades are the same size, the number of shares or contracts can be entered once on the Analysis Setup window. Stock and forex traders will want to include columns for the entry and exit prices; entry prices are used to calculate margin requirements for stock and forex trading. If the data are entered into a spreadsheet, the spreadsheet file should be saved as a .txt or .csv file. See Chapter 3, Input Data, Getting Data into the Program, for more information on compiling data for use in MSA.

If all trades have the same trade risk, defined as the amount you'd lose per share/contract if the trade were a loss, you can specify the risk after importing the trade data by using the **Specify Trades Risk** command of the Trades menu. Trades risks are only necessary when using one of the position sizing methods that requires them, such as fixed fractional.

Step 2

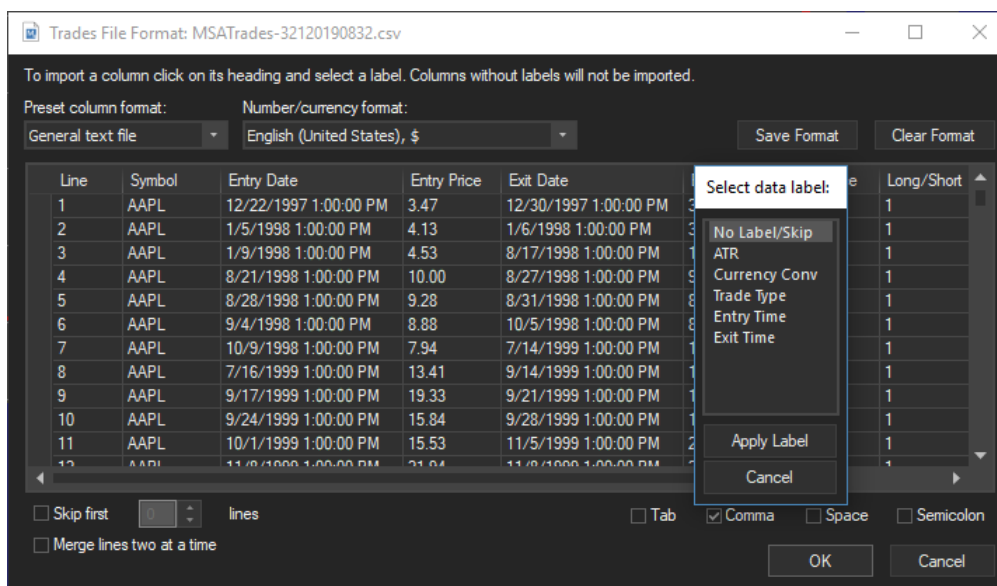
The simplest way to get the trade data into MSA is to use the **Open** command of the File menu to select the file(s) of trade data. This will open and read each file of trade data and create one or more market-system (.msa) files, depending on whether you choose to combine the different files of trade data into one .msa file or create a new .msa file for each file of trade data. If you select multiple files of trade data, you can also have MSA automatically create a portfolio file consisting of the separate .msa files associated with each file of trade data.

Alternatively, you can select the **New** command from the File menu, followed by either the **Import** command or the **Data Source** command of the Trades menu. Either command allows you to select a file of trade data to read in. The **Import** command reads in the trade data but stores it in a separate "trades file". In this case, you're prompted to enter the name of the trades file later when first saving the .msa file. The name of the trades file is shown under **Data Source**.

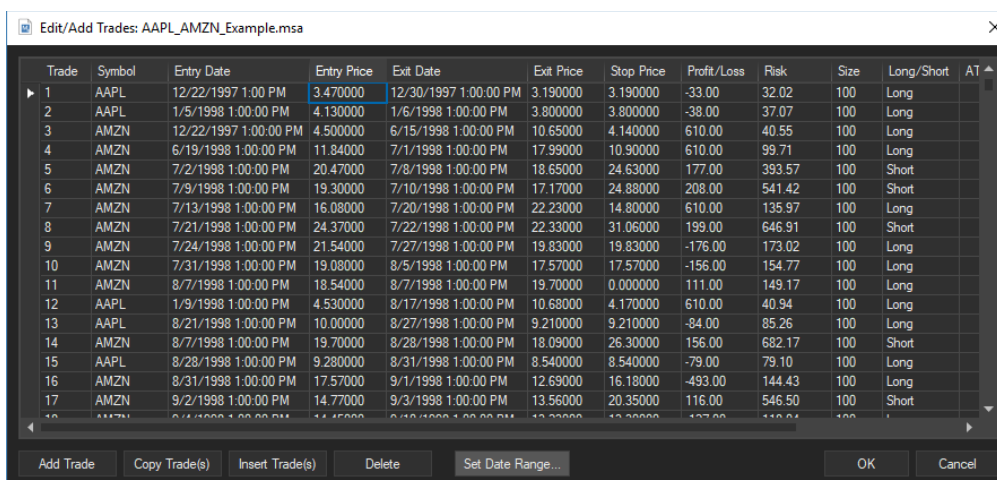
Note: Using the **Open** command to read in trade data and create a new .msa file retains the selected file of trade data as the "trades file", as shown under **Data Source**. If you want to copy the trades into a new trades file, use the **Import** command.

If you select the file of trade data using the **Data Source** command directly, the selected file becomes the trades file, and the trades will be stored and read from this file whenever the .msa file is in use. The advantage of using the **Data Source** command over importing is that if you update the data file with new trades, the market-system (.msa) file will be automatically updated as well. If you have multiple market-system files using the same data source (trades file), they will all be updated automatically if you change the trades file. Trade data are not stored in the .msa file; they are stored in the trades file. The downside of selecting the file of trade data via **Data Source** is that the file will be changed by MSA if you edit the trade data within MSA. Using the **Import** command creates a new trades file, which leaves the original file of trade data unaffected by any changes made in MSA.

RINA xml files contain the formatting information that tells MSA which data item is which part of the trade; for example, which item is the entry price, and which item is the trade profit/loss. For all other text file formats, it's necessary to tell MSA what each column in the file represents. This is done through the Trades File Format window, as shown below, which is displayed after the file of trade data is selected. By clicking on each column heading, you can identify the contents of each column.



Trades can also be entered manually using the **Edit/Add** command of the Trades menu.



This brings up the Edit/Add Trades window. Enter the data for each trade directly in the fields in the grid. If entry and exit prices are entered, it is not necessary to also enter the Profit/loss amount. Similarly, if the stop price is entered, it is not necessary to also enter the Risk amount. If a stop was not used with the trade, leave the risk and stop price fields blank. See Chapter 3, Input Data, Editing Input Data, for more information.

After the trade data have been entered into MSA, save the market-system (.msa) file using the **Save** command of the File menu. Saving the market-system file will save the trade data to the text file specified under Data Source (Trades menu) and save all program settings in the .msa file. Double-clicking on an .msa file will start MSA and open the selected file.

Step 3

Select the **Setup** command from the Analysis menu. On the Input Data tab, use the drop-down list next to "Trading Vehicle" to select either Stocks/Forex or Futures.

Analysis Setup

Input Data Account Settings Options Monte Carlo Settings

Trading Vehicle: Stocks/Forex Point Value (futures only, \$):*

*Required when using price data to calculate profit/loss and risk.

Calculate profit/loss and risk using: Prices (entry/exit/stop)

Where trade size is not specified in input data, use the following value for interpreting profit/loss and/or risk data:

Default Trade Size: 1 shares per trade

Profit/loss and risk data are expressed as percentages of equity

Profit/loss data include trading costs (slippage, commissions, fees)

Entry/exit prices include slippage

Automatically reload chart data every 0 hrs 0 min 0 sec

OK Cancel Apply Help

Analysis Setup

Input Data Account Settings Options Monte Carlo Settings

Starting account size (\$): 100000 Trade size limit: 1000000 shares

Account locale: English (United States), \$

Costs

Commissions & Fees: 0.05 Percent of Value Deducted per Side Assessed per Trade

Slippage: 0.001 Amount (Currency Units) Deducted per Round-Turn Assessed per Share/Contract

Margin

Futures: Initial margin per contract (\$): 0

Stocks/Forex: Minimum margin requirement (%): 50 Leverage: 2.00:1

Withdrawals

Withdraw 0 fixed amount every year % of equity

OK Cancel Apply Help

If selecting Futures, also enter the Point Value. The point value is used to calculate the profit/loss amount from entry and exit prices. For example, if an entry price for the E-mini S&P is given as 1204.75, the point value would be \$50. If the same price were entered as 120475, the point value would be \$0.50.

If all trades entered in step 2 were the same size and the size was not specified in the input data, the trade size can be entered in the field “Default Trade Size.”

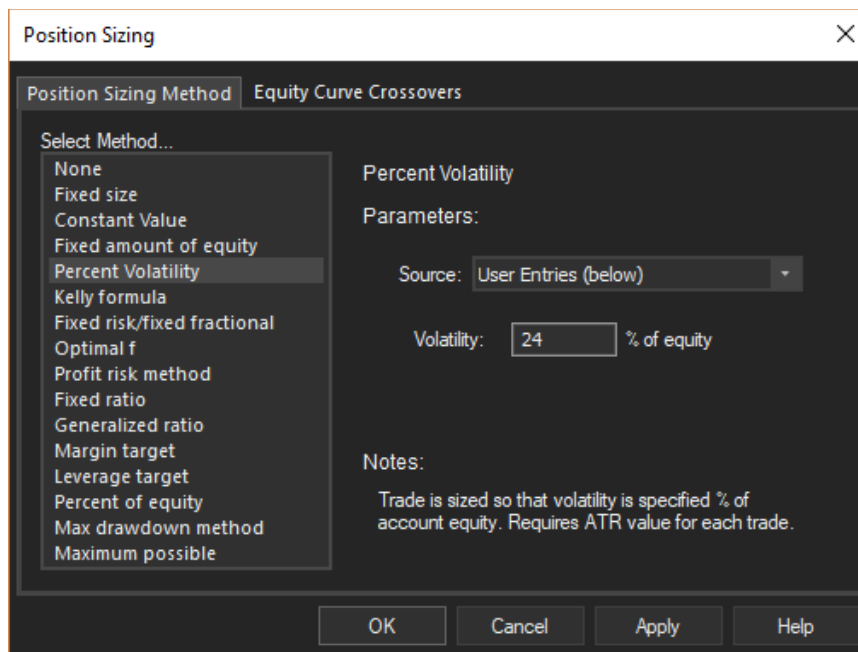
On the Account Settings tab, enter the starting account equity and margin amount (if futures) or margin percentage (if stocks/forex). If the trade data do not include commission and slippage costs, enter those costs here. Click Ok to save the settings and exit.

See Chapter 4, Basic Settings, for more information on the Analysis Setup window.

Step 4

Bring up the Position Sizing window by selecting “Position Sizing...” from the Analysis menu. Select one of the methods listed in the box on the left side of the window.

Most methods have either one or two adjustable parameters. Enter each parameter value in the corresponding box. The Parameter Studies feature (see Chapter 7) is helpful in choosing values for the position sizing parameters. See Chapter 5, Position Sizing, for more detailed information.



Step 5

Explore other analysis features and options of MSA listed in the Analysis menu. For example, selecting the **Monte Carlo Analysis** command performs a Monte Carlo analysis by randomly sampling from the distribution of trades. Try one of the trading rules under “Dependency Rules...” Equity curve crossover rules can be applied using the Equity Curve Crossovers tab of the Position Sizing window.

Step 6

Finding the best combination of settings for any given set of trades is largely a matter of trial and error. Each setting is immediately reflected in the equity curve of the main chart and in the right-hand pane, which displays summary statistics that correspond to the displayed equity curve. For more detailed performance results, select **Performance Statistics** from the

View menu or right-click in the right-hand pane (also see Chapter 12, Viewing the Results). The performance statistics combined with the shape of the equity curve can be used to determine if the chosen settings are acceptable. One possible scenario is to use MSA to optimize the position sizing method while limiting the analysis to a range of trades and saving the rest for out-of-sample testing. You could then select other rules, such as dependency rules or equity crossover rules, and verify the analysis with out-of-sample testing and Monte Carlo analysis.

Step 7

Once a good combination of settings has been found, use the **Trade Size** command of the Analysis menu to get the position size for any upcoming trades.

Enter the current value of your account equity (and optionally the trade risk and market price) then press the "Calculate" button. The number of shares or contracts plus the required margin and other metrics will be displayed for the next trade based on all current settings in the software. For stocks the required margin is the cost of the trade. For example, with no leverage (100% margin) and an entry price of \$25, 200 shares of stock will cost \$5000, which is the required margin for the trade.

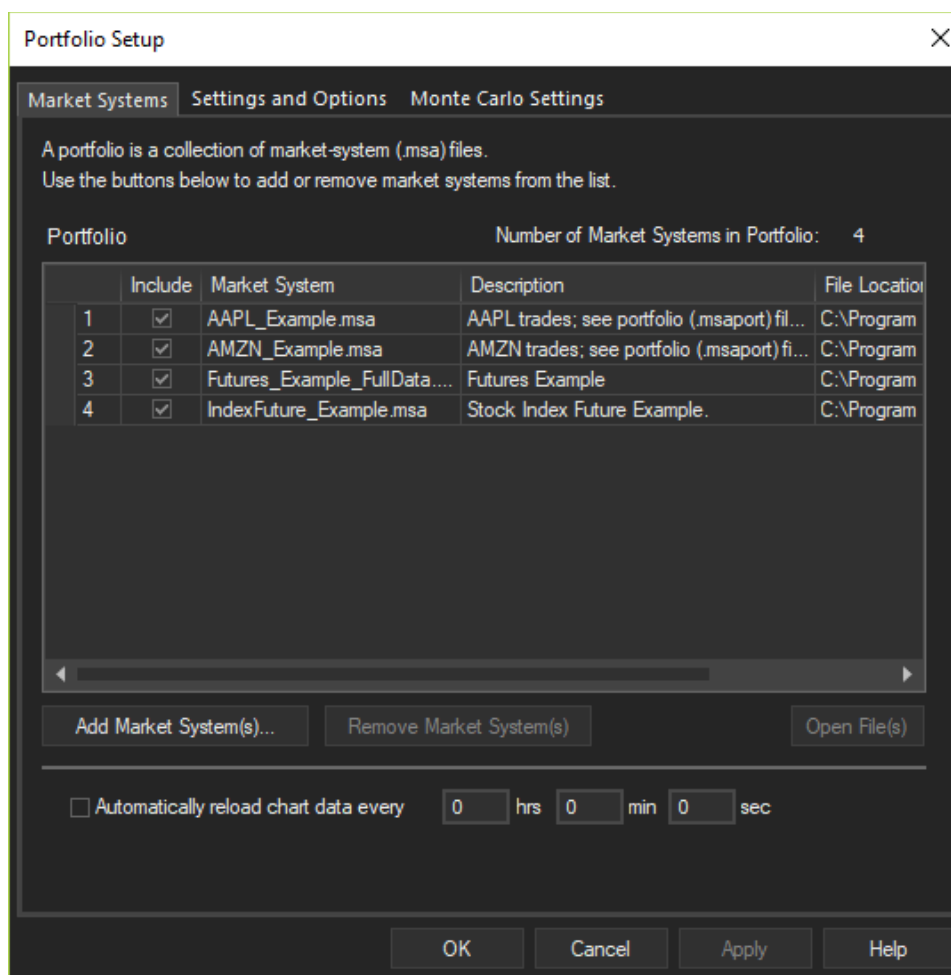
To keep the calculations up-to-date, make sure the trades file, as listed under **Data Source**, is up-to-date. For example, you could enter each new trade into the program using the **Edit/Add** command (Trades menu) or use the included WriteTrades function for TradeStation/MultiCharts. The Trade Size command is described in more detail in Chapter 5, Position Sizing, Real Time Position Sizing.

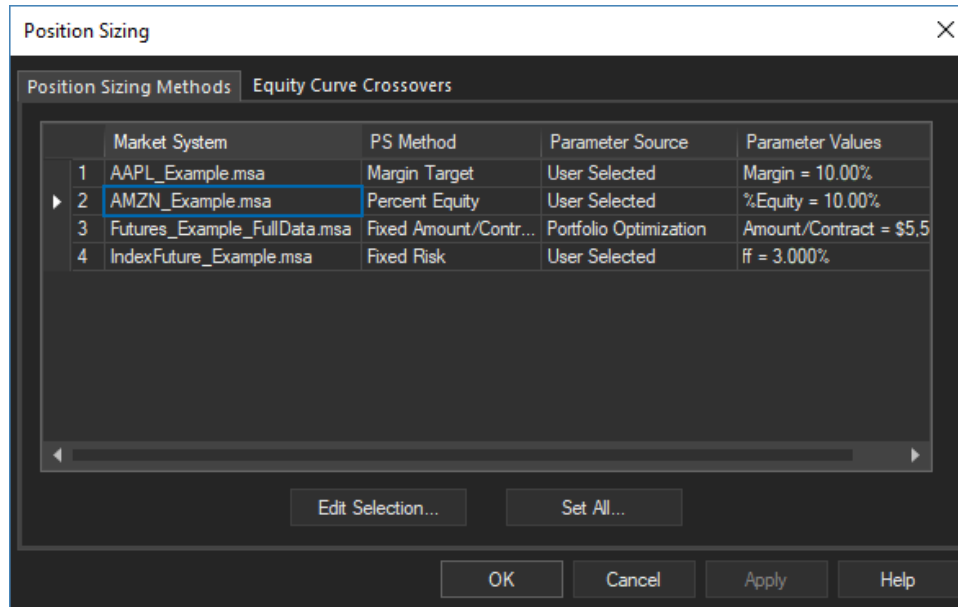
Step 8

Once you've created more than one market-system (.msa) file, you can create a portfolio by opening a new portfolio (.msaport) file and selecting any number of market-system files. Create a new portfolio document by selecting **New** from the File menu and selecting **New Portfolio** from the submenu. The available menus should change to include a Portfolio

menu. Select **Setup** from the Portfolio menu or from the right-click menu and click the Market Systems tab. Use the Add Market System(s)... button to select any number of existing market-system (.msa) files that you've already created. On the Settings tab, enter your starting account equity. Click Ok to save your changes and exit. The resulting equity curve will display the combined result of all selected market systems, with the trades in order of exit date and including any rules and settings from the individual market-system files.

A short-cut is available for creating a portfolio file from a set of files of trade data. Select the **Open** command of the File menu and select multiple files of trade data together by holding down the shift key or control key while selecting the files. A dialog box will give you the option of combining the trades from all files into one .msa file or creating multiple .msa files with an optional portfolio file comprising all the market-system files. The market-system file or files and, optionally, the portfolio file will be created automatically.





Select **Position Sizing** from the Portfolio menu or from the right-click menu to bring up a list of each market system with its default position sizing settings. Double-click on any market system to change the position sizing method and/or parameters. By default, the settings are retrieved from the market-system file. To change a parameter value, change the Parameter Source to User Selected on the Position Sizing window then enter the new value in the space provided.

Equity curve crossover rules can be added to the portfolio from the Equity Curve Crossovers tab of the Position Sizing window. These rules are in addition to any equity curve crossover rules defined in the market-system file, which will still apply to the market system after it's added to a portfolio unless specifically turned off. You can turn off the equity curve crossover rules in the market-system files by checking the box labeled "Deactivate all crossover rules ..." on the Equity Curve Crossovers tab of the Position Sizing window.

To add a dependency rule to the portfolio, select Dependency Rules from the Portfolio menu or from the right-click menu. These rules are in addition to any dependency rules defined in the market-system file, which will still apply to the market system after it's added to a portfolio unless specifically turned off. The dependency rules for the market system can be turned off by checking the box labeled "Deactivate all dependency rules ..." on the Portfolio Dependency Rules window.

If you change any settings in an individual market-system file, save the .msa file, then select Reload from the portfolio menu to update the portfolio file.

To get help on any feature or command while using MSA, press F1 at any time. The Getting Started help screen can be displayed at any time by selecting the **Getting Started Screen** command from the View menu.

Chapter 2

Introduction

Overview

Market System Analyzer (MSA) will help you get the most out of your current approach to trading the markets. MSA is designed to help you optimize position sizes, uncover profitable win/loss patterns, and identify when a trading strategy is no longer working.

MSA analyzes "market systems." A market system is defined as the combination of a financial market and a trading system or method applied to that market; for example, a moving average crossover system applied to the Euro market. MSA analyzes market systems in terms of the trades they generate. The program is designed to extract the maximum amount of information from the minimum amount of input data. Moreover, all analysis features in MSA are accessible from simple menu commands, making it easy to perform powerful analyses without any complicated programming.

The analysis features available in MSA include:

- 15 **position sizing methods** and several options for applying position sizing.
- The ability to combine market systems into portfolios.
- A **randomization** feature that lets you visualize the effect of trade order on trading performance.
- **Monte Carlo analysis** to quantify the effect of trade randomization on trading performance.
- A unique **parameter studies** feature that lets you plot position sizing parameters against any of nine performance measures.
- **Position sizing optimization** so you can maximize your trading performance using any of the available position sizing methods.
- **Dependency analysis** to determine if your trading system or method has a statistically significant tendency to form runs of wins or losses.
- **Dependency rules** to exploit any trade dependency that may exist.
- **Significance testing** to determine the likelihood that your trading system or method is inherently profitable.
- A unique **equity curve crossover** feature with rules for modifying your trading based on crossovers of the equity curve with its moving average.

In addition, Market System Analyzer enables you to:

- Perform **real time position sizing**.
- **Import trades** from a text file.
- **Synthetically generate a series of trades** from summary performance statistics.
- **Edit, add, or delete trades**.
- **Export, copy, or print** trades or performance results.
- Perform the position sizing optimization on a **sliding window of trades**, with automatic walk-forward testing.

- Perform the dependency analysis on a **sliding window of trades** to uncover short-term dependencies.
- **Restrict the analysis to a range of trades**, saving the rest for out-of-sample testing.
- Work with your existing **EasyLanguage systems**.
- **Format the chart**: change fonts, line and bar colors, grid, title, etc.

Market System Analyzer can be used for several different purposes:

- As an educational tool.
- To test and evaluate trading systems and methods.
- For day to day trading decisions -- to decide whether to take an upcoming trade and, if so, how many shares or contracts to trade.

The software is designed for both individual and professional traders. The familiar Windows interface makes the program easy to use, and detailed help files are available if needed to explain how to use each analysis feature. To get started, all you need is a list of profit/losses for the trading system or method you want to analyze.

Installation

The only essential requirement to install and use Market System Analyzer (MSA) is a 64-bit version of the Windows operating system, preferably version 7 or newer. Recent versions of Windows are all 64-bit. If you're not sure if your computer has a 64-bit version of Windows, you can check the System settings under the Control Panel or Settings window. The installation program for MSA will not continue if it's run on a 32-bit version of Windows.

There are no special requirements for memory or processor speed. Nonetheless, the Monte Carlo analysis and portfolio optimization take advantage of all available cores of multicore processors. The more cores the processor has, the faster these analyses will run.

If you obtained MSA by downloading it from the web site, the downloaded setup file should be named MSA_Setup_vxxx_Trial.exe, where xxx represents the version number of the release; e.g., MSA_Setup_v400_Trial.exe for MSA version 4.0.0. This is the trial version of the software. The licensed version is obtained via a download link provided after purchase. The name of the setup file for the licensed version will be MSA_Setup_vxxx_Licensed.exe.

To install MSA, run the downloaded setup file. This can be done either by double-clicking the file or via the Windows Run command, which is available through the search box in the Windows task bar. The installation should begin.

The installation program will prompt you for the location to install the program files. The default location is the folder Program Files\Adaptrade Software\Market System Analyzer 4.x\ . You can install the program in another location if you wish. The licensed version can be installed on top of the trial version.

Once the installation is complete, you should find the MSA icon on your desktop (optionally) and the MSA program in the programs menu. You should also find a folder called Examples in the Market System Analyzer 4 folder. The Examples folder contains sample files of type .msa and .msaport and sample text files containing trade data. The Market System Analyzer 4 folder also contains a ReadMe file that lists the additional files contained within the installation folder. These include EasyLanguage files for the WriteTrades function (see Chapter 3), which allows you to generate a text file of trade data from a TradeStation or MultiCharts system for use in MSA.

The licensed (paid) version of MSA also includes the EasyLanguage files for the PSCalc function (see Appendix). PSCalc implements the position sizing methods used in MSA. A sample trading system to illustrate the use of the function is also included.

MSA can be uninstalled through the Windows Control Panel or Settings window.

Market Systems and Portfolios

Critical to understanding MSA is the concept of a market system, defined as the combination of a market and the trading system or method applied to that market. For example, a trading range breakout system applied to T-bonds is a single market system. The same system applied to crude oil, or a different system applied to T-bonds, would be a different market system.

A market system is fully represented by the series of trades that results from trading the system or method on the market. As long as the list of trades is available, the details of the trading system logic and of the underlying market are unnecessary. This is the approach adopted by MSA. The list of trades is the fundamental input data required by MSA to define a market system.

In addition, market systems can be combined into portfolios. Provided two or more market systems have been established in MSA, a portfolio can be defined as a combination of market systems. The files for the market systems (.msa files) must be saved in order to create a portfolio. Once the market-system files are available, a portfolio is created by selecting the existing .msa files.

In a portfolio, MSA automatically combines the trades from the separate market systems as if all selected market systems were being traded together in the same account. The program accounts for overlapping trades in terms of costs and margin requirements and calculates the performance of the overall portfolio. The settings made in the individual market-system files are applied to the portfolio. Additional settings can be made for the portfolio overall, and the position sizing for each market system in a portfolio can be set within the portfolio file.

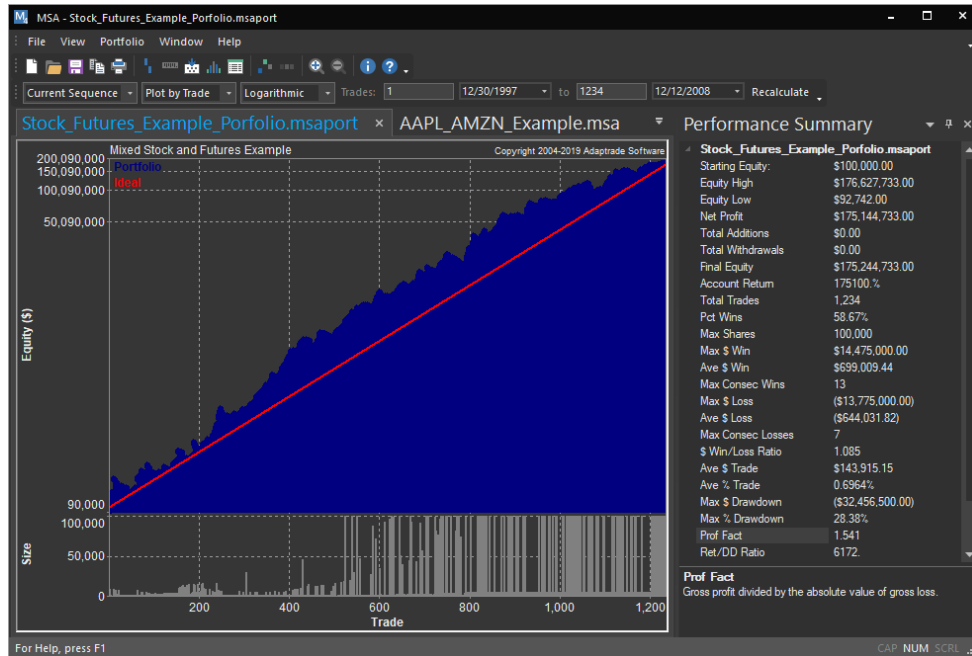
Each market system and each portfolio is represented by a separate window in MSA. Both types of windows can be open in MSA at the same time, where each window is identified by a tab containing the name of the file.

Understanding the Document Windows

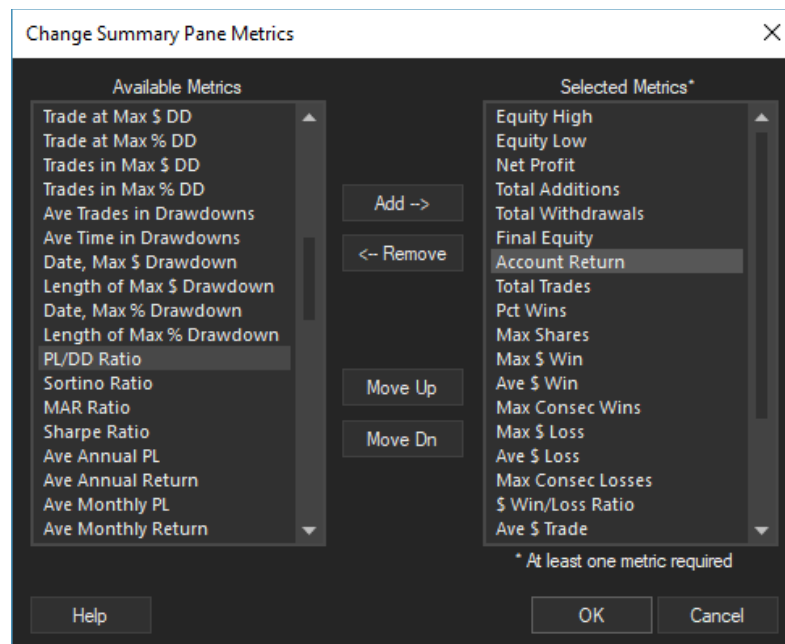
MSA can work with multiple document windows, as shown below. These windows represent the documents opened via the File menu. MSA can work with documents for both market systems and portfolios. In either case, a document window is displayed within a tab. Each document window contains the main chart, which displays the equity curve and the number of shares/contracts for the current sequence of trades using the analysis settings and options currently in effect. In addition to the equity curve, the main chart optionally displays a moving average of the equity curve and an “ideal equity curve.” The moving average can be used to modify position sizing (see Chapter 5, Position Sizing, Equity Curve Crossovers). Below the equity curve is a bar chart for the number of shares/contracts for each trade. The number of shares/contracts is determined by the position sizing method selected by the user.

To the right of the document windows is a summary pane (“Performance Summary”), which contains a list of performance statistics for the document currently selected. The performance statistics in the summary pane correspond to the equity curve and are updated whenever the equity curve changes based on the user’s selections. The performance results in the summary

pane are a customizable version of the full performance report, which can be opened by right-clicking in the summary pane.



To change the metrics shown in the summary pane, right-click in the pane and select the option "Select Metrics". This will bring up the Change Summary Pane Metrics window, as shown below. Metrics currently shown in the summary pane are listed on the right. New metrics can be added from the list on the left using the Add button or removed from the right-hand list using the Remove button. New items will be added above the item currently selected on the right-hand side. Multiple items can be selected together using the control or shift key while clicking. Use the Move Up and Move Dn buttons to change the order of items in the list on the right.



Almost everything that happens in MSA is reflected in the document windows. All changes and settings made in the program are reflected in the equity curve, in the bar chart for the number of shares/contracts, and in the corresponding performance statistics in the summary pane. The equity curve and the bar chart are a visual representation of the program's data (the profit/loss sequence) and the analysis options and settings. These settings include the position sizing method, which adjusts the number of shares/contracts for each trade, the range of trades to analyze, the order of the trades, trade dependency rules, and other analysis options. The initial account equity and the slippage and commission costs are also reflected in the charts.

A commonly used term in MSA is the "current sequence of trades." The current sequence of trades is the set of trades currently under analysis and in the order displayed in the main chart. The current sequence of trades may be a subset of the trades originally entered or imported via the Trades menu and may be in a different order than the original trades. The document window always displays the current sequence of trades. You can change the order of the trades in the current sequence using the **randomize** button on the toolbar or choose to restrict the analysis to a range of the original sequence of trades. In either case, this will change the "current sequence," although the original sequence, as initially entered or imported via the Trades menu, remains unchanged. To see the original sequence at any time, use the **Edit/Add** command (Trades menu). The current sequence can be restored to the original sequence at any time by restoring the original trade order and trade range via the toolbar.

The document windows in MSA can be modified in a number of ways. The summary pane can be resized by clicking and dragging its left border. The two graphs (equity and trade size) can be resized in the same manner by clicking and dragging in the horizontal area separating the two graphs.

Above the main chart, a drop-down menu in the menu bar allows the plotting of the equity curve to be switched between "Linear" and "Logarithmic." Logarithmic plotting is useful when position sizing is applied. An equity curve with equal rates of return from period to period will plot as a straight line on a logarithmic chart.

Another drop-down menu in the menu bar can be used to change the plotting from "Plot by Trade" (the default), which plots equity versus trade number, to plotting versus date ("Plot by Day", "Plot by Week", "Plot by Month" or "Plot by Year"). Plotting by date plots the equity at the end of the selected period (day, week, month, or year) by the period ending date. Plotting by date is only available if dates are available for every trade in the trades file.

If a Monte Carlo analysis has been performed, the "Current Sequence" drop down menu can be changed to "Monte Carlo", which plots four equity curves together: the equity curve for the current sequence of trades, the equity curve representing the chosen confidence level for Monte Carlo analysis (e.g., 95%), the equity curve at the corresponding lower confidence band (i.e., 100 - confidence level, such as 5% for a confidence level of 95%), and the equity curve at 50% confidence. See the chapter Monte Carlo Analysis for more information.

The trade range option in the menu bar allows the analysis to be restricted to a range of trades. After entering the first and last trades to include in the analysis, click the "Recalculate" button in the menu bar to update the analysis. The trade range can also be changed using the calendar controls adjacent to the trade number edit boxes.

Lastly, clicking on the equity curve will display data for the selected trade in a box that tracks the cursor, as well as in the status bar at the bottom of the chart. Using the zoom feature, any part of the chart can be magnified and later restored to normal magnification.

Program Conventions

MSA contains a number of features that are common throughout the program. Many of these conventions may be familiar from other Windows programs you already use. Learning these program conventions will make using MSA more convenient and efficient.

One such convention is context menus. In most windows in MSA, including document windows and the performance reports, you can right-click anywhere in the window to bring up a context menu with common program commands. Right-clicking in the document window over the charts brings up the largest context menu, which contains commands for setup, position sizing, dependency rules, chart formatting, and other common commands. It's often more convenient to right-click than navigate to the menus in the menu bar. This right-click menu can be customized using the **Customize** command (View menu), Menu tab.

Another short-cut in MSA is provided by double-clicking in the document window. Double-clicking over the chart brings up the Format Chart window.

MSA also includes the common convention of copying to the clipboard. Any window that contains a context menu can be copied to the clipboard. For example, the main chart can be copied using the copy button in the toolbar, by right-clicking and selecting Copy, or by using the Ctrl-C keyboard shortcut. This copies the entire chart image to the clipboard as a bitmap.

The right-hand performance summary pane can be copied by right-clicking in the pane or by clicking in the pane to set the focus then using the Ctrl-C shortcut. In this case, the copy command copies the text from the pane to the clipboard. The text is copied in tab-delimited format so that it can be pasted into a spreadsheet correctly. Similarly, the different performance reports can be copied to the clipboard as tab-delimited text.

Another convention in MSA is that the different performance reports in MSA all contain the same menus, which include commands for copying, as described above, printing, and saving (exporting) to a text file. For exporting, the available formats are tab-delimited text (.txt files), comma-delimited text (.csv), unformatted Word documents (.doc), and web files (.htm).

Similar to other Windows programs, the menus available in the menu bar of the main window of MSA change depending on the type of document currently open and selected. In particular, you'll notice that when a market-system (.msa) document is open and active, an Analysis menu is present. If you then open a portfolio (.msaport, or .msp) document, the Analysis menu will no longer be accessible, but a Portfolio menu will be present. The available menus and associated commands are appropriate to the type of document that's currently active. To see the Analysis menu again, you would simply have to click on the tab for a market-system document to make it the active window.

Starting in MSA 4, all dialog windows, such as Setup, Position Sizing, Dependency Rules, and so on, include an implemented "Apply" button. The Apply button can be used to apply the changed settings to the chart without closing the dialog window. This makes it convenient to try different settings before clicking the OK button.

Lastly, MSA uses the Windows help system convention. This means that you can bring up a help topic for a command or open window by pressing the F1 key. If a help topic is available for that command or window, the help system will be opened with the corresponding topic displayed.

Data Requirements

MSA is designed to extract the maximum amount of information from the minimum amount of data. Because a market system can be defined by its trades, the only data required by the program is a list of profit/losses for the trading system or method you want to analyze. Optionally, to apply fixed fractional position sizing, or a variant of fixed fractional called the profit risk method, you will also need the risk of each trade. The risk is defined as the dollar amount that the trade would lose per contract (share) if it were a loss. Commonly, the trade risk is taken as the size of the money management stop applied, if any, to each trade. If your trading doesn't use protective (money management) stops, the risk can be taken as the largest historical loss. Trade risks are only used with these two position sizing methods and in the calculation of R-multiples.

You may also specify trades in terms of the entry and exit prices, along with the trade direction – long or short, instead of the profit/loss itself. For example, if a stock was bought at a price of 52 and sold at a price of 54, the profit/loss would be \$2 per share. If you traded 100 shares, the total profit/loss would be \$200. You can either enter \$200 as the profit/loss, with a trade size of 100 shares, or enter the entry and exit prices of 52 and 54. Optionally, the stop price can be entered in place of the risk. If, for example, a sell stop was placed at a price of 49, the trade risk would be 52 - 49 or \$3 per share. Alternatively, the stop price of 49 could be entered.

Each trade can optionally include the date and time for the entry and exit. For the purpose of constructing the equity curve, the exit date/time is used; i.e., the equity is accumulated when the trade is closed out. Entry dates/times are used primarily to determine the cost and margin requirements of open positions as well as periodic performance results.

The Trade menu provides the commands needed to work with trade data in MSA. There are several methods of entering the trade data into the program. Trade data can be read from an existing text file specified via the **Data Source** command, imported through the **Import** command, or selected via the File **Open** command. Data can be entered manually through the **Edit/Add** command, or a synthetic series of trades can be created based on specified statistical properties of the trades (see Chapter 3, Input Data, Creating Trades from Statistics). This method randomly generates a series of trades based on the average profit, average loss, maximum profit, maximum loss, and percentage of winners. See Chapter 3, Input Data, Getting Data into the Program.

If the trade risk value is the same for all trades, the **Specify Trade Risks** command of the Trades menu can be used to set the trade risk for all trades to one of the following values: the largest loss, maximum loss, average loss plus N standard deviations, or a user-entered value.

Trade data are only entered for market-system documents, not portfolio documents. If a portfolio document is active, the Trades menu will not be available. To work with the trade data in a portfolio, open the market system containing the data and work with the data in the market-system document.

When a market-system document is saved as a .msa file, the trade data are saved in a separate trades file, which is listed under the **Data Source** command. With regards to trade data, the .msa file only saves the name of the trades file. Using the **Save** command saves both the .msa file and the trades file.

Examples

To help you get started with Market System Analyzer (MSA), there are several sample data files provided with the installation. These files can be found in the MSA Examples folder of the installation folder, which is typically Program Files\Adaptrade Software\Market System Analyze 4.x\. The files include market-system files (extension .msa), portfolio files (.msaport), and the trades files (.csv) read by the market-system files.

To open a sample file, use the **Open** command of the File menu, navigate to the Examples folder, select one of the .msa files, and click the Open button. Open a portfolio file using the same command by selecting a .msaport file.

Note: Because the examples are stored in the Program Files folder, if you want to save any changes you make to an example file, it's necessary to run MSA "as administrator" (e.g., right-click the MSA desktop icon and select "Run as administrator"). Either that or "save-as" the example file to a new name in a different folder, such as your documents folder.

A brief description of the examples included with version 4.0 follows.

AAPL_Example.msa. This example consists of trades of Apple stock. All data fields are defined, including trade risk, which makes this example suitable for use with fixed fractional trading. The option to trade in even lots of 100 shares per lot has been selected, as shown on the Analysis Setup window, Options tab.

AMZN_Example.msa. Similar to the first example but for Amazon stock trades.

AAPL_AMZN_Example.msa. This example combines the trades from the first two examples into one market-system file, which illustrates one way to handle trades from different markets. The alternative method is to create a portfolio consisting of the separate market-system files (see below).

AAPL_AMZN_Example_Portfolio.msaport. This example combines the first two market-system files into a portfolio, which is an alternative to the prior example. The benefit of creating a portfolio is that you can have separate settings in each market-system file, and you can set the position sizing for each market system separately.

Forex_Example.msa. This example consists of forex trades for a currency similar to EURUSD. Notice that the Stocks/Forex vehicle has been chosen on Analysis Setup and that the option to calculate profit/loss and risk amount based on prices has been selected (Setup, Input Data tab). It's assumed that the trades are calculated in dollars (\$). Otherwise, the "Currency Conversion" field in the input file would be needed to convert the trades to dollars.

IndexFuture_Example.msa. In this example, the trades represent a stock index future, similar to the E-mini S&P 500 futures. Notice that a point value has been provided on Analysis Setup, which is required with futures to calculate the profit/loss amounts from entry and exit prices.

Futures_Example_FullData.msa. This is another example of a trade history from a futures trading strategy. Similar to the first two examples, this one contains data for all relevant data fields: entry and exit prices, entry and exit date/times, and profit/loss and risk amounts.

SelectSectorSPDR_Example.msa. This example represents trades of the Select Sector SPDRs, which is an ETF. As such, it's defined as a "stock" on Analysis Setup. The position sizing is set to "Percent of Equity" with a parameter value of 20%, which means that each trade will have a position size so that the value of the trade is 20% of the account equity at the time the trade is taken. Setting the parameter to 100% would mean that the entire account is invested in each trade. To use a value greater than 100% would require leverage, which can be set on Analysis Setup, Account Settings tab ("margin").

Stock_Example_NoPriceData.msa. This is an example of a set of trades that do not include entry and exit prices. In this case, the trades are defined by the profit/loss amounts, as can be seen on the Edit/Add Trades window (Trades menu). Also note that on the Input Data tab of the Analysis Setup window, the option to calculate profit/loss and risk data from the profit/loss and risk amounts has been selected. Without entry prices, some position sizing methods -- those that require calculating the value of the position -- cannot be used. Also, metrics that depend on position values, such as leverage, will be displayed as "0".

Stock_Example_PLDataOnly.msa. This example contains trades that consist solely of the profit/loss amount for each trade; basically, just a list of the profit/loss amounts. Because only the profit/loss amounts were provided as input data, the default trade size was set to 100 shares. This tells the program that each profit/loss amount represents the result of trading 100 shares. If each trade amount was for a different number of shares, the position size would also need to be provided as input data. Alternatively, a list of percentages could be provided, where each value represented the percentage gain or loss in account equity from the trade. In that case, the corresponding option on the Input Data tab of Analysis Setup would need to be selected (i.e., "Profit/loss and risk data are expressed as percentages of equity"). With only a list of profit/loss amounts -- and no entry/exit prices or dates/times -- some position sizing methods are not available, and some performance metrics, including periodic returns ("Return Tables"), are not available.

Stock_Futures_Example_Porfolio.msaport. This example is a portfolio file combining several of the market-system files above. If you open the Portfolio Setup window, you should see a list of the four market systems that comprise the portfolio. If you then open the Position Sizing window, you should see that each market system uses a different position sizing method. The parameter values for the different position sizing methods have been arrived at using the portfolio optimization feature of MSA. The results of the portfolio optimization can be viewed via the View menu (Optimization Results).

The best way to learn MSA is to try things. Select a list of trades from your favorite system or trading method using **Data Source** and try the various analyses. If you have questions along the way, try pressing F1 to bring up the associated help topic at any time. Also try the **FAQ (Frequently Asked Questions)** list of the help system or search for a help subject using the help index.

Chapter 3

Input Data

Getting Data into the Program

All analyses in Market System Analyzer (MSA) are performed on data representing the trade history of a trading system or discretionary trading method. One way to supply the required data to MSA is to specify a text file of trade data via the **Data Source** command of the Trades menu. This defines the so-called "trades file," which is where the trade data will be read from or written to when opening or saving, respectively, the market-system (.msa) file. Alternatively, the data may be imported from a text file or entered manually via the editor; see Editing Input Data below. When importing or manually entering trades, a separate trades file is used to store the trade data.

To save time when creating a new market-system (.msa) file, the file can be created at the same time the data are specified by using the **Open** command of the File menu. In this case, just use the **Open** command to select the file of trade data. The new .msa file will be created automatically after the data are read in, and the trades file will be set to file you selected.

Note: MSA stores all trade data in the trades file, rather than in the market-system (.msa) file. This makes it possible to update or alter the trade data outside of MSA. The trades file is the same as the original source of trade data when the file of trade data is selected using the **Data Source** command or opened with the File **Open** command. When using the **Import** command, the trade data are stored in a separate file. The advantage of using the original file of trade data as the trades file is that if you update the original data file with new trades, the market-system (.msa) file will be automatically updated as well. If you have multiple market-system files using the same data source (trades file), they will all be updated automatically if you change the trades file. The drawback of selecting the original file of trade data to be the trades file is that the original file will be changed by MSA if you edit the trade data within MSA. Using the **Import** command creates a separate trades file, which leaves the original file of trade data unaffected by any changes made in MSA.

MSA can read trade data presented in two different file formats. The first one is RINA xml format. This type of file is used by several trading platforms, including TradeStation and MultiCharts, to save strategy details, price data, and trading results. Among other data, this format specifies the trade entry and exit dates/times and prices, as well as the profit/loss amount, trade size, and trade direction (long or short). If a RINA xml file is supplied, no further formatting or specification is required (i.e., the Trades File Format window, as described below, is not used).

The other formatting option is a text file with one trade per line or one trade every other line. Each column in the file will contain a different data field, such as the profit/loss, entry price, exit price, trade size, etc. The simplest such file would contain a single column of the profit or loss for each trade. A typical text file of profit/loss data for MSA is shown below.

300.00
 -250.00
 500.00
 175.00
 -425.00
 -300.00
 350.00
 ...
 ...

For example, the first trade was a profit of \$300.00, and the second trade was a loss of -\$250.00. The third trade was a profit of \$500.00, and so on. A more complete file might look like the spreadsheet shown below. Each line contains the data for one trade: entry date/time, entry price, exit date/time, exit price, stop price, trade direction, profit/loss, trade risk, and position size.

	A	B	C	D	E	F	G	H	I
1	7/23/2001 13:15	1324.25	8/8/2001 13:15	1312.75	1368.195	-1	545	1,701.00	1
2	8/10/2001 13:15	1324	8/16/2001 13:15	1297.5	1290.872	1	-1,355.00	1,656.38	1
3	8/28/2001 13:15	1293	8/30/2001 13:15	1255.25	1332.435	-1	1,857.50	1,971.75	1
4	9/17/2001 13:15	1166.25	9/21/2001 13:15	1065.5	1219.765	-1	5,007.50	2,675.75	1
5	10/10/2001 13:15	1195	10/19/2001 13:15	1189.25	1166.537	1	-317.5	2,213.75	1
6	10/22/2001 13:15	1209	10/29/2001 13:15	1198.75	1168.207	1	-542.5	2,407.13	1
7	10/29/2001 13:15	1198.75	10/30/2001 13:15	1182.5	1245.39	-1	782.5	2,441.25	1
8	10/31/2001 13:15	1195.75	11/6/2001 13:15	1241.25	1146.925	1	2,245.00	2,441.25	1
9	11/13/2001 13:15	1257.75	11/28/2001 13:15	1253	1233.068	1	-267.5	1,714.13	1
10	11/29/2001 13:15	1267.5	12/10/2001 13:15	1271	1238.193	1	145	1,950.38	1
11	12/17/2001 13:15	1259.25	12/18/2001 13:15	1269.25	1220.715	1	470	1,812.25	1
12	12/31/2001 13:15	1269	1/2/2002 13:15	1260.5	1294.135	-1	395	1,317.75	1
13	1/3/2002 13:15	1289.5	1/14/2002 13:15	1266.75	1238.63	1	-1,167.50	1,648.50	1
14	1/15/2002 13:15	1271.75	1/22/2002 13:15	1244.5	1238.78	1	-1,392.50	1,648.50	1
15	1/29/2002 13:15	1238.5	2/14/2002 13:15	1245.5	1256.75	-1	-380	1,925.00	1
16	3/15/2002 13:15	1285.75	3/20/2002 13:15	1279.5	1250.575	1	-342.5	1,611.50	1
17	3/20/2002 13:15	1279.5	3/21/2002 13:15	1269	1311.73	-1	495	1,538.25	1
18	3/26/2002 13:15	1269.5	3/28/2002 13:15	1271	1238.158	1	45	1,688.50	1

MSA can read the data fields listed in the table below.

Data Field	Description	Examples/Acceptable Formats*
Profit/Loss	Trade profit or loss in dollars	Profit: 400.25, \$1,025.64 Loss: -325, (325)
Risk	Trade risk in dollars	Same as Profit/Loss
Trade Size	Number of shares or contracts corresponding to profit/loss and risk	2 1000 25,028 Sign (+/-) indicates long/short if no trade direction column.
Entry Price	Price at which trade was entered	1204.25 54.37 1,189.75
Exit Price	Price at which trade exited	Same as Entry Price

Stop Price	Price at which money management stop was placed	Same as Entry Price
Entry Date	Date/time at which trade was entered	3/29/2007 12/10/2005 11:00 AM (Standard Windows date formats, interpreted by locale setting.)
Exit Date	Date/time at which trade exited	Same as Entry Date
Trade Direction	Whether trade was long or short	Long trades: long, EnterLong, Long, LNG, L, Buy, C (for "compra"), 1 Short trades: short, EnterShort, Short, SHT, S, Sell, V (for "venta"), -1
Symbol	String representing market	ES, MSFT, GPB, Index1
ATR	Average true range	Same units as price.
Currency Conversion	Factor multiplied by prices and ATR	Numeric. Defaults to 1.0 if not specified.
Trade Type	Indicates regular trade, cost/fee, or addition/withdrawal	R or 0 for regular trade; C, F, or 1 for cost/fee; A or 2 for add/withdraw amount; P or 3 for add/withdraw percentage of equity.
Entry Time	Time at which trade was entered (if not already defined as part of Entry Date).	13:15, 8:30 AM, Standard Windows time formats, interpreted by locale setting.
Exit Time	Time at which trade exited (if not already defined as part of Exit Date).	Same as Entry Time.

*Interpreted based on selected locale.

It's not necessary to enter data for all fields. For example, if the entry price, exit price, and trade direction (long or short) are entered, MSA will calculate the profit/loss amount, so it's not necessary to enter the profit/loss amount as a separate item in this case.

Trade Risk

The risk is defined as the dollar amount the trade would lose if it were a loss. Commonly, the trade risk is taken as the size of the money management stop applied, if any, to each trade. For example, a stop size of 10 points in the E-mini S&P would be a risk of \$500 per contract. If the entry price, stop price, and trade direction are entered, it's not necessary to enter the

risk amount in dollars. MSA will calculate the trade risk from the entry and stop prices in this case. If a profit/loss or risk value is entered, the amount should be for the same number of shares or contracts listed in the Trade Size column.

If you don't use protective (money management) stops, the risk can be taken as the largest historical loss. Trade risks are only used with two position sizing methods (fixed fractional and profit risk) and for calculating R-multiples.

Trade Size

The trade size field is also not required in every case. If all the trades are for the same number of shares or contracts, the size can be entered separately on the Analysis Setup window on the Input Data tab under Default Trade Size. The trade size field is also not required if the trade data are entered in terms of prices. However, if you're entering historical trade data and you want to be able to plot the trades using the actual, historical position sizes, it will be necessary to include a column for the trade size.

Entry and Exit Dates

When entering entry and exit dates, MSA requires an exit date for each and every trade in order to use the date data. Entry dates are not required but will be used to determine if two or more trades occur simultaneously. If you enter exit dates without entry dates, MSA will automatically set the entry dates to the exit dates for computational purposes.

ATR

The average true range field is provided for use with the percent volatility position sizing method. If you don't plan to use this method, it's not necessary to provide ATR values. If you do provide values for this field, the ATR value should be calculated on the bar prior to trade entry to avoid the benefit of hindsight. The ATR values should be provided in price units; i.e., the same units as the entry and exit price. The point value provided on the Setup screen will be used to convert price units to currency amounts (e.g., dollars).

Currency Conversion

This field is used to convert the price data to a different currency. The field value is multiplied by the entry price, exit price, stop price, and ATR values. It defaults to a value of 1.0 if not provided. It is not multiplied by the P/L and risk amounts, which are assumed to be provided in the same currency units as the account.

The currency conversion field can be used to provide a pip value for forex trades. Depending on the currency, the pip value may change from trade to trade. If currency prices are used as input data, the currency conversion field will act as the pip value when the trading vehicle is set to "Stocks/Forex".

Trade Type

The trade type field will normally be set to "regular" (or a value of 0) to indicate a trade. If this field is not provided, trades are assumed be "regular" trades. If this field is set to "Cost" or "Fee" ("C" or "F") or to a value of 1, the profit/loss amount will be assumed to represent a cost or fee amount. Costs and fees include such items as commissions, trading fees, and miscellaneous adjustments to account equity. A cost or fee amount is deducted from the account equity at the date/time specified by the trade exit date/time. Costs/fees are not subject to position sizing.

If this field is set to "Addition" or "A" or the value 2, the profit/loss amount will be interpreted as an addition to or withdrawal from equity. Additions are positive P/L values; withdrawals are negative P/L values. An addition/withdrawal amount is treated differently

than a cost/fee amount. The returns and drawdowns are adjusted so that an addition/withdrawal does not directly alter the performance. For example, if you have a 50% return at the end of the year, and withdraw half of your profits for the year on December 31st, the rate of return should still show a 50% return, despite the lower equity after the withdrawal. If the withdrawal were entered as a cost/fee, the return would be displayed as 25%, rather than 50% in this example.

It's also possible to enter an addition or withdrawal as a percentage of account equity. To do this, the trade type is set to "Percent" or "P" or the value 3. In this case, the P/L value is interpreted as the percentage of current account equity to add (positive P/L) or withdraw (negative P/L). For example, if the P/L value is -5.0 for this trade type, 5% of equity would be withdrawn at the date specified by the trade exit date.

A schedule of account withdrawals can be entered on the Setup window, Account Settings tab, to withdraw a set amount or percentage of equity at regular intervals (every week, month, quarter, or year). Withdrawals are discussed in more detail in the next chapter.

Entry and Exit Times

Normally, the trade entry and exit times are part of the date/time fields for entry and exit dates. In some cases, as with trade data saved from MultiCharts, the date and time are provided as separate fields. Use these fields if the time must be a separate field. If the dates and times are combined into date/time fields, use the Entry Date and Exit Date fields instead.

Getting Data From TradeStation or MultiCharts

If you use TradeStation or MultiCharts to run your trading system(s), there are several options for generating the text file of trade data. One method is to use the EasyLanguage function WriteTrades, which can be found in the installation directory of Market System Analyzer. WriteTrades collects the data for each trade as the system executes and writes the data out to a user-specified text file. The WriteTrades function is described in more detail in the next section. Another method is to save the performance report as an Excel (.xls) file, open the Excel file, and save the Trades List sheet as a text (.csv or .txt) file. MSA can directly import WriteTrades files and text-formatted Trades List sheets. Lastly, you can save the results as a RINA xml file.

Getting Data From Other Sources

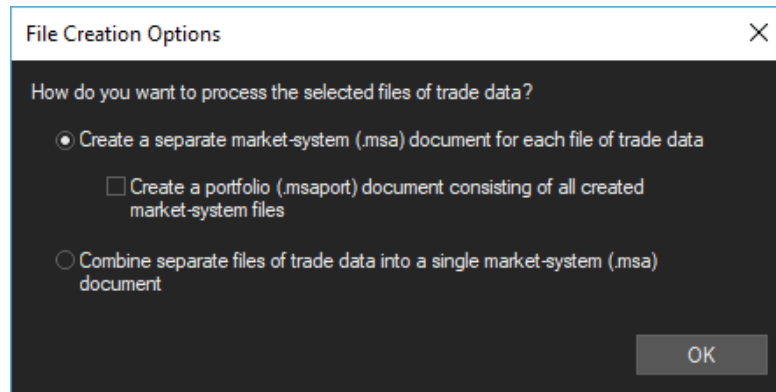
Many traders record their trade results in a spreadsheet. Provided the spreadsheet contains the required data, as explained above, it's only necessary to save the spreadsheet as a text file (either .csv or .txt format). The columns of pertinent trade data can be arranged in any order in the spreadsheet/text file. As shown below, the Trades File Format window allows you to identify the contents of each column you want MSA to read. Unlabeled columns are ignored.

If your trading software supports the RINA xml format for trade results, you can save or export your results in that format. MSA directly reads RINA xml files without the need for additional formatting specifications.

Reading the Trade Data into MSA

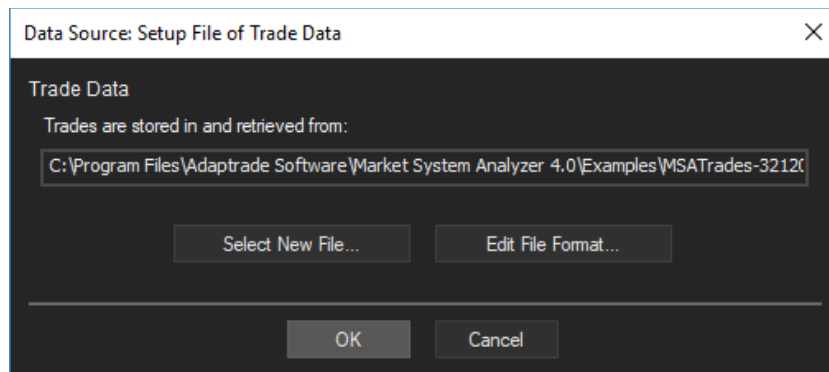
Once the trade data have been compiled into a text file, the data can be read into MSA using the **Data Source** command of the Trades menu, the **Import** command of the Trades menu, or through the **Open** command of the File menu.

To create a new MSA file based on the file of trade data, the easiest method is to select **Open** from the File menu. If you select multiple files of trade data at the same time, this will bring up the File Creation Options dialog, as shown below.



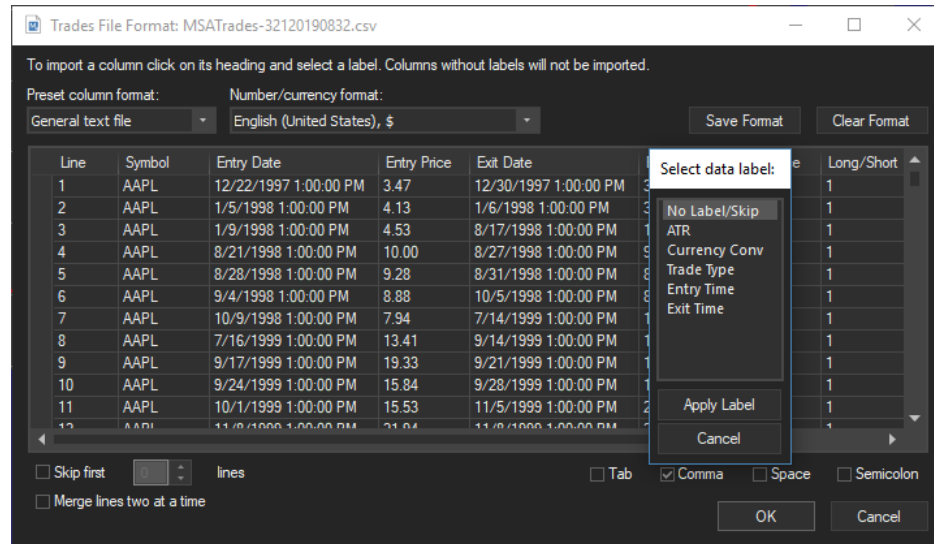
This dialog gives you the option to create one market-system (.msa) file for each file of trade data or to combine the files into a single .msa file. If you select the option to create multiple .msa files, you can optionally choose to also combine the separate .msa files into a portfolio. For each newly created .msa file, the trades file will be set to the name of the file of trade data.

If you choose to select the file of trade data using **Data Source** directly, the Data Source window is opened, as shown below.



After selecting the text file of trades, click the Save button to read the data. If the selected file is not a RINA xml file, MSA will open the Trades File Format window, shown below, to allow you to specify the format of the selected file. The Trades File Format window is also displayed when importing a text file of trades. There are several options available in check boxes below the data display that control how the data are interpreted. In the section labeled “Delimiters,” check the box or boxes that describe how the columns of data in the text file are separated. Columns can be separated by commas, spaces, tabs, and/or semi-colons.

Note: If a RINA xml file is selected as the trades file (e.g., selected via **Data Source**), MSA will prompt you for a different trades file when saving the .msa file if the trades have been modified or edited. This is because MSA does not write to RINA xml files; it only reads from them.



To skip over one or more lines at the top of the text file, such as a line of column headings, check the box labeled "Skip first [] lines." Click the arrows to select the number of lines to skip. If the data for each trade occupy two lines, check the next box, "Merge lines two at a time." This will combine each pair of lines into one long line. For example, the trades list from a TradeStation performance report uses two lines per trade, so this option is required to properly interpret files of that format. The final option, "Profit/loss and risk data are expressed as percent of equity," accommodates the case where instead of dollar amounts for the profit/loss and trade risk, percentages are used. If this box is checked, the profit/loss and risk values are interpreted as percentages of account equity assuming 100% of equity was allocated to each trade.

So that MSA knows what the different columns of data represent, you need to choose a label for each column of data you want to read in. To select a column label, click on the column heading, which will open the pop-up window "Select data label", as shown in the figure. For example, if the third column is the entry price, you would click on the heading for column three and double-click on "Entry Price" from the pop-up window. This identifies the third column as containing the entry prices. Any column you don't want to import should be left blank, which is done by selecting the label "No label/Skip."

For convenience, the "Preset column format" pull-down menu at the top left of the Trades File Format window allows you to set the column headings to match one of the saved formats. The initial list of preset formats consists of formats for a TradeStation Trades list, a WriteTrades3 file, and a general text file. Once you've set the formatting the way you want, you can save it by clicking the "Save Format" button, which will prompt you for a name to save it under. The next time you open the Trades File Format window, your saved format will appear in the pull-down menu as one of the preset formats. Saved formats are stored in the folder Documents\Market System Analyzer 4\File Formats\ within your user folder.

To clear the column headings, select "None/Clear Format." Once all the pertinent columns of data have been identified, click the Ok button, then click Ok on the Data Source window. The data will be read in and plotted in the chart window.

After formatting and reading in the trade data, it's a good idea to select **Save** from the File menu to save the current .msa file. The name of the trades file you selected in **Data Source** is stored in the .msa file, but the trades themselves are stored in the trades file. If you have not yet selected the trades file when saving the .msa file, you will be prompted to select one or to

enter a name for a new one. If the market-system file has not been previously saved, you will be prompted to enter a name for the file. The name of the file will be shown in the title bar of the main window.

Once the trade data have been defined, you can go to the Analysis Setup window (**Analysis Setup** command) to enter the primary settings, such as whether the data represent stocks or futures, the starting account size, margin, etc. See Menu Commands, Analysis Menu Commands, Setup Command.

WriteTrades EasyLanguage Function

The WriteTrades function is an EasyLanguage user function -- designed to work with TradeStation and MultiCharts -- that generates a text file of trade data in a format that can be used directly in Market System Analyzer (MSA). If you use TradeStation or MultiCharts to trade your system, you can use the WriteTrades function to create a list of trades produced by the system, provided you have access to the EasyLanguage code for the system.

The WriteTrades function can be found in the installation directory for MSA, typically Program Files\Adaptrade Software\Market System Analyzer 4.x\. There are several versions of WriteTrades. As of this writing, the standard version is WriteTrades32 (released with MSA version 3.2.0), and the file name is WriteTrades32.eld. There is also a version called WriteTradesSym, which differs from WriteTrades32 only in that it automatically appends the chart symbol name to the file name before saving the data. The description below is for WriteTrades32.

To install either version, either double-click on the file or open TradeStation and use the **Import/Export EasyLanguage** command from the File menu. In MultiCharts, open the PowerLanguage editor and select the **Import** command from the File menu.

To use the WriteTrades function, all you need to do is insert the following line at the end of your system:

```
Value99 = WriteTrades32(TradeRisk, StopL, StopS, NATR, CurrConv, "filename");
```

where TradeRisk is the risk of the trade in currency units (e.g., dollars), StopL is the stop price for a long trade, StopS is the stop price for a short trade, NATR is the period (number of bars) for calculating the average true range (ATR), CurrConv is the currency conversion factor, and "filename" is the name of the file to write the data to, including the full path name. For example, suppose you use a 12 point stop in the E-mini S&P, which is equivalent to a risk of \$600 per contract. Let's also say that the stop is relative to the entry, which is at the close of the most recent bar. Assuming you want to write the data to the file c:\tradedata.txt, you would write

```
Value99 = WriteTrades32(600, C - 12, C + 12, 10, 1, "c:\tradedata.txt");
```

Here, a length of 10 bars has been entered for NATR, although the ATR will only be used if percent volatility position sizing is chosen. Since there is no need for currency conversion, a value of 1 has been entered for CurrConv.

As explained in the previous section, it's not necessary to have both the dollar value of risk and the stop prices, so this could also be written as

```
Value99 = WriteTrades32(0, C - 12, C + 12, 10, 1, "c:\tradedata.txt");
```

If you don't use a stop or don't want to use fixed fractional or profit risk position sizing, which are the only position sizing methods in MSA that requires the trade risk, specify "0" for the first three inputs:

```
Value99 = WriteTrades32 (0, 0, 0, 10, 1, "c:\tradedata.txt");
```

When selecting a text file created from WriteTrades using the **Data Source** command, select the pre-set column format "WriteTrades3 function" on the Trades File Format window. This will pre-select the column headings correctly to match the data generated by the function.

The return value variable, Value99, can actually be any variable you choose. EasyLanguage provides pre-declared numeric variables Value1 - Value99. Most EasyLanguage code uses the lower-numbered variables, if any, so using Value99 should avoid conflicts in most cases.

To make sure the function works properly, please note the following:

1. The WriteTrades function should be called as the last line of your trading system, outside of all loops and other program statements.
2. If entering a value for the trade risk (first function parameter), the risk value should be for the same number of shares or contracts as the corresponding trade profit/loss. For example, if the 20th trade was for 300 shares, then when WriteTrades is called for the 20th trade, the first input to the function should be the dollar value of the risk for 300 shares. In many cases, it will be easier to enter the stop price (2nd and 3rd parameters) than the stop amount.

The EasyLanguage code for the WriteTrades function contains a comment block at the top of the code with further details about the function inputs and usage. The code can be viewed in the EasyLanguage editor in either TradeStation or MultiCharts.

Creating Trades from Statistics

Market System Analyzer (MSA) includes a statistical trade generator, which can be used to approximate or recreate a series of trades to match a given trading system or method. To create a series of trade profit/losses based on the statistical properties of your trading system or method, select the **Create Trades from Statistics** command from the Trades menu. This can be used as an alternative method to quickly enter a trade history for an existing trading system or discretionary trading method. For example, suppose you have a history of 30 trades. Rather than importing the trades or entering them manually, you could enter the five summary statistics described below to recreate the series. The advantages of this approach are (1) you can create a series of trades that's as long as you want, and (2) the synthesized series will contain random characteristics that may increase the reliability of the analysis results.

The **Create Trades from Statistics** command brings up the Create Trades from Statistics window, as shown below. Fill in all the fields and indicate using the drop-down list whether the created trades should replace the existing trades or add to the existing list of trades. If you decide to replace the existing trades and you don't want to lose them, make sure to save the open file before clicking the Create Trades button.

You can create as many trades as you want, up to available memory limits. For the largest losing and average losing trade statistics, you can use either a positive or negative number with the same result. The program uses a proprietary algorithm to randomly generate the series of trades so that it approximates the specified statistical properties. The more trades

that are generated, the closer the statistics of the generated series will match the input statistics. A sample size of at least 100 trades is recommended to generate a representative series.

For the trade statistics (largest winning, average winning, largest losing, and average losing trade), enter the dollar amounts corresponding to the trade size entered in the box next to “Trade amounts are for.” For example, if you entered 100 shares in the “Trade amounts ...” box, the trade amounts should be for 100 shares.

After using this feature to generate a series of trades, you can check how closely the statistical properties of the generated series match the input statistics by selecting the **Performance Results** command from the View menu. If the statistics are not sufficiently close to the statistics you entered, try repeating the process. Because of the random nature of the process, a second series of trades based on the same inputs will often have slightly different results, which may match the inputs more closely.

After generating the trades, dates can be attached to the trades using the trade editor (**Edit/Add**, Trades menu) via the Set Date Range button.

Specifying a Risk Value for All Trades

Market System Analyzer (MSA) allows you to specify a risk value to be assigned to all trades. If all your trades have the same risk, it's often easier to specify this value once for all trades rather than including a separate column for trade risk in the text file to import. The **Specify Trade Risks** command of the Trades menu allows you to do this.

The **Specify Trade Risks** command brings up the Trade Risks window, as shown below. This window offers several options for specifying a risk value to be assigned to existing trades. The options are as follows:

1. The largest historical loss. This is the largest loss among the trades currently loaded into MSA. This option is often used with fixed fractional trading.
2. The average loss. This is the simple numerical average of all losing trades.
3. The average loss minus X standard deviations. This subtracts a user specified multiple of the standard deviation of the losing trades from the average losing trade. Enter a value for X, the number of standard deviations, then click the Calculate button to compute the risk value.
4. A user-specified risk value. This value can be entered as either a positive or negative number (it has the same effect either way). A typical value would be the size in dollars of the money management stop used for trading.

For the Trade Risk window, the loss and risk amounts are always on a per-share or per-contract basis. For example, if the largest loss in the trade history is -\$500, and this trade took place with 100 shares, then the largest historical loss shown in the Trade Risks window would be \$5.00 (-\$500/100 shares is a loss of \$5 per share). This also applies to user-specified risk values (i.e., the option “Use the following value”). When using this option, the risk value should be entered on a per-share basis for stocks/forex or a per-contract basis for futures.

After specifying the risk value, choose whether to replace all current risk values or assign the specified risk value only where risks are currently undefined. The latter option is useful if you have already manually entered risk values for some trades and want to fill in the remaining risks with the value specified here.

The fixed fractional (fixed risk) and profit risk position sizing methods are the only position sizing methods of MSA that require risk values. The calculation of R-multiples also requires risk values.

Note that this command directly modifies the input data. The specified risk values are stored in the trades file.

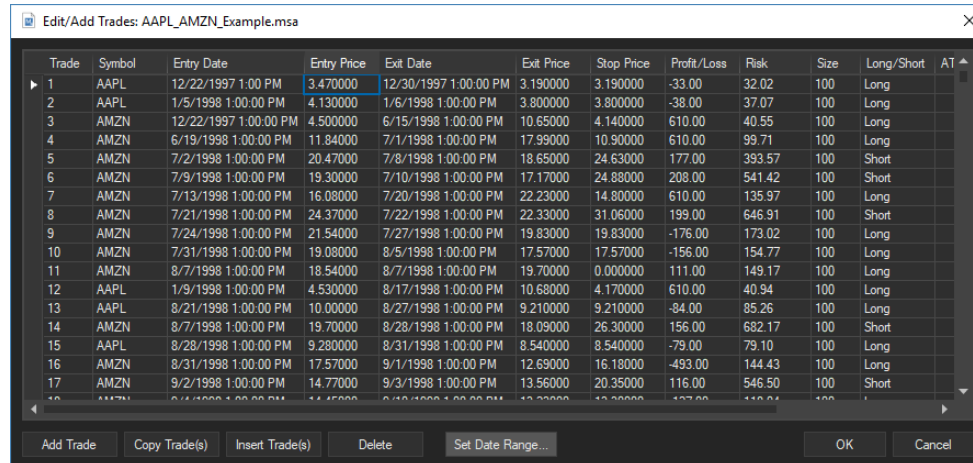
Editing Input Data

The **Edit/Add** command of Market System Analyzer (MSA) allows you to manually enter new trade data into MSA or edit trades that have already been entered. Selecting the **Edit/Add** command from the Trades menu brings up the Edit/Add Trades window, as shown below.

The window lists all trades currently in the market-system file, regardless of the date range setting in the menu bar. All items in the grid can be edited in-place, either by simply entering new values or by using the control that is activated when clicking the item. For the Entry Date and Exit Date items, an arrow button at the right-hand side of the date/time brings up a calendar control, which allows you to select a new date. Alternatively, each part of the date and time can be selected and new values entered. To change the year, enter a two-digit value,

rather than the full, four-digit year. The Long/Short and Trade Type items use drop-down menus, which allow you to select from the available options.

To add a trade, use the Add Trade button beneath the trade list. A new trade will be added above the one currently selected. If there is no current selection, the trade will be added to the bottom of the list. To deselect all current selections, click the part of the window just outside the grid.



Trade	Symbol	Entry Date	Entry Price	Exit Date	Exit Price	Stop Price	Profit/Loss	Risk	Size	Long/Short	AT
1	AAPL	12/22/1997 1:00 PM	3.470000	12/30/1997 1:00:00 PM	3.190000	3.190000	-33.00	32.02	100	Long	
2	AAPL	1/5/1998 1:00:00 PM	4.130000	1/6/1998 1:00:00 PM	3.800000	3.800000	-38.00	37.07	100	Long	
3	AMZN	12/22/1997 1:00:00 PM	4.500000	6/15/1998 1:00:00 PM	10.650000	4.140000	610.00	40.55	100	Long	
4	AMZN	6/19/1998 1:00:00 PM	11.840000	7/1/1998 1:00:00 PM	17.990000	10.900000	610.00	99.71	100	Long	
5	AMZN	7/2/1998 1:00:00 PM	20.470000	7/8/1998 1:00:00 PM	18.650000	24.630000	177.00	393.57	100	Short	
6	AMZN	7/9/1998 1:00:00 PM	19.300000	7/10/1998 1:00:00 PM	17.170000	24.880000	208.00	541.42	100	Short	
7	AMZN	7/13/1998 1:00:00 PM	16.080000	7/20/1998 1:00:00 PM	22.230000	14.800000	610.00	135.97	100	Long	
8	AMZN	7/21/1998 1:00:00 PM	24.370000	7/22/1998 1:00:00 PM	22.330000	31.050000	199.00	646.91	100	Short	
9	AMZN	7/24/1998 1:00:00 PM	21.540000	7/27/1998 1:00:00 PM	19.830000	19.830000	-176.00	173.02	100	Long	
10	AMZN	7/31/1998 1:00:00 PM	19.080000	8/5/1998 1:00:00 PM	17.570000	17.570000	-156.00	154.77	100	Long	
11	AMZN	8/7/1998 1:00:00 PM	18.540000	8/7/1998 1:00:00 PM	19.700000	0.000000	111.00	149.17	100	Long	
12	AAPL	1/9/1998 1:00:00 PM	4.530000	8/17/1998 1:00:00 PM	10.680000	4.170000	610.00	40.94	100	Long	
13	AAPL	8/21/1998 1:00:00 PM	10.000000	8/27/1998 1:00:00 PM	9.210000	9.210000	-84.00	85.26	100	Long	
14	AMZN	8/7/1998 1:00:00 PM	19.700000	8/28/1998 1:00:00 PM	18.090000	26.300000	156.00	632.17	100	Short	
15	AAPL	8/28/1998 1:00:00 PM	9.280000	8/31/1998 1:00:00 PM	8.540000	8.540000	-79.00	79.10	100	Long	
16	AMZN	8/31/1998 1:00:00 PM	17.570000	9/1/1998 1:00:00 PM	12.690000	16.180000	-493.00	144.43	100	Long	
17	AMZN	9/2/1998 1:00:00 PM	14.770000	9/3/1998 1:00:00 PM	13.560000	20.350000	116.00	546.50	100	Short	

When entering a new trade, the Trade Type defaults to “Regular”. As explained in Getting Data into the Program under the description of the Trade Type input data field, trades can also be entered to represent cost/fees or additions/withdrawals. To enter either of these trade types, select the corresponding option using the Trade Type drop-down menu and enter the amount in the Profit/Loss field.

The Copy Trade(s) and Insert Trade(s) buttons work together. First, select one or more trades to copy using the Shift and/or Control keys to select multiple trades. Then click the Copy Trade(s) button. Next, select the trade where you want to insert the copied trades, and, finally, click the Insert Trade(s) button to insert the trades at that location.

You can delete one or more trades by selecting them from the list then clicking the Delete button below the list. You can also use the Delete button to clear specific cells in the grid.

The Set Date Range button can be used to assign entry and exit dates to a list of trades when dates are not already part of the trade list; e.g., when using the Create Trades From Statistics feature. Clicking this button opens a window that allows you to enter a date range for the list of trades and an optional average trade length to be assigned to each trade.

The window also has a right-click (context) menu with options for the buttons described above, as well as options to copy the entire table to the clipboard and to copy selected items in csv or html format to the clipboard. In addition, the context menu has an option to save the trade data to a text file in any of the following formats: tab-delimited text (.txt), comma-delimited text (.csv), unformatted Word (.doc), or html (.htm).

Chapter 4

Basic Settings

Overview

Once the trade data are entered into Market System Analyzer (MSA), there are a number of settings that should be made to properly set up the market-system document. These basic settings include specifying the trade vehicle (stocks/forex or futures), the starting account equity, margin, point value (for futures), account locale, and position sizing and withdrawal options. For market systems, these settings are made via the **Setup** command of the Analysis menu.

The most important basic settings for portfolios are the list of market systems in the portfolio, the starting account equity, and the account locale. These settings are made using the **Setup** command of the Portfolio menu.

Market System Settings

To enter the basic settings for a market-system (.msa) document, select the **Setup** command of the Analysis menu. The Analysis Setup window has four tabs: Input Data, Account Settings, Options, and Monte Carlo Settings.

Input Data tab

The Input Data tab allows you to control how the input data are interpreted. The Trading Vehicle drop-down menu allows you to choose between “Futures” and “Stocks/Forex.” If the trading vehicle is futures, position sizing will be in terms of “contracts.” If the trading vehicle is stocks/forex, position sizing will be in terms of “shares.” The other major difference between stocks/forex and futures is how the margin requirement is determined. For futures, the required margin is a fixed amount per contract. The margin requirement for stocks/forex, on the other hand, is a fraction of the purchase price, which is determined from the entry price. As the name implies the stocks/forex vehicle is intended for both stock and forex trading.

If the trading vehicle is futures, the point value for the futures contract can be entered in the space following “Point Value (futures only):” The point value is used to determine the value of a futures position, which is required with several position sizing methods, such as the leverage target method. The point value is multiplied by the price to determine the value of the position. For example, if the price of an E-mini S&P futures contract is 1225.00, the point value would be \$50, and value of the position would be 50 x 1225 or \$61,250. For the stock/forex vehicle, the point value is always equal to 1.

Analysis Setup

Input Data Account Settings Options Monte Carlo Settings

Trading Vehicle: Stocks/Forex Point Value (futures only, \$): 1

*Required when using price data to calculate profit/loss and risk.

Calculate profit/loss and risk using: Prices (entry/exit/stop)

Where trade size is not specified in input data, use the following value for interpreting profit/loss and/or risk data:

Default Trade Size: 1 shares per trade

Profit/loss and risk data are expressed as percentages of equity

Profit/loss data include trading costs (slippage, commissions, fees)

Entry/exit prices include slippage

Automatically reload chart data every 0 hrs 0 min 0 sec

OK Cancel Apply Help

The drop-down menu next to “Calculate profit/loss and/or risk using:” is used to specify how the input data are used to determine the profit/loss and risk values when both profit/loss/risk and price data are available. If the first option, “Profit/loss/risk data,” is chosen, the profit/loss and risk data themselves are used. If the second option, “Prices (entry/exit/stop),” is chosen, the price data are used to calculate the profit/loss and risk values. The default is Profit/loss/risk data. Prices should be used for forex trades if you plan to use the currency conversion factor since profit/loss values are not multiplied by the currency conversion factor; see Getting Data into the Program in the Input Data chapter.

The next entry on this tab is the default trade size. This is used to interpret the profit/loss and risk data if the trade size has not been included with the input data. For example, if the profit/loss amount is \$500, and there is no corresponding trade size in the input data, the default trade size will be used. If the default trade size is 100 shares, for example, then the profit/loss value of \$500 will be interpreted as \$500 per 100 shares or a profit of \$5 per share. This can be used to simplify the data entry when all trades are for the same number of shares or contracts. In this case, the trade size can be entered here, and the trade size field can be skipped when importing or entering the data. If the trades are specified in terms of entry, exit and stop prices rather than profit/loss and risk amounts, the default trade size will only be used when the position sizing is set to “None.”

The first check box in the bottom part of the window can be used to indicate that the profit/loss and risk data are percentages of account equity rather than dollar amounts. This is intended to accommodate the trade reports of some trading platforms that list the percentage return of each trade, rather than the dollar amount. For example, if a trade was a 1.4% profit, it could be entered as 1.4. Checking the box would instruct MSA to interpret the value as the percentage of account equity at the time the trade was taken, assuming that 100% of account equity was invested in the trade and that all profit/losses are re-invested. If this option is chosen, MSA tracks the equity after each percentage profit/loss to determine the

corresponding dollar amount of profit/loss for each trade. Ultimately, the dollar amounts corresponding to the percentages are needed for position sizing calculations.

If the trade profit/loss data already include an amount for commissions, slippage and fees, check the middle box. If this is done, the fees will not be deducted from the profit/loss amount but will be listed in the results. Similarly, if the entry and exit prices include the slippage, you would check the next box. In this case, MSA will not deduct the amount entered for slippage from the profit/loss results determined from the price data (if applicable) but will list the slippage in the results.

The last box is used to automatically reload the chart data at specified intervals. If this box is checked, the program will reload the trade data from the trades file every specified number of hours, minutes, and seconds. For example, if you entered zero in the first box, 3 in the second box, and 15 in the last box, MSA would reload the chart data every three minutes and 15 seconds. This is intended for day traders who have set up their trading software to update the trades file after each trade. For example, a system written for TradeStation could use the WriteTrades function included with MSA for this purpose.

Account Settings tab

The Account Settings tab, shown below, allows you to set basic options related to your trading account, such as the starting account equity value, margin requirements, and trading costs. At the top of the page, you can enter the starting account size in currency units (e.g., dollars) and the maximum allowable number of shares/contracts. The starting account size is used to begin the equity curve calculation. This is the amount of money in the trading account at the start of the simulation. The starting account size must be greater than zero to generate an equity curve. The program will automatically calculate the minimum value necessary to cover the maximum drawdown without position sizing and set the starting equity to that value by default.

The screenshot shows the 'Analysis Setup' dialog box with the 'Account Settings' tab selected. The dialog is divided into several sections:

- Input Data:**
 - Starting account size (\$): 100000
 - Trade size limit: 1000000 shares
 - Account locale: English (United States), \$
- Costs:**
 - Commissions & Fees:**
 - 0.05 (input), Percent of Value (dropdown)
 - Deducted per Side (dropdown)
 - Assessed per Trade (dropdown)
 - Slippage:**
 - 0.001 (input), Amount (Currency Units) (dropdown)
 - Deducted per Round-Turn (dropdown)
 - Assessed per Share/Contract (dropdown)
- Margin:**
 - Futures: Initial margin per contract (\$): 0 (input)
 - Stocks/Forex: Minimum margin requirement (%): 50 (dropdown)
 - Leverage: 2.00:1
- Withdrawals:**
 - Withdraw 0 (input)
 - fixed amount every year (dropdown)
 - % of equity

Buttons at the bottom: OK, Cancel, Apply, Help.

The "Trade size limit" puts a limit on the number of shares or contracts generated in producing the equity curve. The default is 1,000,000 shares or 5000 contracts. One reason to change this value would be to set it to the exchange's position size limit for the futures contract being traded. For example, if you're trading a futures contract that has an exchange-mandated position size limit of 500 contracts, you could change this value to 500.

You can also select the locale for your trading account on this tab. The locale determines the currency unit used for display purposes (dollar, Yen, Euro, etc.) as well as the number format. The default value is the locale set in Windows in the control panel under Regional and Language Options.

Trading costs consist of Commissions & Fees and Slippage. Both costs are specified with three drop-down menus. The first allows you to choose between "Amount (Currency Units)" and "Percent of Value". The latter is the percentage of the dollar value of the trade. The second drop-down menu offers a choice between deducting the cost "per Side" or "per Round-Turn". "per Side" means that the amount is deducted once at the entry and again at the exit whereas "Round-Turn" means that the amount is deducted once per trade. The third drop-down menu determines whether the cost is assessed "per Trade" or "per Share/Contract". The latter means that the total cost is determined by multiplying the specified value by the position size.

The margin is entered according to whether the trading vehicle is futures or stocks/forex. If the trading vehicle is futures, the margin is specified as the initial margin requirement per contract; e.g., \$6000 per contract for the E-mini S&P 500 futures. If the trading vehicle is stocks/forex, the margin requirement is entered as a percentage of the purchase price of the trade. For example, if the margin is 50%, the equity in the trading account would need to be at least 50% of the purchase price of the trade. To purchase 100 shares of a \$25 stock would require \$1250. A "margin account" in the U.S. generally allows no less than 50% margin.

For the stocks/forex vehicle, margin is related to leverage. The lower the margin requirement, the higher the leverage. The relationship is as follows: $\text{Leverage} = 100/\text{margin}$. For example, a margin of 50% implies leverage of two, or 2:1 ("two to one"). Margin of 25% would be leverage of 4:1. The leverage is listed to the right of the percentage margin.

Periodic Withdrawals. This option allows you to set up a schedule of regular withdrawals within the simulation that MSA performs. Withdrawals can be specified as a fixed amount (e.g., \$5000) or a percentage of account equity (e.g., 4% of equity). The withdrawals can be scheduled weekly, monthly, quarterly, or yearly. The actual withdrawal date/time is 1 second prior to midnight on the last day of the week, month, quarter, or year. Once the settings are made, withdrawal "trades" are added to the trades file at each withdrawal date. These withdrawal trades are given the symbol "Period WD" and can be examined using the **Edit/Add** command of the Trades menu. The value of the withdrawal (either amount or percent of equity) will be shown in the Profit/loss field. The trade type will be shown in the Edit/Add Trades list as either "Amt-Add/With" for a withdrawal amount or "Per-Add/With" for a percentage withdrawal.

Periodic withdrawal trades cannot be changed via the trade editor. To change or remove the withdrawals, use this tab of the **Setup** command. To add one-time additions or withdrawals, use the trade editor and set the trade type to one of the Addition/Withdrawal options, as discussed in Chapter 3, Input Data.

Because periodic withdrawals are implemented as a specific type of trade, they can only be added to market systems, not portfolios. When a market system with periodic withdrawals is

added to a portfolio, the withdrawals will be automatically included in the portfolio. Periodic withdrawals specified as a percentage of equity will be applied to the portfolio equity.

Options tab

The Options tab, as shown below, contains a number of options for position sizing, dependency analysis, and the significance test. The first option, "No skipped trades. Trade a minimum of [] shares/contracts/units per trade", if checked, means that even if the account size is too small to support one share/contract/unit, as determined by the position sizing method, the specified minimum number of shares/contracts/units will be traded nonetheless. This option can be useful for smaller accounts, where you might choose to exceed the risk limits imposed by the position sizing method. It is also a way to force the simulation to trade through a drawdown that would otherwise result in a position size of zero.

Analysis Setup

Input Data Account Settings Options Monte Carlo Settings

Position Sizing Options

No skipped trades. Trade a minimum of 100 shares per trade.

Trade 1 shares per trade until equity reaches (\$) 0

Trade in units of 100 shares

Limit number of open positions to 0

Skip trade if total allocated margin would exceed 30% of equity.

Dependency Analysis

Perform runs test over a sliding window 0 trades in length.

Significance Test

Number of rules and/or restrictions in the trading system or method: 15

Confidence level: 95

Risk-free interest rate for Sharpe ratio: 0 % monthly

OK Cancel Apply Help

The second option in this section, "Trade [] shares/contracts/units per trade until equity reaches []," means that the program will trade exactly the specified number of shares/contracts/units, ignoring the position sizing method, until the equity reaches the specified value. At that time, the chosen position sizing method will take effect. This option can be useful for small futures trading accounts, where typical position sizing methods often switch from one contract to two after a win then back down to one contract after a loss. To avoid this kind of "unstable" position sizing, it's sometimes preferable to simply trade a fixed number of contracts until the account equity is large enough to take full advantage of a more formal position sizing method, such as fixed fractional trading.

The next option is to trade in units of a specified number of shares or contracts. This is particularly useful for stock and forex trading, where you may want to trade in "even lots" of, say, 100 shares of stock or 100,000 shares of forex. In this case, you would check the option and enter 100 in the box to trade in units of 100 shares. The number of shares for each trade will be a multiple of 100. For forex trading, a full-size lot is generally 100,000 shares, a mini

lot is 10,000 lots, and so on. When this option is checked, some parameters and results will be listed in terms of “units” rather than shares or contracts.

The next option allows you to limit the number of simultaneous open positions to a specified number. This only applies if you have trades that overlap in time so that multiple trades are open at the same time. In this case, you can specify the maximum number of trades that are allowed to be open at the same time. Once that limit is reached, no new entries will be allowed until an open position exits. This option overrides all other options, including the "no skips" option.

The final option in the first section skips an entry if taking the trade would cause the total allocated margin for all open positions to exceed the specified percentage of account equity. Like the prior option, this option is relevant to situations where you may have multiple positions open at the same time. Rather than skipping the entry based on the number of open positions, as with the prior option, this option enables you to skip the entry based on the total margin of all open positions. This option overrides all other options, including the "no skips" option.

The next option affects the dependency analysis. In addition to performing the dependency analysis (runs test) over all trades in the current sequence, the runs test can optionally be performed over a sliding window of trades, N trades in length. To add this analysis, check the box and enter the value for N. The analysis will repeat the runs test over a window of trades N trades in length, moving the window one trade forward each time. For example, if there are 100 trades, and N = 30, the first runs test will be conducted over trades 1 - 30. The next runs test will be over trades 2 - 31, the third over trades 3 - 32, etc. The last runs test will be performed over trades 71 - 100. The results for each runs test will be displayed in the Dependency tab of the Performance Results window. Also see Chapter 9, Trade Dependency, Overview.

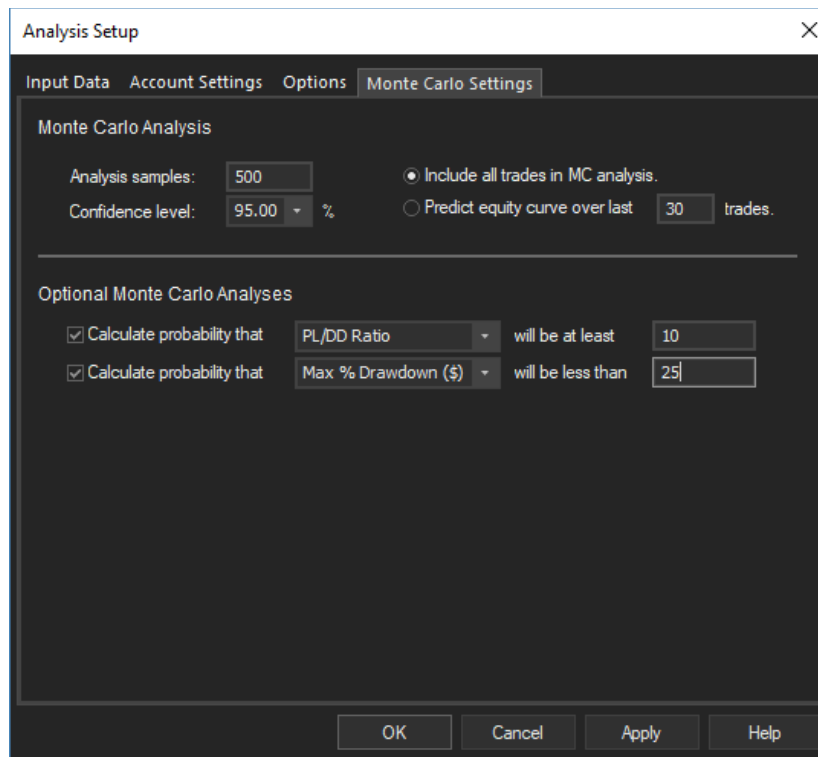
The next section is where you enter the inputs for the statistical significance test. Enter the number of rules and/or restrictions imposed by the trading system or method and select the confidence limit for the average trade calculation. See Chapter 10, Significance Testing, for more information.

Finally, this tab allows you to enter a value for the risk-free interest rate used in calculating the Sharpe ratio. The interest rate is a monthly rate, not an annual rate. See Chapter 12, Viewing the Results, Performance Results, for the definition of the Sharpe ratio.

Monte Carlo Settings tab

The Monte Carlo Settings tab, as shown below, presents options and settings for the Monte Carlo analysis. The number of samples used in performing the Monte Carlo calculations can be entered here. The default is 500 samples. Choosing more than this will provide more accurate results but will slow down the analysis proportionally to the number of samples; twice as many samples will take twice as long, for example. You can also select the probability at which the Monte Carlo results are recorded. The default is 95%. Any value from 50% to 100% can be entered. This is the probability that is displayed in the Monte Carlo Results window. Also see Chapter 6, Monte Carlo Analysis, Overview.

You can choose between two types of Monte Carlo analyses. Selecting "Include all trades in MC analysis" will perform a standard Monte Carlo analysis based on randomizing the trade order. Following the analysis, the equity curve plot will display four lines: the current sequence of trades, the equity curve at the specified confidence level, the equity curve at the lower confidence level (100 minus the specified confidence), and the equity curve at 50% confidence.



If you choose "Predict equity curve over last N trades", where N is the number entered in the edit box, the trades prior to the last N trades will be randomly sampled (with replacement) to extrapolate the equity curve over the last N trades based on the prior trades. As with the other option, four equity curves will be displayed, this time over the last N trades: the current sequence and the curves at high, low, and median confidence. This feature can be used to detect when the trading strategy is underperforming based on the prior history. In particular, if the current sequence is below the predicted curve at high confidence (i.e., the lower curve), the strategy may be out of sync with the market and may need to be modified (e.g., re-optimized) or abandoned.

There are two optional Monte Carlo analyses that can be performed. The first option calculates the probability that the specified performance metric will be at least as large as the entered value. For example, if the selected metric is the average annual return and the entered value is 30, this would calculate the probability that the average annual return would be at least 30%.

The second option calculates the probability that the selected metric will be less than the entered value. For example, if the selected metric is the profit factor and the entered value is 1.5, this would calculate the probability that the profit factor would be less than 1.5.

Note that if you want to calculate one of the optional analyses over a specified time period, you can use the date range controls in the menu bar to change the time span for the simulation prior to running the optional analyses. For example, if you wanted to know the probability that Van Tharp's SQN was at least 5 over the last three months, you could first change the date range to the last three months before applying the first optional rule.

Portfolio Settings

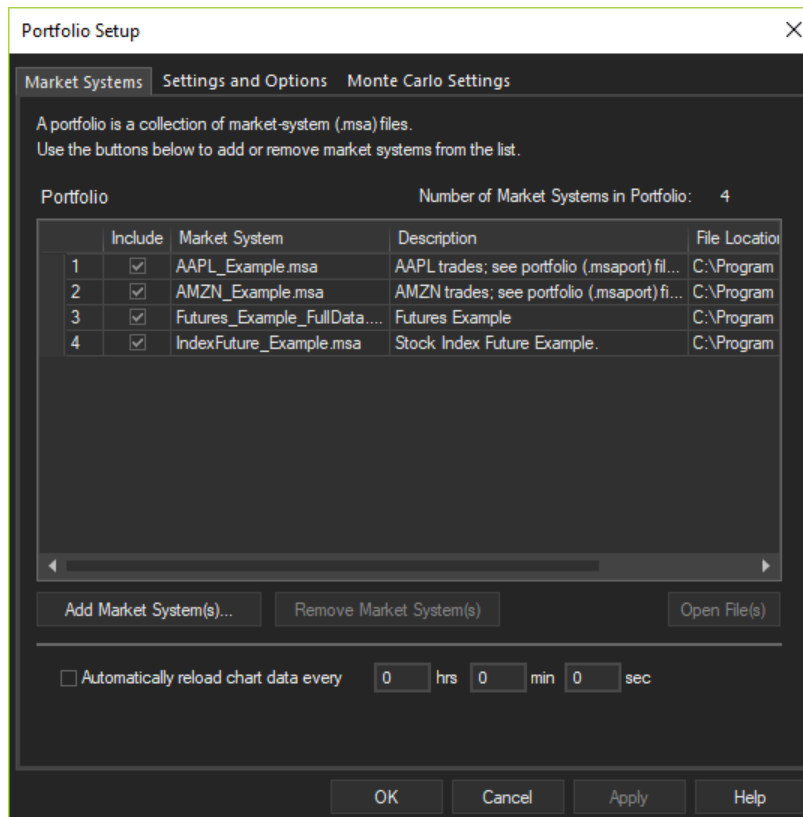
To enter the basic settings for a portfolio (.msaport) document, select the **Setup** command of the Portfolio menu. The Portfolio Setup window has three tabs: Market Systems, Settings and Options, and Monte Carlo Settings, described below.

Market Systems tab

Use the Add Market System(s)... button on this tab to select any number of existing market-system (.msa) document files. The selected market systems will be added to the portfolio. A market system can be removed using the Remove Market System(s) button. To open one of the market-system documents comprising the portfolio, either double-click on the market-system name in the list or use the Open File(s) button.

You can use the Include column to add or remove any of the loaded market systems to or from the portfolio without removing the corresponding data from the file. After unchecking a market system, click the Apply button to update the chart and see the effect on the portfolio results. This can be used to quickly evaluate different combinations of market systems.

The check box at the bottom of this tab is used to automatically reload the chart data at specified intervals. If this box is checked, the program will reload the trade data from the trades files for each market system at every specified number of hours, minutes, and seconds. For example, if you entered 5 in the box for seconds, with zero in the other boxes, MSA would reload the chart data every five seconds. This is intended for day traders who have set up their trading software to update the trades file after each trade. For example, a system written for TradeStation could use the WriteTrades function included with MSA for this purpose.



Settings and Options tab

The Settings and Options tab, shown below, allows you to set basic options related to your trading account, such as the starting account equity value, options for position limits, dependency analysis, and the significance test. At the top of the page, you can enter the starting account size in currency units (e.g., dollars). The starting account size is used to begin the equity curve calculation. This is the amount of money in the trading account at the start of the simulation. The starting account size must be greater than zero to generate an equity curve.

You can also select the locale for your trading account on this tab. The locale determines the currency unit used for display purposes (dollar, Yen, Euro, etc.) as well as the number format.

The next section on this tab contains options for setting position limits. This allows you to limit the number of simultaneous open positions. The first option allows you to specify the maximum number of trades that are allowed to be open at the same time. Once that limit is reached, no new entries will be allowed until an open position exits. The second option in this section skips the trade if taking it would cause the total allocated margin for all open positions to exceed the specified percentage of account equity.

The screenshot shows the 'Portfolio Setup' dialog box with the 'Settings and Options' tab selected. The dialog is divided into several sections:

- Account Settings:**
 - Starting account size (\$): 100000
 - Account locale: English (United States), \$
- Position Limits:**
 - Limit number of open positions to 3
 - Skip trade if total allocated margin would exceed 40 % of equity.
- Trade Dependency:**
 - Perform runs test over a sliding window 0 trades in length.
 - Deactivate all dependency rules currently active in individual market system files.
- Significance Test:**
 - Number of rules and/or restrictions in the trading system or method: 12
 - Confidence level: 95
- Risk-free interest rate for Sharpe ratio:** 0 % monthly

At the bottom of the dialog are four buttons: OK, Cancel, Apply, and Help.

Options related to dependency analysis are presented in the next section. In addition to performing the dependency analysis (runs test) over all trades in the current sequence, the runs test can optionally be performed over a sliding window of trades, N trades in length. To add this analysis, check the box and enter the value for N. The analysis will repeat the runs test over a window of trades N trades in length, moving the window one trade forward each time. For example, if there are 100 trades, and N = 30, the first runs test will be conducted over trades 1 - 30. The next runs test will be over trades 2 - 31, the third over trades 3 - 32, etc. The last runs test will be performed over trades 71 - 100. The results for each runs test will be

displayed in the Dependency tab of the Performance Results window. Also see Chapter 9, Trade Dependency, Overview.

There is also an option in this section to deactivate all dependency rules in individual market systems. Checking this box will turn off any dependency rules that have been selected in the individual market systems comprising the portfolio. In this case, the only dependency rules that will affect the portfolio trading results will be those selected for the portfolio. These rules are applied to the trade sequence for the portfolio, which includes all market systems taken together.

The next section is where you enter the inputs for the statistical significance test. Enter the number of rules and/or restrictions imposed by the trading system or method and select the confidence limit for the average trade calculation. See Chapter 10, Significance Testing, for more information.

Finally, this tab allows you to enter a value for the risk-free interest rate used in calculating the Sharpe ratio. The interest rate is a monthly rate, not an annual rate. See Appendix: Performance Metrics for the definition of the Sharpe ratio.

Monte Carlo Settings tab

The Monte Carlo Settings tab, shown below, presents options and settings for Monte Carlo analysis. The number of samples used in performing the Monte Carlo calculations can be entered here. The default is 500 samples. Choosing more than this will provide more accurate results but will slow down the analysis proportionally to the number of samples; twice as many samples will take twice as long, for example.

The screenshot shows the 'Portfolio Setup' window with the 'Monte Carlo Settings' tab selected. The window has a dark background and a light-colored title bar. The 'Monte Carlo Settings' tab is highlighted in the top navigation bar. Below the tab, the 'Monte Carlo Analysis' section contains the following settings:

- Analysis samples: 500
- Confidence level: 95.00 %
- Include all trades in MC analysis. (Selected)
- Predict equity curve over last 30 trades.

The 'Optional Monte Carlo Analyses' section contains the following settings:

- Calculate probability that Ave Annual Return will be at least 30 (Checked)
- Calculate probability that Sharpe Ratio will be less than 1.0 (Checked)

At the bottom of the window, there are four buttons: OK, Cancel, Apply, and Help.

You can also select the probability at which the Monte Carlo results are recorded. The default is 95%. Any value from 50% to 100% can be entered. This is the probability that is displayed in the Monte Carlo Results window. Also see Chapter 6, Monte Carlo Analysis, Overview.

You can choose between two types of Monte Carlo analysis. Selecting "Include all trades in MC analysis" will perform a standard Monte Carlo analysis based on randomizing the trade order. Following the analysis, the equity curve plot will display four lines: the current sequence of trades, the equity curve at the specified confidence level, the equity curve at the lower confidence level (100 minus the specified confidence), and the equity curve at 50% confidence.

If you choose "Predict equity curve over last N trades", where N is the number entered in the edit box, the trades prior to the last N trades will be randomly sampled (with replacement) to extrapolate the equity curve over the last N trades based on the prior trades. As with the other option, four equity curves will be displayed, this time over the last N trades: the current sequence and the curves at high, low, and median confidence. This feature can be used to detect when the portfolio is underperforming based on the prior history. In particular, if the current sequence is below the predicted curve at high confidence (i.e., the lower curve), one or more of the strategies in the portfolio may be out of sync with the market and may need to be modified (e.g., re-optimized) or abandoned.

There are two optional Monte Carlo analyses that can be performed. The first option calculates the probability that the specified performance metric will be at least as large as the entered value. For example, if the selected metric is the average annual return and the entered value is 30, this would calculate the probability that the average annual return would be at least 30%.

The second option calculates the probability that the selected metric will be less than the entered value. For example, if the selected metric is the profit factor and the entered value is 1.5, this would calculate the probability that the profit factor would be less than 1.5.

Note that if you want to calculate one of the optional analyses over a specified time period, you can use the date range controls in the menu bar to change the time span for the simulation prior to running the optional analyses. For example, if you wanted to know the probability that Van Tharp's SQN was at least 5 over the last three months, you could first change the date range to the last three months before applying the first optional rule.

Chapter 5

Position Sizing

Overview

Position size is the number of shares or contracts bought or sold for a given trade. If your position size is too large, a string of losses could force you to stop trading. With the built-in leverage of futures or forex, trading too many contracts can even cause you to lose more money than you have in your account. On the other hand, if your position size is too small, you'll be underutilizing your account equity, and your performance will suffer. Finding the proper balance is a part of good money management, and most experts agree that money management is one of the most critical aspects of trading.

In Market System Analyzer (MSA), the position sizing method for a market system is selected using the **Position Sizing** command of the Analysis menu. For a portfolio, the position sizing methods for the market systems comprising the portfolio are selected using the **Position Sizing** command on the Portfolio menu. See Chapter 14, Menu Commands, for the specifics of each **Position Sizing** command.

With each position sizing method available in MSA, except for fixed size and constant value position sizing, the number of contracts increases as profits accrue and decreases as the equity drops during a drawdown. Position sizing methods that use this approach are known as antimartingale methods. Antimartingale methods take advantage of the positive expectancy of a winning trading system or method. If you have an "edge" with your trading (i.e., your trading method is inherently profitable), you should use an antimartingale method, such as those listed above. The alternatives, known as martingale methods, decrease the amount at risk after a win and increase the amount at risk after a loss. A commonly used example is "doubling down" after a loss in gambling. Martingale methods are often used by gamblers, who trade against the house's advantage.

Provided you have a profitable trading method, antimartingale methods are always preferable over the long run because they're capable of growing your trading account geometrically. However, it's sometimes possible to lower your risk by taking advantage of patterns of wins and losses, similar to martingale methods. MSA offers two options for doing this: dependency rules and equity curve trading. Both of these methods adjust the position sizing while maintaining the selected position sizing method. While martingale methods are not recommended, these adjustments to the antimartingale methods can sometimes prove beneficial.

When a position sizing method is applied in MSA, the equity curve in the main chart uses that method to accumulate the equity from trade to trade to simulate continuous trading over that series of trades. This approach is intended for evaluating market systems and position sizing methods. However, a different approach is needed for trading on a day to day basis, where it's necessary to determine the number of shares/contracts for the next (upcoming) trade. In MSA this is referred to as real time position sizing (see Real Time Position Sizing, below). This capability is provided with the **Trade Size** command (Analysis menu for market systems; Portfolio menu for portfolios), which is a kind of position sizing calculator. You can use the

Trade Size command to determine the position size for the next trade based on your current account equity and applying the currently selected position sizing method, parameters, and related settings.

Regardless of the position sizing method chosen, the number of shares or contracts in MSA is limited by the margin requirements, provided margin data have been entered on the Analysis Setup window. This insures that the number of shares or contracts could actually be traded with a real money account. To turn off this limit, enter a value of zero for the futures margin or stock/forex margin percentage. The position size is also limited to the trade size limit specified on the Account Settings tab of the Analysis Setup window.

When applying position sizing to a portfolio, MSA uses the settings retrieved from the market-system documents unless a setting made via the Portfolio menu overrides a market-system setting.

For information on applying the position sizing methods of MSA within TradeStation strategies, see the Appendix: Position Sizing Code for TradeStation and MultiCharts.

None

The default position sizing method in MSA is “None.” This is the first method listed on the Position Sizing Method window. In this case, the position size is taken directly from the trade size field of the input data. If the trade size was not provided in the input data, the default trade size entered on the Analysis Setup window is used.

Fixed Size

This is the simplest method of position sizing. With this method, you simply choose the number of shares or contracts, and that number is used for each trade. This option is included because (1) it provides a good baseline for comparison to more sophisticated position sizing methods, and (2) many traders are comfortable trading a fixed lot size.

The Monte Carlo analysis feature of MSA can be used to provide a credible prediction of future performance with a fixed position size. Suppose, for example, that you only want to increase the lot size after your account equity has doubled. You could use the Monte Carlo results to obtain the average trade size at 95% confidence and use that to determine how many trades it would take to double your equity. You could also use the position sizing optimization feature with fixed size position sizing to determine the number of shares or contracts that maximizes your net profit, for example, subject to a limit on the maximum drawdown.

Constant Value

With constant value position sizing, each position is sized so that it has a specified value, such as \$1000 per trade. This method can be used when you want to allocate a specified amount of equity to each trade. The constant value method will determine the number of shares/contracts corresponding to your specified amount. For example, if you plan to purchase a stock at a price of \$25 and you want to spend \$35,000, you would trade $35000/25$ or 1400 shares. In this case, the constant value amount is 35000; each trade will be sized so that the position value is \$35,000.

As with fixed size position sizing, this method does not increase position size based on equity. The position size will vary only with the price of the instrument being traded. Also note that this method requires the entry price for each trade.

Fixed Amount of Equity

In this position sizing method, you choose the amount of account equity to trade one share, contract, or unit. The amount is “per unit” if the “Trade in units” option has been selected on the Options tab of the Analysis Setup window. For example, if the dollar amount is \$5,000 and the trading vehicle is futures, you would trade one contract for every \$5,000 in the account. If the account equity is currently \$50,000, you would trade 10 contracts on the next trade.

As another example, suppose the trading vehicle is stocks, the option to trade in units of 100 shares has been selected, and the account equity is \$30,000. If the dollar amount of equity is \$6,000 per unit, then you would trade five units or 500 shares. If the position size calculated in this manner is fractional, the number is rounded down to the nearest integer. For example, for a fixed dollar amount per contract of \$4,000 and an account equity of \$25,000, the program would calculate $25,000/4,000 = 6.25$, which rounds down to six contracts.

It's important to understand that the calculation for the position size is performed prior to each trade using the current value of account equity. For example, if you start with an account size of \$10,000 and there are several winners in a row, you may have, say, \$15,000 in the account after the 10th trade. For the 11th trade, the position size calculation is based on the account balance of \$15,000. As with all position sizing methods in MSA (except fixed size and constant value), the number of shares or contracts increases with higher account balances and decreases as the equity drops during a drawdown.

Percent Volatility

The percent volatility method sizes each trade so that the value of the volatility, as represented by the average true range (ATR), is a specified percentage of account equity. This method is attributable to Van K. Tharp. See, for example, his book "Trade Your Way to Financial Freedom," 2nd ed., McGraw-Hill, New York, 2007, pp. 426-8.

As an example, consider a futures trading system where the ATR is 7.2 points, and the value of each point is \$50. The ATR values can be calculated over any period you choose and are read in with the trade data using the ATR data input field. With a specified volatility percentage of 4% and account equity of \$20,000, the position size for the next trade would be $0.04 \times 20000 / (50 \times 7.2)$ or 2.22. The result is 2 contracts for the next trade.

TradeStation/MultiCharts users can use the WriteTrades function, discussed in the previous chapter, to write out the ATR value corresponding to each trade.

Kelly Formula

The Kelly formula is a specialized form of fixed fractional position sizing, described below, which uses an approximate formula – the Kelly formula – to determine the fixed fraction that maximizes the equity growth rate. Fixed fractional position sizing risks a specified fraction of account equity on each trade. The Kelly formula specifies a particular value of the fixed fraction. This “Kelly f value” is given by the following equation:

$$Fk = ((WL + 1) * Pw - 1) / WL$$

where WL is the ratio of the average winning trade to the average losing trade and PW is the probability of a winning trade.

For example, if the average winning trade is \$300, the average losing trade is \$400, and the percentage of winning trades is 65%, the Kelly f value would be $((0.75 + 1) * .65 - 1)/0.75$ or 0.183. This means that 18.3% of the account would be risked on each trade.

To determine the position size, the trade risk is assumed to be equal to the largest historical loss. For example, if the largest loss experienced by the system in question was \$1,200 trading one contract, and the account equity was \$35,000, then 18.3% of \$35,000 is \$6,405. This is the amount to risk on the trade according to the Kelly formula. With a trade risk of \$1,200, this means we can trade $6405/1200$ or 5 contracts.

MSA automatically calculates the Kelly f value for the current sequence of trades. The value is displayed in the Position Sizing window in the Parameters section when the Kelly formula is selected from the list of position sizing methods.

Please note the following:

1. The Kelly formula is approximate in that it assumes all wins are the same size and all losses are the same size. The optimal f method, described below, removes this assumption.
2. The formula does not take equity drawdowns into account and may produce very large drawdowns in equity. In many cases, the position size will be limited by margin requirements when using the Kelly formula.
3. The Kelly formula is not generally considered to be a practical or viable method of position sizing and is only included for comparison to other methods and for educational purposes.

Fixed Fractional

The idea behind fixed fractional position sizing is that the number of shares or contracts is based on the risk of the trade. Fixed fractional position sizing is also known as fixed risk position sizing because it risks the same percentage or fraction of account equity on each trade. For example, you might risk 2% of your account equity on each trade. Fixed fractional position sizing has been written about extensively by Ralph Vince. See, for example, his book "Portfolio Management Formulas," John Wiley & Sons, New York, 1990.

The risk of a trade is defined as the dollar amount that the trade would lose per contract/share if it were a loss. Commonly, the trade risk is taken as the size of the money management stop applied, if any, to each trade. If your system doesn't use protective (money management) stops, the trade risk can be taken as the largest historical loss per contract/share. This was the approach Vince adopted in his book Portfolio Management Formulas.

As an example, consider a stock trading system that uses a 2 point stop. It might enter long at a price of 48 with a sell stop at 46, for example. The risk per share would be \$2. With a fixed fraction of 5% and account equity of \$20,000, fixed fractional position sizing would risk $0.05 * 20000$ or \$1,000 on the next trade. Since the risk per share is \$2, this means $1000/2$ or 500 shares would be purchased.

Fixed fractional position sizing is often used with leveraged instruments, such as futures. It's one of the only position sizing methods that directly incorporates the trade risk (also see the Profit Risk method).

Optimal f

Like the Kelly formula, optimal f position sizing is a specialized form of fixed fractional (fixed risk) position sizing. Optimal f position sizing uses the fixed fraction that maximizes the geometric rate of equity growth. This method was developed by Ralph Vince (see reference in previous section) as a more accurate version of the Kelly formula. Unfortunately, optimal f has many of the same drawbacks as the Kelly formula. Namely, the optimal f value often results in drawdowns that are too large for most traders to tolerate. As with the Kelly formula, the position size based on the optimal f is often so high that it's limited by margin requirements.

The optimal f value is calculated according to an iterative procedure that maximizes the geometric growth rate for the current sequence of trades. MSA performs this calculation automatically and displays the resulting optimal f value on the Position Sizing window under Parameters when the Optimal f method is selected. The calculation for the position size is the same as for the Kelly formula except that the optimal f value is used in place of the Kelly f value. The trade risk is taken as the largest historical loss per share/contract.

As with the Kelly formula, optimal f position sizing is included primarily for educational purposes. As a practical alternative to optimal f, consider using the optimization feature of MSA with fixed fractional position sizing. Select rate of return as the optimization parameter to maximize, and check the box for applying a limit to the maximum allowable drawdown. Optimize using Monte Carlo analysis to find a much smaller and therefore less risky fixed fraction than optimal f.

Profit Risk Method

The profit risk method is similar to fixed fractional position sizing. In fixed fractional position sizing, the dollar amount risked on a trade is a percentage of the current account equity. In the profit risk method, the dollar amount risked on a trade is a percentage of the starting account equity plus a percentage of the total closed trade profit. Once the risk amount is determined, the number of shares or contracts is calculated the same way as in fixed fractional trading; namely, the amount to be risked is divided by the trade risk per share/contract.

As an example, consider a futures trade where the risk of the upcoming trade is \$300 per contract. This amount might correspond to the size of the money management stop that will be used during the trade or it might be the largest loss per contract that the trading method has ever produced. Now suppose that the trading account started with a balance of \$25,000 and is currently at a value of \$45,000 (a total closed trade profit of \$20,000). The percentages for the profit risk method might be 2% of initial equity and 5% of profits. This means that the total amount to risk on the trade would be $0.02 \times 25000 + 0.05 \times 20000$ or \$1,500. Since the trade risk is \$300 per contract, the number of contracts to trade is $1500/300$ or 5 contracts.

Compared to fixed fractional position sizing, the profit risk method is sometimes more convenient because it separates the account equity into initial equity and closed trade profit. The percentage applied to the initial equity provides a baseline level of position sizing independent of trading profits. Note that if both percentages are the same, the profit risk method will produce the same result as the fixed fractional method.

If the optimization feature of Market System Analyzer is used with the profit risk method, only the parameter for the percentage of profits will be optimized. The parameter for the percentage of the initial equity will be unchanged by the optimization.

Fixed Ratio

In fixed ratio position sizing the key parameter is the **delta**. This is the amount of profit per share/contract/unit to increase the number of shares/contracts/units by one. A delta of \$3,000, for example, means that if you're currently trading one contract, you would need to increase your account equity by \$3,000 to start trading two contracts. Once you get to two contracts, you would need an additional profit of \$6,000 to start trading three contracts. At three contracts, you would need an additional profit of \$9,000 to start trading four contracts, and so on.

Fixed ratio position sizing was developed by Ryan Jones in his book "The Trading Game," John Wiley & Sons, New York, 1999. Based on an equation presented by Jones, it's possible to derive the following equation for the number of contracts in fixed ratio position sizing:

$$N = 0.5 * [((2 * N_0 - 1)^2 + 8 * P/\text{delta})^{0.5} + 1]$$

where N is the position size, N_0 is the starting position size, P is the total closed trade profit, and delta is the parameter discussed above. The carat symbol (^) represents exponentiation; that is, the quantity in parentheses is raised to the power following the carat (x^2 is "x squared; $x^{0.5}$ is "square root of x").

A few points are worth noting. The profit, P , is the accumulated profit over all trades leading up to the one for which you want to calculate the number of shares/contracts/units. Consequently, the position size for the first trade is always N_0 because you always start with zero profits ($P = 0$). The account equity is not a factor in this equation. Changing the starting account size, for example, will not change the number of shares/contracts/units, provided there is enough equity to avoid dropping below zero.

The trade risk is also not a factor in this equation. If trade risks are defined for the current sequence of trades, they will be ignored when fixed ratio position sizing is in effect. All that matters is the accumulated profit and the delta. The delta determines how quickly the shares/contracts/units are added or subtracted. If the "trade in units" option is selected, delta will be the profit per unit to increase the number of units by one. For stock trading, without the trade-in-units option, the delta will be the profit per share to increase the number of shares by one.

Note that the equation above is applicable only to the case where a single delta is used for both increasing and decreasing the number of shares/contracts. MSA allows you to decrease at a different rate. This is accomplished by specifying a delta fraction for decreasing. The delta fraction is multiplied by the original delta to determine the delta for decreasing the position size. The delta fraction is set to the value 1.0 by default, which implies the two deltas will be the same.

If a delta fraction less than 1.0 is entered, the levels of increase and decrease will be closer together, which will cause the position size to decrease more frequently in drawdowns as the equity drops. This will provide more protection from drawdowns but less ability to recover. If a delta fraction greater than 1.0 is entered, the level of decrease will be farther from the level of increase, so the position size will not drop as quickly or change as often during a drawdown. This will provide less protection during drawdowns but make it easier to recover.

Note that if the optimization feature of MSA is used with fixed ratio position sizing, only the delta parameter will be optimized. The delta fraction will be unchanged by the optimization.

Generalized Ratio

As the name suggests, generalized ratio position sizing is a generalized version of fixed ratio position sizing. Generalized ratio position sizing uses an additional parameter – the exponent – to alter the characteristics of the fixed ratio equation. Generalized ratio position sizing is unique to MSA.

The number of shares/contracts/units in generalized ratio position sizing is given by the following equation:

$$N = 0.5 * [(1 + 8 * P/\delta)^m + 1]$$

where N is the number of shares/contracts/units, P is the total closed trade profit, m is the exponent, which must be greater than or equal to zero, and δ is as described for the fixed ratio method. The carat symbol (^) represents exponentiation; that is, the quantity in parentheses is raised to the power of m .

With an exponent of $\frac{1}{2}$, the generalized ratio method is the same as the fixed ratio method with an initial position size of one. With exponent values less than $\frac{1}{2}$ the position size increases more slowly with increasing profits than with the fixed ratio method. With exponents greater than $\frac{1}{2}$, the position size increases more quickly than with the fixed ratio method. An exponent value of one provides the same proportionality as the fixed fractional method. An exponent value of zero gives one share/contract/unit for each trade.

The number of shares/contracts/units always starts at one with generalized ratio position sizing. This can be seen in the equation above. If the profit, P , is zero, N is equal to 1. For this reason, generalized ratio position sizing is more suitable for smaller accounts. Also, for stock trading, the “trade in units” option should be selected so that the initial number of shares will be equal to one unit. If the unit size is 100 shares, for example, the generalized ratio method will start with 100 shares.

Note that if the optimization feature of MSA is used with generalized ratio position sizing, only the delta parameter will be optimized. The exponent, m , will be unchanged by the optimization.

Margin Target

Margin target position sizing sets the size of each position so that the chosen percentage of account equity will be allocated to margin. For example, if you choose a margin target of 30%, then 30% of the account equity will be allocated to margin. For futures trading, the trading margin is specified on a per-contract basis. The margin requirement for trading one contract of the E-mini S&P futures might be \$4,000, for example. For an account equity value of \$30,000, a 30% margin target would mean that $0.3 \times 30,000$ or \$9,000 would be allocated to margin. With a margin requirement of \$4,000, the number of contracts would be $9000/4000$ or 2 contracts (rounded down from 2.25). In other words, a position size of two contracts requires a margin amount (\$8,000) that is as close to 30% of equity as possible without exceeding that target.

For stock trading, the margin requirement is calculated as a percentage of the purchase price of the position. If the margin requirement is 100% (no leverage), you need to pay the full amount of the trade. For example, a stock trade that enters at a price of \$23 would require \$23 per share. However, a typical retail margin account in the US can be margined up to 50%,

which mean that the margin requirement for a \$23 stock would be only \$11.5 per share. If the margin target is, say, 40%, and the account equity is \$25,000, then \$10,000 should be allocated to margin (i.e., 0.4×25000). For a \$23 stock and a margin requirement of 50%, you would trade $10000/11.5$ or 869 shares. In other words, 869 shares would require margin of about \$10,000, which is 40% of the account equity of \$25,000.

If the margin is undefined or the entry price is undefined for stocks, the position size for the margin target method will default to the maximum allowable position size, as defined on the Account Settings tab of the Analysis Setup window.

Leverage Target

The leverage target position sizing method sets the position size so that the leverage of the resulting position matches the selected target. Leverage is defined as the ratio of the value of the position to the account equity. For example, if 1000 shares of a \$30 stock are purchased with a \$25,000 account, the leverage would be $\$30,000/\$25,000$ or 1.2. Leverages greater than 1.0 imply margin percentages less than 100%. A margin percentage of 50%, for example, is equivalent to a leverage of 2 (“2 to 1” or “2:1”). For stocks, the relationship between the minimum margin requirement in percent and the maximum allowable leverage is provided on the Account Settings tab of the Analysis Setup window.

This method requires the entry price and, for futures, the point value (defined on the Input Data tab of the Analysis Setup window). If the entry prices have not been defined or the point value for futures has not been entered, the position size will be zero.

Percent of Equity

This method is intended primarily for stocks. The number of shares is chosen so that the value of the position is equal to the selected percentage of account equity. For example, if the percent of equity is 40%, the position size will have a value equal to 40% of the account equity. If the account equity is \$30,000, the position would have a value of 0.4×30000 or \$12,000. If the share price is \$25, the position size would be $12000/25$ or 480 shares. In other words, a position size of 480 shares at \$25 per share has a value of \$12,000, which is 40% of the equity value of \$30,000.

As with the leverage target method, this method requires the entry price and, for futures, the point value. If the required data are not available, the position size will be zero.

Max Drawdown Method

This method was devised by trader Larry Williams and described in his book “The Definitive Guide to Futures Trading, Volume II,” Windsor Books, New York, 1989, pp. 184-6. The basic idea is to make sure you have enough equity in your account to weather the worst-case drawdown. At a minimum, you would need enough equity to cover the size of the worst-case drawdown plus the margin requirement. For futures trading, this means that in order to trade one contract, you would need at least the one-contract margin requirement plus the worst-case, one-contract drawdown. Larry Williams recommended taking 150% of the worst-case drawdown plus margin for the first contract.

Each subsequent contract is added when the equity increases by 150% of the worst-case drawdown. This insures that you always have enough equity to avoid losing everything even if the worst-case drawdown repeats itself. In fact, even if the drawdown is 150% of the historical worst-case value and it happens at the most inopportune time (which is immediately

after adding a new contract), you would still be left with enough equity to cover the margin for one contract. In MSA, the percentage of maximum drawdown, such as William's recommended value of 150%, is selected by the user. You can set this percentage to any positive value.

Although originally devised for futures trading, this method works equally well for stocks. If the entry price for a stock trade is not available or the margin has not been specified, the required equity for the first share/contract/unit will be zero. In the unlikely case that the historical sequence of trades has zero drawdown, the position size will default to the maximum allowable value specified on the Account Settings tab of the Analysis Setup window.

Maximum Possible

This method sets the position size to the maximum possible number of shares or contracts based on margin requirements. In other words, you'll trade as many contracts or shares as you can afford.

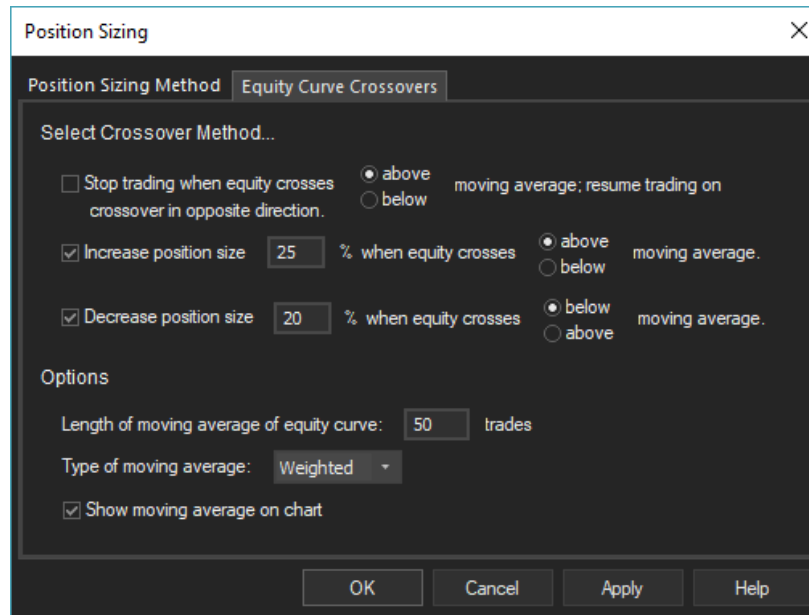
For example, consider a futures trade where the margin requirement for one contract is \$3000. For a \$25,000 account, the maximum possible number of contracts is $25000/3000$ or eight contracts. For a stock trade with an entry price of \$14, a margin requirement of 50% and an account size of \$35,000, the maximum possible number of shares would be 5000 shares ($35000/(0.5 \times 14)$).

If the margin, or the entry price if trading stocks, has not been defined, this method defaults to the maximum allowable position size specified on the Account Settings tab of the Analysis Setup window.

Equity Curve Crossovers

MSA includes an equity crossover feature that allows you to modify the position sizing based on crossovers of a moving average of the equity curve. The equity curve crossover rules are available on the Equity Curve Crossovers tab of the Position Sizing window, as shown below for a market-system document. The same rules can be applied to a portfolio's equity curve using the same command from the Portfolio menu. For a portfolio, you can optionally deactivate any equity curve crossover rules active in individual market-system files.

The basic idea is to either trade more or fewer shares or contracts when the equity curve crosses above or below its moving average. Three rules for implementing this are available. The first rule, "Stop trading when equity crosses above/below moving average; resume trading on crossover in opposite direction" is the most basic and commonly used method. If this rule is selected, you must choose either "above" or "below" to indicate whether to stop trading when equity crosses above or below the moving average. Choose "below" if your system or method tends to produce streaks of wins and losses, so that when it starts to lose, it's best to stop trading until it starts winning again. Choose "above" if your system or method tends to "revert to the mean"; i.e., after several wins, it starts to lose, and vice-versa. Note that the dependency analysis can be used to determine if your system has either of these tendencies with statistical significance. If the first rule is chosen, the other two rules are deactivated.



The second and third rules produce a more subtle change in position sizing than the first one. Whereas the first rule starts and stops trading on crossovers of equity with the moving average, the second and third rules reduce or increase the position size on moving average crossovers. Selecting the second rule will increase the position size for the currently selected method by X% when the equity crosses above/below the moving average. Selecting the third rule will decrease the position size by Y% when the equity crosses above/below the moving average. The second and third rules can be selected together or one or the other can be selected alone. The increase or decrease in the position size is relative to the current value of position size.

If both rules are selected together, make sure that if one rule uses "above", the other uses "below." For example, the second rule might be to increase the position size 50% when equity crosses above the moving average. The third rule might be to decrease the position size by 30% when equity crosses below the moving average. In this case, the parameter is either 50% higher or 30% lower than the baseline value. Alternatively, you can alter the position size on crossovers in one direction but not the other by selecting only one of the second and third rules. For example, if you only select the second rule with a percentage value of 40% and select "above," then the position size will be 40% higher on crossovers above the moving average and will return to the baseline value on crossovers below the moving average.

Under "options" on the Equity Curve Crossovers tab, you can enter the length of the moving average of the equity curve and the type of moving average. The length is the number of trades used to calculate the moving average. MSA has four optional moving average types: simple, exponential, weighted, and TRIX (triple exponential). There is also an option to show the moving average on the chart. The length entry and the option to show the moving average are also available through the **Format Chart** command.

Real Time Position Sizing

Real time position sizing refers to calculating the size of a trading position (i.e., the number of shares of stock/forex or contracts of futures) prior to placing a trade. This is in contrast to the position sizing calculations performed during simulations or back-testing of a trading system or method, such as the calculations performed by MSA in constructing the equity curve for the

chart window. MSA provides the **Trade Size** command of the Analysis menu to enable real time position sizing for individual market systems and the same command on the Portfolio menu for real-time position sizing of portfolios.

The Trade Size window for market systems is shown below.

The screenshot shows a 'Trade Size' window with the following sections:

- Enter values for...:**
 - Current Account Equity (\$): 250000
 - Trade Risk per Unit (\$): 1200
 - Current Market Price/Expected Entry: 1.457
 - Current Average True Range (ATR): 0
- Current Settings:**
 - Position Sizing Method: Margin Target
 - No dependency rules selected.
 - No equity crossover rules selected.
 - Trade at least 100000 shares per trade.
 - Trade in units of 100,000 shares.
- Results:**
 - Position Size for Next Trade: 600,000 shares
 - Trade Cost/Required Margin: \$43,710.00
 - Commissions & Fees: \$300.00
 - Position Risk: \$7,200.00
 - Position Value: \$874,200.00
 - Account Leverage: 3,497 : 1
 - Available Equity: \$206,290.00

Buttons for 'Calculate' and 'Close' are located at the bottom of the window.

To begin, enter the current value of your account equity in the first box. If fixed fractional (fixed risk) or the profit risk position sizing method has been chosen, enter the trade risk in the second box. If the “trade in units” option has been selected, the trade risk will be the risk per unit; e.g., the risk per 100 shares. As explained previously, the trade risk is the dollar amount the trade would lose per share/contract if it were a loss. This is most often determined from the placement of a money management stop order or from the size of the largest historical loss. If required by the selected position sizing method, enter the market price or expected entry price of the trading vehicle and the average true range (ATR) on the bar prior to entry.

Once these data have been entered, click the “Calculate” button in the Results section or press the Enter key on your keyboard. The number of shares or contracts will be displayed, along with several other values; namely, the required margin (for futures) or cost of the trade (for stocks/forex), the commissions and fees associated with the trade, position risk, position value, account leverage, and the account equity that will be available after deducting the trade cost/margin and commissions and fees. You can enter different values for the account equity and trade risk (if applicable) to recalculate the results. Click Close to close the window when finished.

The calculations are performed using the position sizing method, parameters, and settings currently in effect. These settings include the options on the Analysis Setup and Position Sizing windows, including the equity curve crossover rules, as well as the dependency rules. The calculation is performed as if the trade in question was the next trade in the current sequence. That is, the trade for which the position size is calculated is assumed to be the trade that immediately follows the last trade in the current sequence. If, for example, the negative dependency rule has been selected -- "skip the next trade after a win, take the next trade after a loss" -- and the last trade in the current sequence is a win, Trade Size will calculate zero shares/contracts for the next trade. The calculation may also produce a zero position size if the equity curve crossover rule is in effect (depending on the selected rule and the equity curve) or if the entered value of equity is so low that the position size rounds down to zero from a fraction.

Trade Size can also be used as a stand-alone position sizing calculator. In this mode, simply run MSA without opening a .msa file or entering any data into the program. With no data in the program, select "File -> New -> New MSA File" then select your position sizing method and options from the Analysis menu. Press F11 (or select **Trade Size** from the Analysis menu) to open the Trade Size window. Enter the data and click "Calculate," as explained above.

In most cases, the best way to use this feature is to maintain a .msa file containing an up-to-date list of the trades from the system or method of interest. Use MSA to analyze the trades and optimize the position sizing method, preferably limiting the analysis to a range of trades and saving the rest for out-of-sample testing. Select any other rules, such as dependency rules or equity crossover rules, and verify the analysis with out-of-sample testing and Monte Carlo analysis. At this point, assuming the last trade in the current sequence is the most recent trade from your system or method, you can run **Trade Size** with the optimized position sizing parameters and rules to calculate the number of shares or contracts for the next trade. Enter each new trade into MSA to make sure any selected dependency or equity crossover rules reflect the actual trade history. Keeping the list of trades up-to-date also enables you to re-optimize as frequently as after each trade if desired. You should maintain a separate .msa file for each market system you follow with the program in order to store all your analysis settings.

The Trade Size window for portfolios is shown below.

Trade Size

Current Equity (\$): 152640

Enter data for next trade for market system (MS): (4) IndexFuture_Example.msa

Trade Risk:

No New Entry, Exclude MS

Risk Value (\$ per contract): 1875.5

Open Trade, Position Size: 0

Stop Price: 0

Entry/Market Price: 1200

Ave True Range (ATR): 0

Market System	Dep	Cross	Port Dep	Port Cross	New Size	Pos Risk	Pos Value	Open Cost/Margin	New Cost/Margin	New Comm&Fees
1 AAPL_Example.msa	0	0	0	0	100 shr	\$64,082.97	\$12,500.00	\$0.00	\$12,500.00	\$5.00
2 AMZN_Example.msa	0	0	0	0	100 shr	\$38,615.00	\$10,000.00	\$0.00	\$10,000.00	\$5.00
3 Futures_Example_FullD...	0	0	0	0	27 con	\$8,505.00	\$3,240,000.00	\$0.00	\$27,000.00	\$135.00
4 IndexFuture_Example.m...	0	0	0	0	2 con	\$3,751.00	\$120,000.00	\$0.00	\$9,250.00	\$0.00
Total Open Cost/Margin:								\$0.00		
Total New Cost/Margin:									\$58,750.00	
Total Cost/Margin:									\$58,750.00	
Total New Comm&Fees:										\$145.00
Total Position Risk:						\$114,953.97				
Total Position Value:							\$3,382,500.00			
Available Equity:							\$93,890.00			

Calculate Position Sizes

Close

To use this window, enter the current value of your account equity in the space provided. Then enter the data for each market system in the boxes where it indicates "Enter data for next trade for market system (MS)". Use the Next MS button to move to the next market system until the data have been entered for each market system. Finally, click the "Calculate Position Sizes" button. The results are displayed in the table above the calculate button. The results include the name and number of the market system, the position risk ("Pos Risk") if applicable, the calculated position size for the next trade ("New Size"), the margin or cost for both the indicated position size ("New Cost/Margin") and for the open positions ("Open Cost/Margin"), and the commissions and fees corresponding to the calculated position sizes ("New Comm&Fees"). Note that the word "margin" is typically used with futures while "cost" is used with stocks/forex, as with the **Trade Size** command for market systems. This reflects the fact that futures trades require a margin deposit, whereas stocks and forex are typically bought or sold based on the position's value.

There are also columns indicating whether any of the calculated position size is due to a dependency or crossover rule. The columns labeled "Dep" and "Cross" show the position size due to dependency and crossover rules, respectively, from the market-system settings. The columns "Port Dep" and "Port Cross" show the position size due to dependency and crossover rules, respectively, from the portfolio settings. The values in these columns are shown with a "+" sign if the position size added to the total or "-" if it subtracted from the total. If the rule determined that the trade should be skipped, the word "Skip" is shown in the column. For example, a value of "+1" in the Dep column would indicate that a dependency rule in the market-system file increased the position by 1 contract for that market system. A value of -500 in the Port Cross column would indicate that the portfolio equity curve crossover rule decreased the position size by 500 shares. The word "Skip" in the Port Dep column would indicate that a portfolio dependency rule determined that the next trade for that market system should be skipped.

Below the rows for the market system results, totals over all market systems are provided for the open and new cost/margins, commissions and fees for the new trades, and the position risk and position value for the new trades. In addition, the available equity after subtracting the total new cost/margins and total new commissions and fees is also shown.

Most of the required data, such as the trade risk and the entry price, are the same as described above for the **Trade Size** command for market systems. However, for portfolios, it's also necessary to account for any open positions. This is the purpose of the check box "Open trade. Position size". If there is an open position for the market system, the size of the position should be entered here. If no entry is expected for the market system, it can be excluded from the calculations by checking the box "No new entry; exclude MS". This will ensure that no equity is allocated to this market system when determining the position sizes for the other market systems.

Chapter 6

Monte Carlo Analysis

Overview

Monte Carlo analysis is a computational technique for assessing the impact of random variation in a simulation model's parameters. In Monte Carlo analysis, the random variables of a model are represented by statistical distributions, which are randomly sampled to produce the model's output. The output is therefore also a statistical distribution. Compared to simulation methods that don't include random sampling, the Monte Carlo method often produces more useful results, which tend to be more conservative and often more accurate when used as predictions.

In Market System Analyzer (MSA), the trade distribution, as represented by the list of trades, is sampled to generate a trade sequence. Each such sequence is analyzed, and the results are sorted to determine the probability of each result. In this way, a probability or confidence level is assigned to each result. Without Monte Carlo analysis, the standard approach for calculating the historical rate of return, for example, would be to analyze the current sequence of trades using, say, fixed fractional position sizing. It might be found that the rate of return over the sequence was 114%. With Monte Carlo analysis, on the other hand, hundreds or thousands of different sequences of trades are analyzed, and the rate of return is evaluated at a specified probability. For example, the rate of return as determined by Monte Carlo analysis might be 83% with 95% confidence. This means that of all the thousands of sequences considered, 95% had rates of return greater than or equal to 83%.

The Monte Carlo analysis for a market system in MSA is performed when the **Monte Carlo Analysis** command is selected from the Analysis menu. For portfolios, the same command is available on the Portfolio menu. The analysis is performed on the current sequence of trades using the number of samples entered on the Monte Carlo Settings tab of the Analysis Setup window (or the Portfolio Setup window for portfolios). In this context, "sample" means a randomly selected sequence of trades. The default is 500 samples, which means that the Monte Carlo results will be based on 500 random trade sequences. The results in the Monte Carlo Results window will be displayed at the confidence level selected on the Analysis Setup (Portfolio Setup for portfolios) window.

Note: In MSA version 3.5 and above, the Monte Carlo analyses for both market systems and portfolios use parallel processing algorithms that are designed to fully utilize all cores of a multi-core computer to maximize processing speed.

There are two types of Monte Carlo analyses available in MSA. As shown on Analysis Setup, the options are "Include all trades in MC analysis" and "Predict equity curve over last N trades".

Including All Trades in the Monte Carlo Analysis

If this option is selected, each sequence of trades analyzed during the Monte Carlo analysis will consist of a random sampling of the same trades as in the current sequence, with each

trade included once. This method of sampling the trade distribution is known as *random selection without replacement*. Another possible sampling method is *random selection with replacement*. If this method were used, trades would be selected at random from the original list of trades without regard to whether or not the trade had already been selected. In selection with replacement, a trade could occur more than once in the new sequence.

The benefit of selection without replacement is that it exactly duplicates the probability distribution of the input sequence, whereas selection with replacement may not. The drawback to selection without replacement is that the randomly sampled sequences are limited to the number of trades in the input sequence. If you have a short sequence of trades (say, less than 30 trades), this may limit the accuracy of certain calculations, such as the drawdown. Fortunately, the data manipulation features of MSA provide a way to avoid this problem.

If you have a small sample of trades to analyze, it's recommended that you increase the size of your trade list using one of two methods:

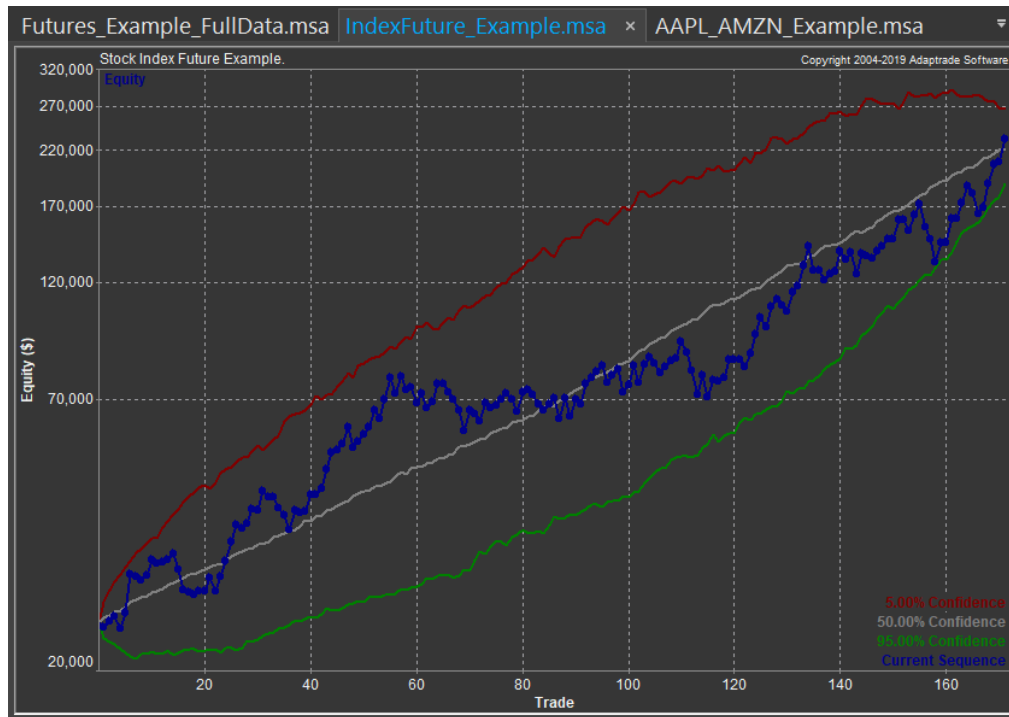
1. Import the list of trades multiple times, appending the imported trades to the existing ones each time. When the list of trades is long enough, such as 100 trades, randomize the sequence several times before performing your analysis. If you entered the trades manually rather than through the import command, export the trades you entered to create a file that can then be imported back in.
2. Use the statistical properties of your small sample, as given in the Performance Results window, to create a larger series of trades using the **Create Trades From Statistics** command.

The first method is similar to random selection with replacement with the added benefit that the final list of trades will have the same statistical properties as the original list. The second method introduces more randomness into the trade sequence, which may be preferable given that trades encountered in the future will likely be different than those of the original sequence. Either of these methods will provide you with a sequence of trades that is as long as needed to generate meaningful results.

When performing the Monte Carlo analysis for a portfolio, MSA randomizes the trade sequence for each market system separately before combining the trade sequences into the portfolio equity curve. This means that any correlations between market systems will be lost during the Monte Carlo analysis. If your analysis or position sizing settings depend on the correlations between market systems, a portfolio Monte Carlo analysis may not generate meaningful results. On the other hand, by removing the correlations, a more conservative result may be generated.

In addition to displaying summary results in the Monte Carlo Results window, the equity curve display will be changed following the Monte Carlo analysis so that it displays probability bands resulting from the analysis. The "Current Sequence" drop-down menu in the menu bar will change to "Monte Carlo", and four equity curves will be displayed, as shown below.

The thicker curve in the figure below is the equity curve for the current sequence of trades. This curve can be changed using the Randomize/Restore commands just like when the "Current Sequence" option is selected in the menu bar. The upper and lower curves in the plot are the lower and higher confidence bands, respectively, for the Monte Carlo analysis. For example, if the confidence level for Monte Carlo analysis is 95%, the lower band will be at 95% confidence, and the upper band will be at 5% confidence (i.e., 100% - 95%). The middle curve represents the results at 50% confidence.

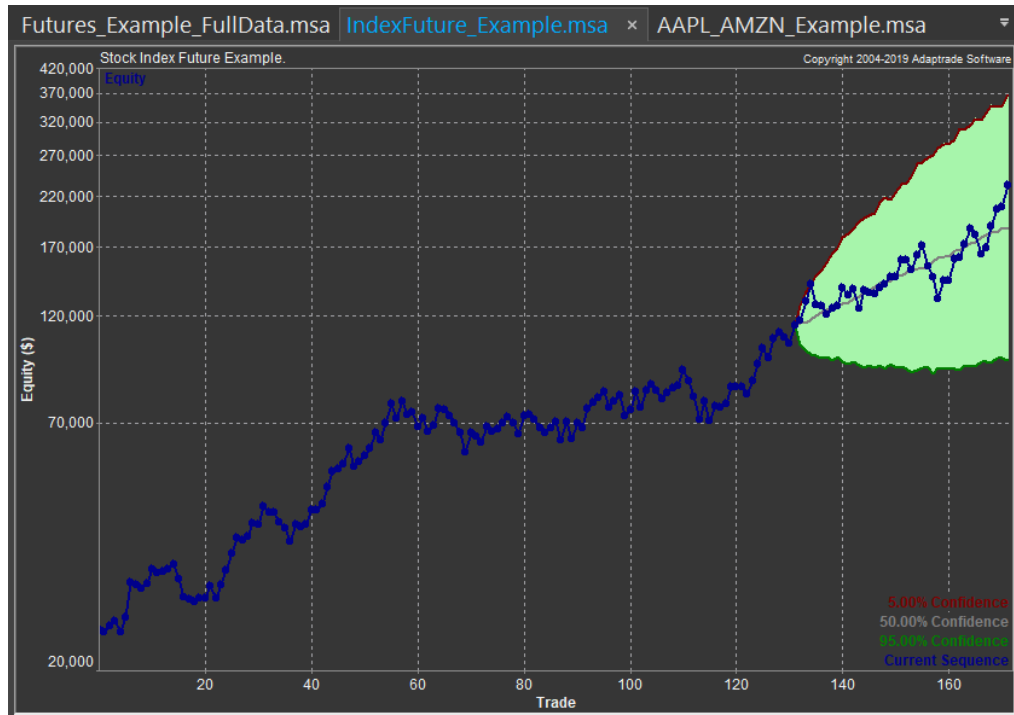


All three curves are calculated trade-by-trade. For example, the equity value at 95% confidence for trade 100 is the equity value lower than 95% of the Monte Carlo iterations for that trade; i.e., 95% of the Monte Carlo iterations had an equity value for that trade higher than the plotted value. In general, increasing the confidence level will increase the width of the channel -- the distance between the upper and lower bands. Setting the confidence level to 100% implies that all equity curves generated from the Monte Carlo analysis fell between the two bands. The curve at 50% confidence represents the trade-by-trade median value of the Monte Carlo iterations. The display can be changed back to the normal equity curve plot by changing the drop-down menu from "Monte Carlo" to "Current Sequence".

Predicting the Equity Curve Over the Last N Trades

If this option is selected, the Monte Carlo analysis will be used to predict a range of possible outcomes for the equity curve over the last N trades, where N is the number of trades entered in the edit box on the Monte Carlo Settings tab of the Analysis Setup (or Portfolio Setup) window. In this case, the trades preceding the last N trades are randomly sampled with replacement to choose N trades for each Monte Carlo sample. These trades are appended to the trades from the historical sequence prior to the last N trades to construct the full equity curve for each Monte Carlo iteration. In other words, for each Monte Carlo iteration, the trades prior to the last N trades are the same as the historical sequence, and the last N trades are chosen by sampling from the prior trades. This approach effectively extrapolates the equity curve -- projects it forward -- over the last N trades, with each Monte Carlo iteration generating a different possible curve over the last N trades. The result is illustrated below.

The green envelope shows the range of possible equity curves generated by the Monte Carlo analysis by sampling from the trades prior to the last N trades in the sequence. As with the other type of Monte Carlo analysis, this analysis generates three curves: the high confidence is the user-chosen confidence level, the low confidence level is 100 minus the entered confidence level, and the middle curve represents 50% confidence (i.e., the median result). The green envelope is the region between the high and low confidence bands.



This envelope represents a prediction for the equity curve over the last N trades. The trades that actually took place are shown overlaid on the prediction envelope. By comparing the actual trades to the prediction envelope, this analysis can be used to determine if the trading strategy or portfolio is still performing within expected bounds. For example, for an individual market system, if the historical sequence of trades falls outside the lower boundary of the envelope, the trading strategy may need to be re-optimized, or it may be prudent to stop trading the strategy. Similarly, for a portfolio, if the equity curve falls outside the lower boundary of the envelope, there may be a problem with one or more of the market systems in the portfolio.

Options

There are two optional calculations that can be performed with the Monte Carlo Analysis. To select these options, select **Setup** on the Analysis menu and go to the Monte Carlo Settings tab (or select **Setup** on the Portfolio menu and go to the Monte Carlo Settings tab). In the Monte Carlo Analysis section, there are two check boxes for calculating the probability that a chosen performance metric will be higher or lower than a specified value. The number of Monte Carlo samples and the confidence level for the Monte Carlo calculations are also selected in this section. Also see Chapter 14, Menu Commands, Analysis Menu Commands, and Portfolio Menu Commands. The results generated by a Monte Carlo analysis are described in Chapter 12, Viewing the Results.

Chapter 7

Parameter Studies

Overview

The Parameter Studies feature of Market System Analyzer (MSA) lets you see how the performance statistics of your system or method vary with the position sizing parameters available to you. For example, you can plot the rate of return versus the fixed fraction or the average trade versus the number of contracts. This kind of analysis is sometimes referred to as **sensitivity analysis**. It allows you to see how sensitive your results may be to changes in the position sizing parameter values.

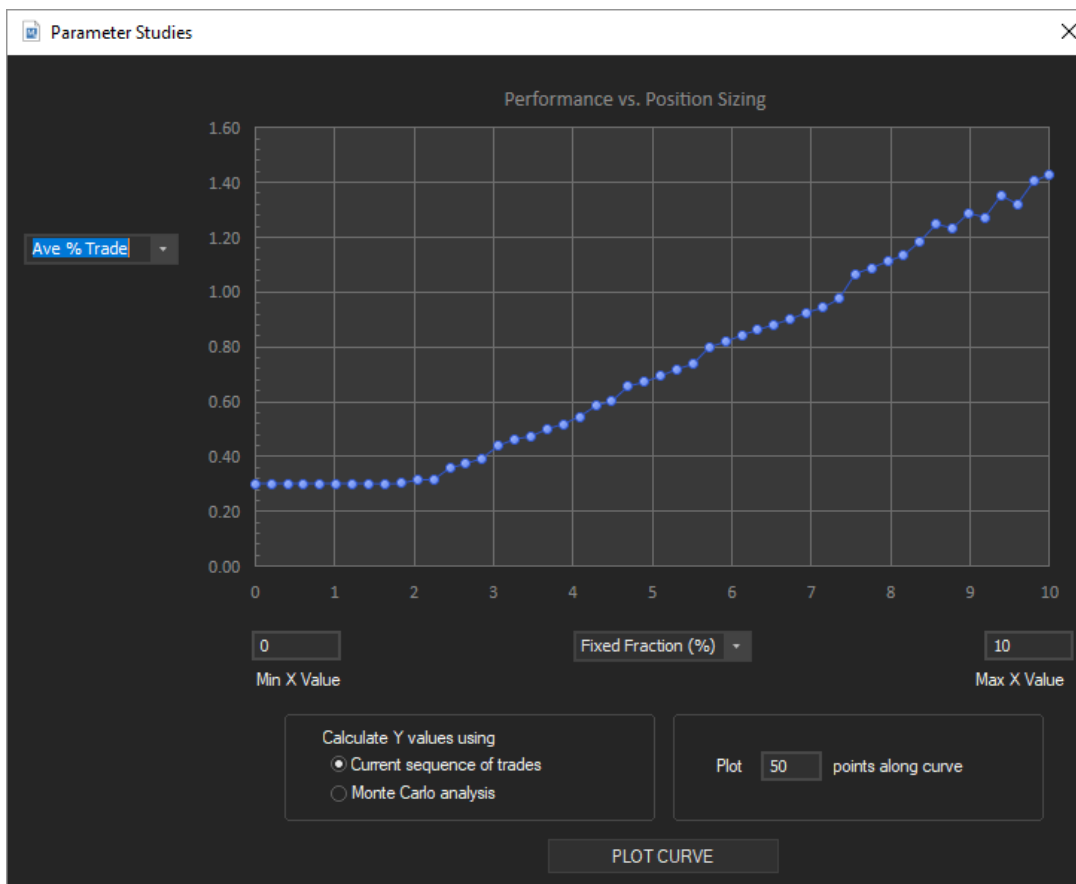
Sensitivity analysis is a useful complement to optimization, which is another feature of MSA. While optimization tells you the best value of the position sizing parameter, it's also important to check how sensitive the results are near the optimum. In general, you want to choose a value where the sensitivity is low. This means that the curve should be relatively flat near the optimum, so that values on either side of the optimum produce results close to the optimum.

Let's say for example that you use the optimization feature to find the delta value for fixed ratio position sizing that maximizes the profit factor subject to keeping the drawdown to less than 30%. Perhaps the optimal delta that results from this optimization is \$3200. You could then bring up the parameter studies window and plot the delta vs. profit factor for delta values in the range of say, 1000 to 5000. You would want to verify that values near 3200 also produce good profit factors. If not, then 3200 may not be a good choice, and you could use the parameter studies plot to find a value where the curve is flatter and therefore less sensitive to the delta value. You could also plot the drawdown vs. delta to make sure any value of delta you chose did not exceed your drawdown limit of 30%.

Plotting a Curve

To use the Parameter Studies feature, select **Parameter Studies** from the Analysis menu, which opens the Parameter Studies window, as shown below. First, select the X and Y axis parameters from the drop-down menus near each axis.

The X (horizontal) axis drop-down menu allows you to select from the following parameters: Trade Size, Pos Value, Fixed Eqty Amount, Volatility (%), Fixed Fraction (%), Profit Risk (%), Delta (Fix Ratio), Delta (Gen Ratio), Margin (%), Leverage, % of Equity, and % of Max DD. These choices correspond to the available position sizing methods that have adjustable parameters; namely, fixed size, constant value, fixed amount of equity, percent volatility, fixed fractional, profit risk method, fixed ratio, generalized ratio, margin target, leverage target, percent of equity, and max drawdown method, respectively.



The Y (vertical) axis drop-down menu provides the following choices: Net Profit, Ave Trade (%), Profit Factor, RR-DD Ratio (return-drawdown ratio), Sharpe Ratio, Mod Sharpe (modified Sharpe ratio), Ave Shares, Max Shares, and Max % DD (maximum percentage drawdown). These choices correspond to the optimizable performance metrics available on the Optimize Position Sizing window. Once the X and Y axis choices are made, type in the minimum and maximum values for the X parameter in the boxes labeled "Min X Value" and "Max X Value" near the X axis. The program provides default values in these boxes based on the X parameter chosen, but a tighter range is usually preferable. You can also optionally select the number of points to plot along the curve; the default value is 50 points.

Lastly, you can choose whether to plot the curve using the current sequence of trades, as shown in the main chart window, or using Monte Carlo analysis. If you choose Monte Carlo analysis, the performance measure on the Y axis will correspond to the performance measure listed in the Monte Carlo Results window. For example, the rate of return will be the rate of return at the confidence level selected for Monte Carlo analysis. Keep in mind that selecting Monte Carlo analysis will slow down the calculation process considerably. If you choose this option, it would be prudent to select a relatively small number of data points (e.g., 10) the first time to see how long the process takes. In many cases, choosing Monte Carlo analysis will provide smoother plots for the same number of points.

After the various inputs and options are selected, click the button at the bottom of the chart labeled "PLOT CURVE." The curve will be plotted as it calculates each point. The selections

made in the Parameter Studies window have no effect elsewhere in Market System Analyzer and are not saved when the window is closed.

Parameter Studies are only applicable to market systems, not portfolios.

Chapter 8

Optimizing Position Sizing

Overview

The optimization feature of Market System Analyzer (MSA) enables you to find the optimal position sizing parameter values for market systems and portfolios. You can maximize one of eight performance metrics and add an optional constraint on the worst-case peak-to-valley drawdown. The optimization can be performed over the current sequence of trades or using Monte Carlo analysis to randomize the trade sequence.

Optimization Objectives

The optimal position sizing results depend on the performance metric maximized during the optimization. These are referred to as the optimization objectives. To see the choices available, select **Optimize Position Sizing** from the Analysis menu (or the same command from the Portfolio menu for optimizing a portfolio). This brings up the Optimize Position Sizing window, as shown below for a market system.

Optimize Position Sizing: IndexFuture_Example.msa

Maximize:

- Net Profit
- Ave Trade, %
- Profit Factor
- Return-DD Ratio
- Sharpe Ratio
- Mod Sharpe Ratio
- Ave Position Size
- Max Position Size

Limit max percent drawdown to %

Optimization Type:

- All trades in current sequence
- Walk forward. Opt window: trades

Simulation Type:

- Current sequence of trades
- Monte Carlo analysis

Search Method:

- Adaptive search (default)
- Exhaustive search (recommended for fixed size position sizing)

Optimization: Successful.

Market System: IndexFuture_Example.msa
Elapsed Time: 00 hr 00 min 00 sec
Estimated Time to Completion:

Iteration No.:	6	Best Result:	
Fixed Fraction:	10.483	Fixed Fraction:	10.440
Net Profit:	197225.00	Net Profit:	207205.00
Max Drawdown (%):	24.891	Max Drawdown (%):	23.442

Buttons: Cancel, Cancel Save, Optimize, View Full Results, Close

The choices for the optimization objective appear in the top left section of the window, labeled "Maximize" The same objectives are available for optimizing portfolios. You can choose to maximize the following performance measures: Net Profit, Average Trade (%), Profit Factor, Return-Drawdown Ratio, Sharpe Ratio, Modified Sharpe Ratio, Ave Position Size, or Max Position Size. In addition, the maximum peak-to-valley percentage drawdown can be limited to a specified value; e.g., 20%. See Appendix: Performance Metrics for a definition of each performance metric. When optimizing using Monte Carlo analysis, the performance metric is evaluated at the confidence level chosen on the Analysis Setup (or Portfolio Setup) window.

When optimizing a market system, the optimization process is applied to whichever position sizing method is currently selected. Likewise, for portfolios, the optimization process applies to the position sizing methods currently selected for each market system, as shown on the Position Sizing window for the portfolio. Each market system may use a different position sizing method if desired, and the portfolio can mix stocks and futures. The program will search for the position sizing parameter value(s) that maximizes the chosen objective, subject to the drawdown constraint, if selected. The following table lists the parameter that is optimized for each position sizing method.

Position Sizing Method	Optimized Parameter
Fixed size	Number of shares/contracts/units
Constant Value	Position value
Fixed amount of equity	Amount per share/contract/unit
Percent Volatility	Percent of equity
Fixed risk (fixed fractional)	Fixed fraction (risk percentage)
Profit risk method	Percentage of profits risked
Fixed ratio	Delta
Generalized ratio	Delta
Margin target	Margin as % of equity
Leverage target	Leverage
Percent of equity	Value of position as % of equity
Max drawdown method	Percent of maximum drawdown

Notes to table:

1. For the profit risk method, only the percentage of profits is optimized. The percentage of initial account equity is unaffected by the optimization.
2. For the fixed ratio method, only the delta is optimized. The initial trade size and the delta fraction are unaffected by the optimization.
3. For generalized ratio position sizing, only the delta parameter is optimized. The exponent is not changed.
4. The following position sizing methods have no adjustable parameters and cannot be optimized: None, Kelly formula, Optimal f, and Maximum possible.

While the optimization is ongoing, the top part of the Optimize Position Sizing window will be dimmed, and the results will be displayed as they are generated in the bottom part of the window. The corresponding chart window will change to display the message "Calculations in progress. Press 'Esc' key to cancel..." To cancel the optimization without saving the results, click the Cancel button at the bottom of the Optimize Position Sizing window or press the escape ('Esc') key. To cancel the optimization while keeping the best results found up to that point, click the Cancel Save button. After the optimization process is complete, the summary results will be displayed in the bottom part of the Optimize Position Sizing window. The complete optimization results can be displayed in a separate window by clicking the View Full Results button. Provided the optimization is successful, the chart window will be recalculated to use the optimal parameter value(s).

Options

There are several available options for optimizing position sizing. These options are available on the upper part of the Optimize Position Sizing window, whether for market systems or portfolios. One option is whether to optimize over all trades in the current sequence or using a sliding window. This option is only available for market-system documents, not portfolios. When optimizing over all trades, the optimization looks for the position sizing parameter value that optimizes the objective over all trades in the current sequence. In other words, the optimization objective is calculated based on the performance statistics generated from the trades shown in the chart window. For example, if the optimization objective is rate of return, the optimization will try to maximize the rate of return calculated over all trades shown in the chart window.

The other choice is to optimize over a sliding window of trades. In this case, the user enters the number of trades in the sliding window, and the optimization is repeated for each window as it slides forward one trade at a time. For example, suppose there are 100 trades in the current sequence, and the user enters a sliding window size of 50 trades. The first optimization will be performed over trades 1 - 50. The optimization window then slides forward one trade, and the next optimization is over trades 2 - 51. The third optimization will be over trades 3 - 52, and so on until the last optimization is performed over trades 51 - 100.

In a sliding window optimization, an optimal result is obtained for each window. These optimal position sizing parameter values can be used in plotting the main chart window by selecting the Position Sizing Method tab in the Position Sizing window under the Analysis menu. On the Source drop-down menu in the Parameters section, select the option "sliding window opt, in-sample" or "sliding window opt, out-of-sample." The former will cause the chart to be plotted using the optimal sliding window parameter values applied as optimized (in sample). The latter choice will apply the parameter value optimized over trades $n - m$ to trade $m+1$. For example, the parameter value optimized over trades 1 - 50 will be applied to calculate the number of contracts for trade 51. In this way, you can test the optimization results "out of sample," without the benefit of hindsight. This is explained further in Chapter 14, Menu Commands, Analysis Menu Commands, Position Sizing Command.

Another option available for optimization is whether to optimize using the current sequence of trades or Monte Carlo analysis. This option is available for either market systems or portfolios. Selecting "Current sequence of trades" from the "Simulation Type" section of the Optimize Position Sizing window instructs the program to perform the analysis calculations using the current sequence of trades, as shown in the chart window. Alternatively, you can select "Monte Carlo analysis" to instruct the program to perform the analysis calculations using Monte Carlo analysis. In this case, the optimization objective will be calculated using Monte Carlo analysis at the confidence level entered on the Setup window under the Monte Carlo Settings tab (likewise for portfolios). For example, if a confidence level of 95% has been chosen for Monte Carlo analysis and the optimization objective is the rate of return, then the optimization will use the rate of return at 95% confidence as the optimization objective.

There are two different search methods available for optimizing individual market systems. The default method, which is referred to as the adaptive search method, iteratively subdivides the interval around the parameter being optimized until the optimal value is found. The alternative method is called the exhaustive search method. This method divides the search interval into evenly spaced values and evaluates every value within the interval. In almost all cases, the adaptive search method will be much faster than the exhaustive method. Consequently, the adaptive search method is recommended for most optimizations. The

exception is when the optimization is for the number of shares/contracts/units in fixed size position sizing. In this case, the adaptive search method may fail to find a solution or may take longer than the exhaustive search method.

For portfolios, the optimization is performed using a genetic algorithm (GA). Genetic algorithms are based on the biological concepts of reproduction and evolution. A GA “evolves” a population of solutions from an initial population of randomly generated members. Members of the population compete against each other based on their “fitness.” The fitter members are selected as “parents” to produce a new member of the population, which replaces a weaker (less fit) member.

Two parents are combined using a technique called crossover, which mimics genetic crossover in biological reproduction. In crossover, part of one parent’s genome is combined with part of the other parent’s genome to produce the child genome. In MSA, the genomes consist of the position sizing parameters for the market systems in the portfolio. The so-called fitness is equal to the metric selected to be maximized with an extra term -- the so-called “penalty” -- to account for the drawdown constraint, if selected.

Other members of the population are produced via mutation, in which one member of the population is selected to be modified by randomly changing parts of its genome. Over successive generations, the overall fitness of the population tends to increase. The process is stopped after a specified number of generations. The solution is taken as the fittest member of the final population.

The GA options for portfolio optimization are the population size, the number of generations, and the crossover and mutation percentages. The population size is the number of solutions produced at each generation. The number of generations determines how long the population is evolved. At each generation, a number of new population members equal to the population size is produced via crossover and mutation and used to replace existing members of the population. The crossover percentage is the percentage of new members produced via crossover; the remaining ones are produced via mutation. The mutation percentage is the probability that mutation will be applied to a population member subject to mutation.

Increasing the population size will generally lead to better results but will take longer. The same is true of the number of generations. The default values for the crossover and mutation percentages usually suffice, although different values can sometimes yield different results.

There is one additional option available when optimizing a portfolio. The option labeled “Starting Point” allows you to set the starting point for the optimization at the current position sizing values or at values chosen by the program. The former choice starts the optimization at whichever values are currently selected for calculating the equity curve, as displayed in the chart window. These values can be changed using the Position Sizing command of the Portfolio menu. This is often a good choice if you believe the current position sizing values are close to the optimum. At the start of the GA, the starting values will be mutated to produce a population that consists of values similar to the starting point.

The latter choice (“Values chosen by program”) randomly selects the parameter value for each market system for each member of the initial population. Several randomly chosen sets of parameter values are generated, and the set that produces the highest value of the fitness is selected as the starting point. Because not all randomly generated values will yield positive results or meet the drawdown constraint (if selected), some trials will be rejected. As a result, this process can be time-consuming. In effect, the process of finding the starting point in this manner is an optimization by itself. The benefit of this approach is that it can often yield results that are quite different than starting from the current parameter values. In fact, if the

results obtained by starting at the current parameter values are not satisfactory, the recommended approach is to perform the optimization again starting at values chosen by the program.

Chapter 9

Trade Dependency

Overview

Trade dependency is the characteristic in which one trade depends on the previous trade. For example, in some trading systems or methods, winning trades tend to follow other winning trades, and losses tend to follow losses. This is known as positive dependency: wins follow wins and losses follow losses. In negative dependency, wins tend to follow losses, and losses tend to follow wins.

Market System Analyzer (MSA) uses a "runs test" to determine if there is any statistically significant dependency in the current sequence of trades. A runs test determines if the runs of wins and losses are significantly longer or shorter than can be expected if the trades occurred in random order. A "run" is simply a consecutive series of wins or losses. For example, suppose the trade sequence consists of \$500, \$200, \$300, \$150, -\$750, -\$250, \$350, \$400, -\$500. This series of nine trades consists of two runs of wins and two runs of losses. The first run of wins is four trades in length, which is followed by a run of two losses. Following that is a run of two wins and finally a run of one loss.

The runs test is a specialized z test that takes the following form:

$$z = \frac{r - (X + 1)}{\sqrt{X(X - 1)/(N - 1)}}$$

where r is the number of runs, W is the number of winning trades, L is the number of losing trades, $X = (2WL)/(W + L)$, and N is the total number of trades ($N = W + L$).

The critical value of the z statistic comes from the z , or normal, distribution. At 95% confidence, for example, the critical value for a two-tailed test is 1.96. So, if the calculated z statistic is greater than 1.96 or less than -1.96, we would conclude that the number of runs is significant with 95% confidence. Positive values of z imply more runs than by chance; negative z values imply fewer runs than by chance.

If there are fewer runs than expected by chance, this implies the runs are longer than expected, which implies positive dependency (wins follow wins; losses follow losses). If there are more runs than by chance, this implies the runs are shorter than expected, which implies negative dependency (wins follow losses and losses follow wins). If the dependency has a high degree of significance (high confidence level) – e.g., 95% or greater – it may be worth exploiting. Market System Analyzer allows you to set dependency rules in this case to exploit the dependency you find (see below).

MSA automatically performs a runs test to analyze trade dependency whenever the current sequence of trades is analyzed. If the sliding window option has been selected in the Options tab of the Analysis Setup window (or Settings tab of the Portfolio Setup window for

portfolios), then the runs test is also performed on a sliding window of trades. The results of the runs test are displayed in the Dependency tab of the Performance Results window (View menu).

Setting Dependency Rules

MSA enables you to set several different trade dependency rules, which alter the position size either by skipping trades or by adding to or subtracting from the position. If a trade is skipped, it will still appear in the chart window and in the Equity Table, but the position size will be zero.

To apply one of the dependency rules, select **Dependency Rules** from the Analysis or Portfolio menu. This opens the Dependency Rules window, as shown below. The different dependency rules are divided among four tabs: Basic Rules, Win Rules, Loss Rules, and Profit/Loss Rules, which are new in version 4.0. The same rules are available for both individual market systems and portfolios.

The choices for the basic dependency rules are as follows:

- No dependency. All trades are included. This is the default.
- Positive Dependency: Skip trades after a loss until a skipped trade would have been a winner. This rule can improve trading performance if wins tend to follow wins and losses tend to follow losses.
- Negative Dependency: Skip the next trade after a win; take the next trade after a loss. This is intended to be used when wins tend to follow losses and losses tend to follow wins.

The Wins Rules tab contains the following rules for consecutive wins:

- After X wins in a row, skip the next Y trades. Here, X and Y are entered by the user. This rule is intended to be used in conjunction with the results of the dependency analysis, which calculates the average length of runs of wins and losses. For example, if the average winning run is 3 trades, and average losing run is 2 trades, you might try skipping the next two trades after three wins in a row.
- After X wins in a row, increase/decrease position size by Y shares/contracts/units. In addition to entering values for X and Y, the user selects either “increase” or “decrease.”

Select “increase” if the trading record indicates that wins occur in runs. Select “decrease” if the trading system or method tends to produce losses after a run of wins. The change in position size applies to the next trade only.

- After X wins in a row, increase/decrease position size by Y%. This is a variation of the preceding rule. For example, if fixed risk position sizing is currently selected, X is 4 trades, “increase” has been selected, and Y is 50, this rule would increase the position size 50% (relative to the fixed fractional equation) after four consecutive winning trades. The higher position size would apply to the next trade only.

The Loss Rules tab contains the following rules for consecutive losses:

- After X losses in a row, skip the next Y trades. X and Y are entered by the user. As with the analogous rule for consecutive wins, this rule can be tailored to the results of the dependency analysis. If, for example, there is positive dependency (meaning losses tend to follow losses) and the average length of the losing runs is 4 trades, then you might try skipping the next three trades after 1 loss in a row.
- After X losses in a row, increase/decrease position size by Y shares/contracts/units. In addition to entering values for X and Y, the user selects either “increase” or “decrease.” Select “decrease” if the trading record indicates that losses occur in runs. Select “increase” if the trading system or method tends to produce wins after a run of losses. The change in position size applies to the next trade only.
- After X losses in a row, increase/decrease position size by Y%. This is a variation of the preceding rule. For example, if margin target position sizing is currently selected, X is 3 trades, “increase” has been selected, and Y is 50, this rule would increase the position size 50% (relative to the standard margin target equation) after three consecutive losing trades. The higher position size would apply to the next trade only.
- After X losses in a row, add Y shares/contracts/units after each loss until a win. Subtract after each win until a loss or back to baseline. This method was developed by Larry Williams and described in his book “The Definitive Guide to Futures Trading, Volume II,” Windsor Books, New York, 1989, pp. 187. The idea is that after a streak of losses, you expect a winning trade, so you start increasing the position size after X losses in a row. If you continue to have losses, you increase the position size by Y after each loss. If you get a win, you decrease the position size by Y. If you continue to get winners, you keep subtracting Y from the position size until you get back to the baseline value of position size. If a loss is encountered, you wait until X losses in a row before adding Y shares/contracts/units. The baseline value of position size is the position size calculated using the currently selecting position sizing method without any other rules applied.

The Profit/Loss Rules tab contains the following rules for periodic profits and losses:

- If profit for day/week/month/quarter/year exceeds X (dollars or percentage of equity), then increase/decrease position size by Y (shares/contracts or percentage). In addition to entering values for X and Y, the user also selects the time period for measuring the profit, whether the profit is measured in dollars (or equivalent currency units) or as a percentage of equity, whether to increase or decrease the position size, and whether the change in position size is specified in shares/contracts or as a percentage of the baseline position size, as calculated in the absence of the rule. If the rule applies, the change in position size applies for the remainder of the specified period. A typical rule might be “If profit for day exceeds \$500, decrease position size by 100%”. This rule would stop trading for the day once the daily profit exceeded \$500.
- If loss for day/week/month/quarter/year exceeds X (dollars or percentage of equity), then increase/decrease position size by Y (shares/contracts or percentage). In addition to entering values for X and Y, the user also selects the time period for measuring the loss, whether the loss is measured in dollars (or equivalent currency units) or as a percentage of equity, whether to increase or decrease the position size, and whether the change in

position size is specified in shares/contracts or as a percentage of the baseline position size, as calculated in the absence of the rule. If the rule applies, the change in position size applies for the remainder of the specified period. A typical rule might be "If loss for week exceeds 2.5%, decrease position size by 5 contracts". This rule would decrease the position size by 5 contracts (relative to the size that would be calculated without the rule) for the remainder of the week once the loss for the current week exceeded 2.5% of equity.

If either of the basic dependency rules is selected, no other rules can be selected. However, if neither of the basic dependency rules is selected, one rule can be selected from each of the consecutive win and consecutive loss rule categories, for a total of up to two dependency rules from the first three categories. For example, you might select the rules "After 4 wins in a row, decrease the position size by 100 shares" and "After 3 losses in a row, increase the position size by 100 shares." Either or both of the profit/loss rules can be selected in addition to the other dependency rules.

Note: For portfolios, these rules are applied to the trade sequence for the portfolio, which includes all market systems taken together. The trades in a portfolio are ordered according to their exit dates.

Chapter 10

Significance Testing

Market System Analyzer (MSA) includes a statistical test to help determine if a trading system or method has an inherent edge. The test is a type of "significance" test called the Student's t test, which is applied to the average trade for the current sequence of trades. The test determines if the average trade is significantly greater than zero at a user specified confidence level. For example, the test will determine if the average trade is greater than zero with, say, 95% confidence.

To perform the test, you'll need to enter the number of rules and/or restrictions imposed by your trading system or method. The number of rules and/or restrictions is used to calculate the number of "degrees-of-freedom," which is necessary to calculate the t value for the t test. There needs to be a sufficient number of degrees of freedom to insure that the system is not over fit to the market. The number of degrees of freedom is the number of trades minus the number of restrictions. With too few trades, we can't be sure that the profitability of our system or method is not due to a chance arrangement of trades. The more trades we have, the greater the number of degrees of freedom and the more confident we can be that our calculated average profit is not a statistical fluke but a real number that is likely to hold up in the future.

To count the number of restrictions, Thomas Hoffman (Babcock, Bruce. The Business One Irwin Guide to Trading Systems. Richard D. Irwin, Inc. 1989, p. 89) suggests examining a trading system's rules and counting any condition that would change the resulting trades. For example, suppose you have a trading system that buys when today's close is less than yesterday's close in an up trend. It defines an up trend as when a shorter moving average is greater than a longer moving average. For simplicity, let's assume the sell side is the reverse, and there are no stops. It's a simple stop and reverse system.

We would probably count the moving average cross over condition as three restrictions, one for the condition itself, and one for each moving average period. The price pattern would be another restriction for a total of four restrictions for the long side. We would then count four more for the short side. This would give us eight restrictions in total. If we had, say, only eight trades, there would be no degrees of freedom, and we shouldn't have any confidence in the average trade number, even if it were very high. On the other hand, if we had 100 trades, we would have 92 degrees of freedom, which would give us much more confidence in the average trade number.

In MSA, the t test is expressed as a confidence interval for the average trade:

$$CI = t * SD/\sqrt{N}$$

where CI is the confidence interval around the average trade, t is the Student's t statistic, SD is the standard deviation of the trades, N is the number of trades, and $\sqrt{}$ represents "square root." The t statistic is retrieved from a look-up table and depends on the number of degrees of freedom and the user-chosen confidence level.

The confidence interval means that the average trade is likely to lie between $T - CI$ and $T + CI$. For the system to be profitable at our specified confidence level, we want the average trade, T , to be greater than zero at the lower bound, $T - CI$; i.e.,

$$T > CI.$$

If this condition is true at the specified confidence level, it means that the system or method is inherently profitable subject to the assumptions of the test. One of these assumptions is that the statistical properties of the trades remain the same. Specifically, if the average trade and its standard deviation remain the same in the future, the results will continue to be valid. However, as markets change and evolve over time, the properties of the statistical distribution of trades may change as well, so caution is warranted in interpreting the results.

Note: The significance test performed in MSA assumes the strategy in question is from a single evaluation. If the strategy was arrived at by evaluating multiple candidates, such as optimizing the strategy inputs and selecting the best result, then a different, stricter test would be required.

MSA performs the statistical significance (t) test automatically whenever the current sequence of trades is analyzed. The test is performed for both market-system and portfolio documents. The number of rules and/or restrictions imposed by the trading system or method and the confidence limit for the average trade calculation are entered on the Setup window (Analysis menu, Options tab, for market systems or Portfolio menu, Settings and Options tab, for portfolios). The results of the significance test are displayed in the Significance Test tab of the Performance Results window (View menu). The results include the average trade at the specified confidence level (average trade +/- confidence intervals), the worst-case trade at the specified confidence, and the probability that the average trade is greater than zero. See Chapter 12, Viewing the Results, Significance Test Results for a detailed description of the test results.

Chapter 11

Correlation Analysis

Market System Analyzer (MSA) automatically performs a correlation analysis on portfolio documents. The correlation between each pair of market systems is calculated whenever the current sequence of trades is analyzed by the program. The correlation analysis is based on the following equation for the linear correlation coefficient:

$$r = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2 \sum(y - \bar{y})^2}}$$

where x and y represent arrays of values for the two market systems for which the coefficient is calculated, and \bar{x} and \bar{y} are the averages of x and y, respectively.

The correlation coefficient lies in the range -1 to +1. Values less than zero indicate negative correlation, which means that when one market system is gaining, the other market system tends to be losing. Similarly, positive correlation (correlation coefficients greater than zero) indicate that the two market systems move more or less together. A correlation coefficient of zero implies the two market systems are uncorrelated.

The correlation coefficients are calculated and reported four different ways, based on:

1. Daily returns.
2. Monthly returns.
3. Annual returns.
4. Detrended equity curves.

For the first three calculations, the x and y arrays in the equation shown above represent the period returns (daily, monthly, or annual, respectively) for a pair of market systems. The period returns are based on the equity curve for each market system by itself, as optionally displayed in the portfolio chart window using the **Equity Curve Selection** command of the View menu. A period is only included in the calculations if the same period is present in both market systems. The correlation calculation is performed for each pair of market systems and reported in tabular form in the Correlation Tables tab of the portfolio performance report; see Chapter 12, Viewing the Results.

For the calculations based on the detrended equity curves, the equity curve for each market system is first detrended using either a linear or logarithmic trend line, depending on whether the position sizing is constant (fixed size, constant value, or "None") or variable, respectively. This converts the equity values into equity differences relative to the trend line, so that some difference values are positive (equity curve above the trend line) and some are negative (equity curve below the trend line), analogous to using period returns, where some returns are positive and some are negative.

The array of equity difference values for each market system is then converted so that the points are equally distributed along the date axis of each market system and so that each array

in the pair has the same number of points. This is accomplished by first restricting the values to a range of dates that is common to both market systems in the pair (i.e., only points for which the curves overlap are used in the calculation) and then interpolating the equity difference values, as necessary, between date values. The resulting arrays contain the same number of equity difference values corresponding to the same dates. The correlation coefficient equation shown above is then applied to these arrays.

The coefficients based on the period returns (daily, monthly, or annual) use the traditional method for calculating correlation coefficients. The method based on the detrended equity curves should provide similar results but may use more data points since it uses as many points on the equity curves as possible, rather than aggregating data into time periods. Compared to the methods based on period returns, the method based on the detrended equity curves should provide results most similar to the results based on daily returns.

The closer the coefficient is to -1 or +1, the stronger the correlation. A market system with strong negative correlation to another market system is particularly valuable, especially if the market system is profitable overall. This means that when one system is losing money, the other one is making money, which can offset the losses from the other system. This results in a smoother equity curve and therefore better risk-adjusted returns.

In fact, even a market system that loses money can improve the overall results of a portfolio if it has a strong negative correlation to another market system in the portfolio. This is because when the two equity curves are combined in the portfolio, the overall risk of the portfolio will be reduced as profits from one market system offset losses from the other. With less risk, the position size can be increased, which leads to greater returns.

The correlation tables can be used to assess the mix of market systems in a portfolio. Ideally, one would want negative correlation coefficients between all market-system pairs. The market systems in such a portfolio would tend to offset each other's losses, which would produce the best risk-adjusted returns. By contrast, if two market systems are highly correlated (positive correlation coefficient close to 1), their profits and losses will tend to coincide, which means there's little benefit in including both market systems in the same portfolio.

Note that the correlation analysis requires that the market systems comprising the portfolio have exit dates for all trades. If the program is unable to compute the correlation coefficient, the symbol "NA" will appear in the table in place of the coefficient value.

Chapter 12

Viewing the Results

Equity Table

The Equity Table lists the trade-by-trade results of the equity curve simulation, as depicted in the chart window. Specifically, the Equity Table lists the symbol, trade type (regular, cost/fee, or add/withdrawal), entry and exit dates of each trade, the profit/loss and risk on a per share/contract/unit basis, the position sizing parameter value, the position size (shares, contracts or units), trading costs (commission and fees), the profit/loss for the position (trade profit/loss per share/contract/unit times the number of shares/contracts/units less any commission and slippage costs), required margin, drawdown (amount and percentage in parentheses), and the current account equity. For a portfolio, the Equity Table also includes a column for the market system, which includes the number of the market system in parentheses followed by the name.

The Equity Table can be sorted by any column by clicking once on the column heading. Click again on the heading to reverse the sorting order.

A context (right-click) menu is available for the Equity Table with commands for copying the entire table to the clipboard in tab-delimited format, copying the current selection in the table to the clipboard in CSV or HTML format, saving the table to a text file in various formats, printing the table, and for opening the help file for the Equity Table.



Trade	Symbol	Type	Entry Date	Entry Price	Exit Date	Exit Price	PL/Unit	Risk/Unit	% Equity	Units	Costs	Pos PL	Margin
1	XLI	Regular	7/12/1999 4:00:00 PM	29.94000	7/22/1999 4:00:00 PM	30.63000	69.00	375.00	20.00	6	9.00	405.00	17,964.0
2	XLU	Regular	8/4/1999 4:00:00 PM	30.61000	8/9/1999 4:00:00 PM	30.98000	37.00	375.00	20.00	6	9.00	213.00	18,366.0
3	XLY	Regular	8/4/1999 4:00:00 PM	26.48000	8/13/1999 4:00:00 PM	26.93000	45.00	375.00	20.00	7	10.50	304.50	18,536.0
4	XLU	Regular	8/11/1999 4:00:00 PM	30.80000	8/13/1999 4:00:00 PM	30.39000	39.00	375.00	20.00	6	9.00	225.00	18,000.0
5	XLI	Regular	7/23/1999 4:00:00 PM	29.69000	8/25/1999 4:00:00 PM	30.05000	36.00	375.00	20.00	6	9.00	207.00	17,814.0
6	XLF	Regular	8/25/1999 4:00:00 PM	24.64000	8/26/1999 4:00:00 PM	25.33000	69.00	375.00	20.00	8	12.00	540.00	19,712.0
7	XLY	Regular	8/31/1999 4:00:00 PM	26.20000	9/1/1999 4:00:00 PM	26.64000	44.00	375.00	20.00	2	3.00	85.00	5,240.00
8	XLV	Regular	8/30/1999 4:00:00 PM	27.29000	9/3/1999 4:00:00 PM	27.67000	38.00	375.00	20.00	7	10.50	255.50	19,103.0
9	XLU	Regular	8/31/1999 4:00:00 PM	29.06000	9/3/1999 4:00:00 PM	29.44000	38.00	375.00	20.00	0	0.00	0.00	0.00
10	XLI	Regular	8/30/1999 4:00:00 PM	29.05000	9/3/1999 4:00:00 PM	29.41000	36.00	375.00	20.00	7	10.50	241.50	20,335.0
11	XLF	Regular	8/30/1999 4:00:00 PM	23.64000	9/3/1999 4:00:00 PM	24.12000	48.00	375.00	20.00	8	12.00	372.00	18,912.0
12	XLE	Regular	8/26/1999 4:00:00 PM	28.87000	9/7/1999 4:00:00 PM	29.33000	46.00	376.00	20.00	7	10.50	311.50	20,209.0
13	XLV	Regular	9/9/1999 4:00:00 PM	27.37000	9/10/1999 4:00:00 PM	27.95000	58.00	375.00	20.00	7	10.50	395.50	19,159.0
14	XLE	Regular	9/14/1999 4:00:00 PM	28.25000	9/15/1999 4:00:00 PM	29.06000	81.00	375.00	20.00	7	10.50	556.50	19,775.0
15	XLU	Regular	9/16/1999 4:00:00 PM	28.91000	9/17/1999 4:00:00 PM	29.29000	38.00	375.00	20.00	7	10.50	255.50	20,237.0
16	XLK	Regular	9/16/1999 4:00:00 PM	41.95000	9/17/1999 4:00:00 PM	42.98000	103.00	375.00	20.00	4	6.00	406.00	16,780.0
17	XLU	Regular	9/20/1999 4:00:00 PM	28.67000	9/21/1999 4:00:00 PM	29.19000	52.00	375.00	20.00	7	10.50	353.50	20,069.0
18	XLU	Regular	9/24/1999 4:00:00 PM	28.56000	9/27/1999 4:00:00 PM	28.97000	41.00	375.00	20.00	2	3.00	79.00	5,712.00
19	XLK	Regular	9/23/1999 4:00:00 PM	40.93000	9/27/1999 4:00:00 PM	41.88000	95.00	375.00	20.00	5	7.50	467.50	20,465.0
20	XLI	Regular	9/24/1999 4:00:00 PM	28.14000	9/30/1999 4:00:00 PM	28.49000	35.00	375.00	20.00	0	0.00	0.00	0.00
21	XLY	Regular	9/16/1999 4:00:00 PM	26.00000	10/4/1999 4:00:00 PM	26.56000	56.00	375.00	20.00	8	12.00	436.00	20,800.0
22	XLU	Regular	10/15/1999 4:00:00 PM	28.35000	10/19/1999 4:00:00 PM	28.95000	60.00	375.00	20.00	0	0.00	0.00	0.00

To view the Equity Table, select **Equity Table** from the View menu. Unlike most other windows in MSA, the Equity Table can be kept on the screen while you work elsewhere in the program. Any changes to the data or analysis settings will be reflected in the Equity Table while it's open, just as they are in the chart window.

Performance Results

The Performance Results window displays all performance results for the current sequence of trades, as displayed in the chart window. Tabs along the top of the window are used to organize the results by category. The Performance Results window for a portfolio document is shown below. This window differs from the Performance Results window for a market-system document only in that the portfolio window includes additional tabs for "Market Systems" and "Correlation Tables," which are not applicable to individual market systems.

Average Trade (Expectation)	\$13,056.12	\$8,459.79	\$14,854.23
Average Trade (%)	0.4689%	0.3354%	0.5211%
Trade Standard Deviation	\$289,822.39	\$70,073.73	\$339,065.16
Trade Standard Deviation (%)	3.335%	2.002%	3.729%
Win/Loss Ratio	0.8697	1.790	0.7424
Win/Loss Ratio (%/%)	1.029	1.615	0.8827
Return/Drawdown Ratio	495.1	47.68	358.8
Profit/Drawdown Ratio	3.358	4.312	2.823
Sortino Ratio	1.194	0.6200	0.9849
MAR Ratio	1.813	0.5925	1.528
Modified Sharpe Ratio	0.1406	0.1675	0.1397
Sharpe Ratio	0.4210	0.2469	0.3619
Average Risk	\$178,259.58	\$104,004.89	\$207,308.48
Average Risk (%)	3.666%	2.996%	3.928%
Max Risk (%)	20.31%	10.01%	20.31%
/Risk Value	\$3,473,550.00	\$1,603,840.00	\$3,473,550.00
Date of Max Risk	3/17/2008 8:45:00 AM	10/24/2008 1:00:00 PM	3/17/2008 8:45:00 AM
Average R-Multiple (Expectancy)	0.2073	0.3620	0.1468
R-Multiple Standard Deviation	1.325	2.106	0.8360
Total R-Multiple	255.8	125.6	130.2
Van Tharp SQN	5.495	3.202	5.229
Average Margin	\$1,178,752.89	\$600,607.40	\$1,404,927.05
Average Margin (%)	31.74%	23.25%	35.06%
Max Margin (%)	56.32%	51.64%	56.32%
/Margin Value	\$2,774,310.00	\$446,630.00	\$2,774,310.00
Date of Max Margin	10/31/2006 8:42:00 AM	12/1/2004 8:40:00 AM	10/31/2006 8:42:00 AM
Average Account Leverage	8.180	1.327	10.86
Max Account Leverage	19.19	15.71	19.19

To view the Performance Results window, select the **Performance Results** command from the View menu or right-click in the right-hand (Performance Summary) pane of the main window. The results are grouped into the following tabs:

Settings Tab

The Settings tab lists the basic settings on which the analysis is based. For market-system documents, these settings consist of the account settings, data input settings, and position sizing settings and rules, as discussed in the Basic Settings, Input Data, and Position Sizing chapters. For portfolios, the settings include the portfolio starting account equity, the list of market systems comprising the portfolio, and the position sizing settings and rules currently in effect, as discussed in the Basic Settings chapter and in the Menus chapter, Portfolio Menu, **Position Sizing** command.

When viewing the performance results for a portfolio, refer to the individual market-system reports for costs, margins, fees, and position sizing rules, other than the position sizing methods, specific to each market system.

Summary Tab

This tab lists the performance statistics generated over the entire trading period, as reflected in the chart window. The results are listed for all trades, for long trades only, and for short trades only. The performance metrics are described in Appendix: Performance Metrics.

Return Tables Tab

The Return Tables tab lists the annual, monthly, weekly, and daily returns in tabular form. Each table includes columns for the period (year, month, week, or day), net profit, net additions/withdrawals during the period, ending equity, percentage return, drawdown, percentage drawdown, number of trades, percentage of winning trades, and profit factor. The table of annual results also includes a column for the Sharpe ratio. Because the Sharpe ratio is calculated from monthly returns, it's only applicable to the annual table. The last two rows in each table are highlighted in bold text. These are the average and standard deviation, respectively, of the elements in the corresponding columns.

Market Systems Tab (portfolios only)

This tab displays a table that breaks out the portfolio results by market system. The table contains columns for net profit, percentage return, drawdown, percentage drawdown, number of trades, average trade, percentage of winning trades, profit factor, and Sharpe ratio. The last two rows in the table list the average and standard deviation, respectively, of the market-system values in the corresponding columns.

Dependency Tab

The results from the dependency analysis, as determined from a statistical runs test (see Chapter 9, Trade Dependency), are displayed in this tab. The top section of this tab displays the results of the runs test applied to all trades in the current sequence. The dependency identified from the runs test is listed as either Positive or Negative. Positive dependency means that wins tend to follow wins and losses tend to follow losses. Negative dependency means that wins tend to follow losses and losses tend to follow wins. The confidence level for the stated dependency is listed as a percentage. The higher the number, the more significant the dependency. A confidence level of 95% or greater may be considered significant.

The total number of runs is listed next. This is the sum of the number of runs of wins and the number of runs of losses. A run is simply a consecutive series of trades, including series of one trade. The average length of the winning and losing runs is also listed in this section.

The bottom section lists the results for the sliding window runs test, if selected in the Options tab of the Setup command in the Analysis Menu (Settings tab of the Setup command for portfolios). The sliding window runs test repeats the runs test over each sliding window. For each window, the following results are listed: window number, trades comprising the window, dependency (Positive/Negative), and confidence level (%).

The dependency results can be used as a guide in setting the dependency rules, as explained in Chapter 9, Trade Dependency, Setting Dependency Rules.

Significance Test Tab

The significance test results are displayed in this tab. See Chapter 10, Significance Testing, for a discussion of the significance test.

The window lists the number of trades and the number of degrees of freedom for the current sequence of trades. Below that, the average trade is listed with confidence intervals calculated at the confidence level selected by the user. For example, if the average trade is \$300 and the confidence interval at 95% confidence is +/- \$250, then the average trade should lie between \$50 ($300 - 250$) and \$550 ($300 + 250$) with 95% confidence. The average trade in this case will be shown as \$300 +/- 250. The worst-case average trade at the specified confidence level is then shown. This is the average trade minus the confidence level. In this example, the worst-case average trade at 95% confidence would be \$50; i.e., the average trade of \$300 minus the confidence interval value of \$250.

The probability that the average trade is greater than zero is also calculated and displayed in the tab. Provided the trade distribution stays the same in the future, this is the probability that the system or trading method will be profitable in the future. Finally, if the worst-case average trade at the specified confidence level is less than zero, the following message is displayed: "System/method may not be profitable at specified confidence level." Given the confidence level and trade distribution, this indicates that there are too few degrees of freedom (too few trades or too many restrictions) to be confident in the results. On the other hand, if the worst-case average trade at the specified confidence level is greater than zero, the following message is displayed: "Trades pass statistical significance test at specified confidence level." In this case, provided the trade distribution stays the same in the future, the probability that the system or trading method will be profitable in the future is at least as great as the specified confidence level.

Correlation Tables Tab (portfolios only)

The Correlation Tables tab displays the results of the correlation analysis, which is explained in Chapter 11, Correlation Analysis. Each correlation table displays the correlation coefficient for each pair of market systems in a portfolio. The correlation coefficient indicates how closely the equity curves correspond. The correlation coefficient can vary between -1 and +1. A negative value (negative correlation) indicates that the market systems tend to move in opposite direction; when one is winning the other is losing, and vice-versa. A positive value (positive correlation) indicates that the market systems tend to move together so that wins and losses tend to coincide. A coefficient of zero implies no correlation. A value of "NA" means the program was unable to calculate the coefficient. This typically happens when dates are unavailable for all trades.

The Performance Results window can be kept on the screen while you work elsewhere in the program. Any changes to the data or analysis settings will be reflected in the Performance Results window while it's open, just as they are in the chart window.

A context (right-click) menu allows you to copy the contents of the Performance Results window, save it to a file, print the report, or open the associated help file. When saving, copying, or printing, the entire performance report is sent, including all tabs.

Monte Carlo Results

The Monte Carlo Results window displays the results from the most recent Monte Carlo analysis. This window will be opened immediately after the Monte Carlo Analysis is performed via the Analysis menu (Portfolio menu for portfolios) or it can be opened directly from the View menu by selecting the **Monte Carlo Results** command.

Confidence Level	Net Profit	Rate of Return	Maximum Drawdown	Return/Drawdown Ratio	Profit Factor	Modified Sharpe Ratio	Sharpe Ratio
99.0	\$153,056.50	153.1	\$43,158.00	15.86	11.73	1.51	1.51
99.1	\$153,056.50	153.1	\$43,158.00	15.86	11.73	1.51	1.51
99.2	\$152,874.00	152.9	\$45,752.00	16.27	11.57	1.51	1.51
99.3	\$152,874.00	152.9	\$45,752.00	16.27	11.57	1.51	1.51
99.4	\$151,791.00	151.8	\$47,813.50	16.38	11.55	1.51	1.51
99.5	\$151,791.00	151.8	\$47,813.50	16.38	11.55	1.51	1.51
99.6	\$150,611.50	150.6	\$49,947.50	16.47	11.40	1.50	1.50
99.7	\$150,611.50	150.6	\$49,947.50	16.47	11.40	1.50	1.50
99.8	\$147,698.50	147.7	\$52,353.50	17.31	9.755	1.47	1.47
99.9	\$147,698.50	147.7	\$52,353.50	17.31	9.755	1.47	1.47
100.0	\$146,105.50	146.1	\$53,983.00	18.19	9.631	1.46	1.46

Monte Carlo Results at 97.50% Confidence	
Total Net Profit: \$159,811.00	Minimum Number of Shares: 100
Final Account Equity: \$259,811.00	Max Number of Shares: 3,600
Return on Starting Equity: 159.8%	Average Number of Shares: 1031
Profit Factor: 1.551	Percent Profitable: 80.15%
Largest Winning Trade: \$4,959.00	Largest Losing Trade: (\$12,345.00)
Largest Winning Trade (%): 2.531%	Largest Losing Trade (%): -3.886%
Average Winning Trade: \$574.29	Average Losing Trade: (\$1,923.71)
Average Winning Trade (%): 0.3426%	Average Losing Trade (%): -0.9077%
Max Consecutive Wins: 18	Max Consecutive Losses: 6
Average Trade: \$173.78	Trade Standard Deviation: \$1,606.78
Average Trade (%): 0.1065%	Trade Standard Deviation (%): 0.7156%
Win/Loss Ratio: 0.3665	Sortino Ratio: 0.5956
Win/Loss Ratio (%/%) : 0.3845	MAR Ratio: 0.5722
Return/Drawdown Ratio: 13.37	Modified Sharpe Ratio: 0.1512
Profit/Drawdown Ratio: 5.131	Sharpe Ratio: 0.3265

If the trade data or analysis settings have been changed since the last Monte Carlo analysis was performed, this item will be dimmed in the View menu, and the Monte Carlo analysis must be performed again to view the results. The Monte Carlo Results window is divided into three sections:

Trading Parameters

The Trading Parameters section contains all the analysis settings for the current sequence of trades, as described above for the Settings section of the Performance Results window. This section also lists the number of Monte Carlo samples used in the analysis.

Key Results at Select Confidence Levels

This section is intended to show how specific results vary with the confidence level. The following results are tabulated for confidence levels ranging from 50% to 100%: net profit, rate of return, maximum peak-to-valley drawdown, maximum percentage peak-to-valley drawdown, return/drawdown ratio, profit factor, modified Sharpe ratio, and Sharpe ratio.

Monte Carlo Results at X% Confidence

This is the main results section, which displays the results at the confidence level entered by the user on the Monte Carlo Settings tab of the Analysis Setup window or Portfolio Setup window; e.g., X% = 95%. A subset of the performance metrics listed in the full performance report is included here.

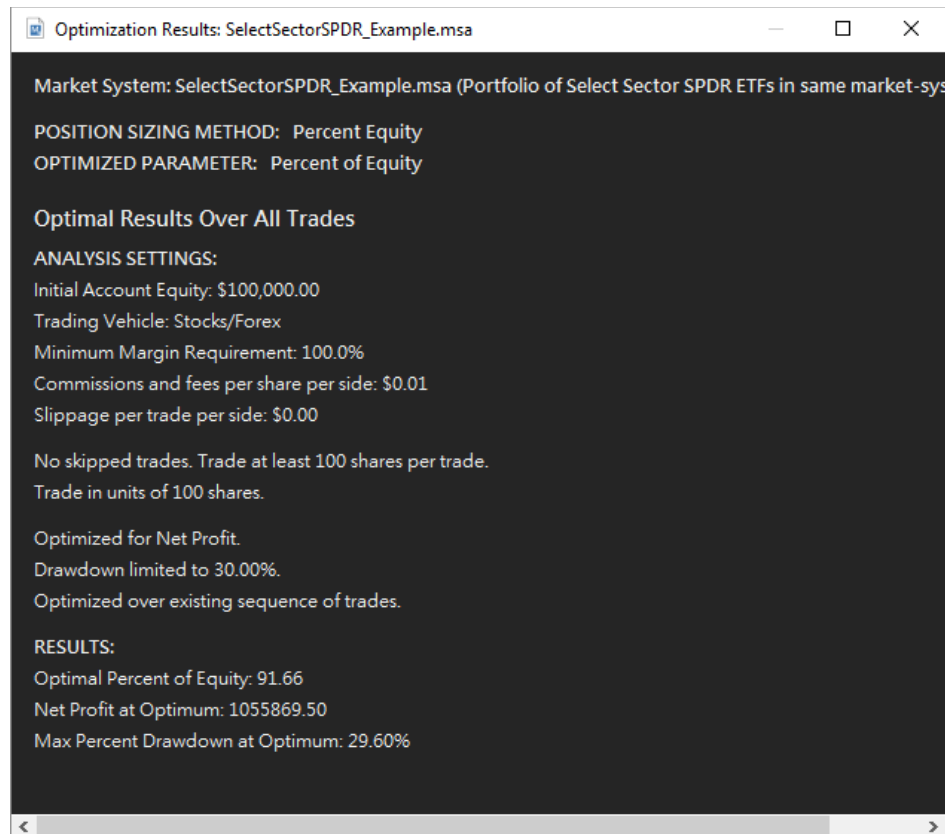
The results can be interpreted as follows. If a metric is such that higher values are better, such as net profit, then the value listed in this section is such that X% of the Monte Carlo samples had a metric value of at least as much as the listed value. If a metric is such that lower values

are better, such as drawdown, then the value listed in this section is such that X% of the Monte Carlo samples had a metric value less than the listed value.

A context (right-click) menu allows you to copy the contents of the Monte Carlo Results window, save it to a file, print the report, or open the associated help file.

Optimization Results

The Optimization Results window, as shown below, displays the results of the position sizing optimization. This window can be opened after the optimization is performed via the **Optimize Position Sizing** command or it can be opened directly from the View menu by selecting the **Optimization Results** command. For market-system documents, MSA stores the most recent optimization results for each position sizing method. If no optimization has been performed for the currently selected position sizing method, this item will be dimmed in the View menu. Selecting a position sizing method for which an optimization was previously performed for the current sequence of trades will make this item available on the View menu.



For portfolios, the results of the most recent portfolio optimization are stored and can be viewed using the **Optimization Results** command, regardless of whether the analysis settings have been subsequently changed. If the settings have been changed since the last optimization, the portfolio should be re-optimized to reflect the new settings. If no optimization has yet been performed for the portfolio, this command will be dimmed in the View menu.

For market-system documents, the Optimization Results window consists of two sections. The first section, entitled "Optimal Results Over All Trades," is for the optimization performed over all trades. If this optimization has not been performed for the currently selected position

sizing method, this section will not appear. If present, this section consists of two parts, ANALYSIS SETTINGS, and RESULTS. Under ANALYSIS SETTINGS, all analysis options selected at the time the optimization was performed are listed, including the optimization objective, drawdown constraint, if selected, initial account equity, whether or not the optimization was performed using Monte Carlo analysis, and so on.

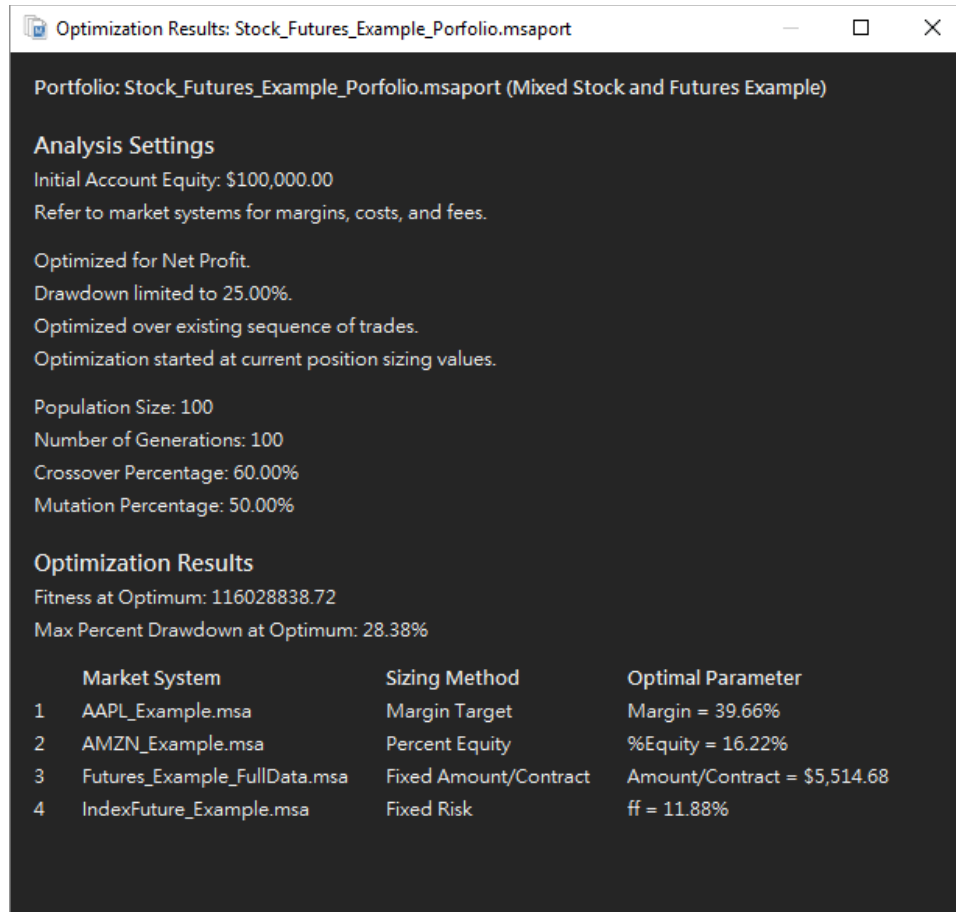
Following ANALYSIS SETTINGS, the RESULTS section lists the following optimization results: optimal value of the position sizing variable, optimization objective (e.g., rate of return, average trade (%), etc.) at the optimum, and the maximum closed trade percentage peak-to-valley drawdown at the optimum. To see a complete list of performance statistics at the optimum, select **Performance Results** from the View menu.

The second section in the Optimization Results window is entitled "Optimal Results for Sliding Windows." If an optimization was performed using the sliding windows option for the currently selected position sizing method, the results of that optimization will appear in this section. If a sliding window optimization was not performed for the currently selected position sizing method and current sequence of trades, this section will not be shown. The ANALYSIS SETTINGS part of this section lists all analysis settings in effect at the time the optimization was performed and all optimization choices made for the sliding window optimization.

The RESULTS section presents the optimal results for each sliding window in tabular form. The table consists of the following columns: window number, trade range, optimal value of the position sizing parameter, value of the optimization objective at the optimum, and the maximum closed trade percentage peak-to-valley drawdown at the optimum. Each line in the table corresponds to a single optimization, performed over the trades listed under the Trades column.

The trade numbers in the Trades column refer to the order of the trades present when the optimization was performed. If the sequence of trades was subsequently randomized using the **Randomize Trade Order** command of the View menu (or the Randomize button on the toolbar), the current sequence may consist of a different ordering of the trades than was present at the time of optimization. However, if the trade order is changed subsequent to a sliding window optimization, the optimal position sizing parameter values move with the trades. For example, if the optimal fixed fraction for trade number 16 is 0.042 following the sliding window optimization, and the trade order is randomized so that trade 16 becomes trade 61, then the optimal fixed fraction for trade 61 will be 0.042. This is done so that a Monte Carlo analysis performed with sliding window-derived parameter values will be more meaningful.

For portfolio documents, the Optimization Results window is as shown below. It consists of an Analysis Settings section and an Optimization Results section. The settings section lists all analysis options selected at the time the optimization was performed, including the optimization objective, drawdown constraint, if selected, initial account equity, whether or not the optimization was performed using Monte Carlo analysis, and so on. It also includes the genetic optimization settings: population size, number of generations, and the crossover and mutation percentages.



The Optimization Results section displays the optimization objective (e.g., rate of return, average trade (%), etc.) at the optimum and the maximum closed trade percentage peak-to-valley drawdown at the optimum. This section also displays a table listing the optimal value of the position sizing variable for each market system and the position sizing method selected for the market system at the time the optimization was performed.

A context (right-click) menu allows you to copy the contents of the Optimization Results window, save it to a file, print the report, or open the associated help file.

Chapter 13

Working with MSA Files

Overview

Market System Analyzer (MSA) creates and reads files with the extensions .msa and .msaport. (MSA can also read older portfolio files with the extension .msp, although it's recommended that these older portfolio files be saved with the new .msaport extension to avoid conflicts with Windows installer files that also share the .msp extension.) Files of type .msa store the settings for a single market system. Files of type .msaport store the settings for a portfolio. Because portfolios in MSA consist of multiple market systems, .msaport files also contain the file names of the .msa files comprising the portfolio. The trade data for a market system is stored in a separate trades file, which can be any text file with a format that MSA can read. The name of the trades file, as shown in the **Data Source** command (Trades menu), is stored in the .msa file.

The commands for working with MSA files are the **New**, **Open**, **Close**, **Save**, and **Save As** commands, which are found on the File menu. Although text files of trades can be read into MSA (provided their contents are in the proper format) using the **Open** command, the other File menu commands only apply to files of type .msa and .msaport. When a .msa or .msaport file is opened or saved in MSA, the name of the file will be displayed in the title bar of the document window. The .msa and .msaport files are in binary format and can only be read by the MSA program.

When a market-system document is saved and the trades file has not been specified under **Data Source**, MSA will prompt you to enter a name for the trades file. In this case, MSA creates a default name of the form MSATrades_mmddyyhhmmss_rnd.csv, where mmddyy represents the month, day and year, hhmmss represents the current hours, minutes and seconds, and rnd is a three-digit random number. You can either accept this default name or enter a different name.

Previously created .msa and .msaport files can be opened outside of MSA by double-clicking on the file name or within MSA by using the **Open** command of the File menu. Multiple files of either type can be opened simultaneously in MSA. The File menu lists the 15 most recently opened files. To open a file on this list, simply select it from the list.

Current versions of MSA can read prior versions' files, such as version 2 or version 3 .msa files. However, once the document is saved from within the current version, the file will no longer be readable by the older version of MSA that originally created it. For example, if you save a version 3 .msa file within version 4, it will become a version 4 file, and version 3 will no longer be able to read it.

Saving Analysis Reports

MSA allows you to save most analysis results to a text file. Most windows in MSA that display analysis results contain a context (right-click) menu with a "Save to File..." command.

Selecting this command opens a file save window, such as "Export Performance Results", "Export Monte Carlo Results", and so on. This window allows you to enter or select a location and file name to save the analysis results displayed in the results window. The results can be saved to any of the following formats: tab-delimited text (.txt), comma-delimited text (.csv), unformatted Word (.doc), or html (.htm).

In addition, you can choose to save all current analysis results to a single file by selecting **Export Analysis Report** from the File menu. This command combines the separate analysis reports with headings for each section. The same file type options are offered as with the separate reports (.txt, .csv, .doc, or .htm).

Chapter 14

Menu Commands

File Menu Commands

The File menu of Market System Analyzer (MSA) offers the following commands:

New	Creates a new document.
Open	Opens an existing document.
Close	Closes an open document
Save	Saves an opened document using the same file name.
Save As	Saves an opened document to a specified file name.
Export Analysis Report	Writes an analysis report to a specified file name.
Print	Prints the main window.
Print Preview	Displays the document on the screen as it would appear printed.
Print Setup	Selects a printer and printer connection.
Properties	Displays file properties for the selected document.
1, 2, 3, ...	Opens one of the most recently opened files.
Exit	Exits MSA.

New Command

Use this command to create a new document in MSA. The new command consists of two sub-menu items:

New MSA File	Creates a new market-system (.msa) file.
New Portfolio	Creates a new portfolio (.msaport) file.

The new document will be blank.

You can open an existing document with the **Open** command.

Open Command

Use this command to open an existing market-system (.msa) or portfolio (.msaport/.msp) document or to select one or more text files of trade data. If text files are selected, a .msa file will be created automatically for each file of trade data or, optionally, all trade data will be read into a single .msa file. Also, if multiple .msa files are created from multiple text files, an optional portfolio (.msaport) file can be created automatically from the newly created .msa files.

You can create new documents with the **New** command.

File Open Window

The following options allow you to specify which file to open:

File Name

Specifies the file you want to open. This field lists files with the extension you select in the List Files of Type box.

Files of Type

Specifies the type of file you want to open. MSA creates files of type .msa and .msaport. You can also select "Trade Files (*.txt, *.csv, *.xml)" or "All Files (*.*)" in this box. Select "Trade Files" to open a text file of trade data and create a corresponding .msa file.

Close Command

Use this command to close the active document. When you close a document, MSA prompts you to save the document if it has any unsaved changes, then closes the document window.

Save Command

Use this command to save the active document to its current name and directory. When you save a document for the first time, MSA displays the **Save As window** so you can name your document. If you want to change the name and directory of an existing document before you save it, choose the **Save As** command.

Save As Command

Use this command to save and name the active document. MSA displays the **Save As window** so you can name your document.

To save a document with its existing name and directory, use the **Save** command.

File Save As Window

The following options allow you to specify the name and location of the file you are about to save:

File Name

Specifies a file name to save a document with a different name. MSA adds the extension you specify in the **Save As Type** space.

Export Analysis Report

Use this command to export a report containing all analysis results to a file. MSA displays an Export Analysis Report window so you can name the document and choose the location where the document will be saved. The results can be saved to any of the following formats: tab-delimited text (.txt), comma-delimited text (.csv), unformatted Word (.doc), or html (.htm). Also see Chapter 13, Working with MSA Files, Saving Analysis Reports.

Print Command

Use this command to print the main window. This command presents a **Print window**, where you may specify the range of pages to be printed, the number of copies, the destination printer, and other printer setup options.

Print window

The following options allow you to specify how the document should be printed:

Printer

Specifies the active printer and printer connection. Choose the **Setup** option to change the printer and printer connection.

Print Range

Specify the pages you want to print:

All	Prints the entire document.
Selection	Prints the currently selected text.

Pages Prints the range of pages you specify in the **From** and **To** fields.

Copies

Specifies the number of copies you want to print for the above page range.

Collate

Prints copies in page number order, instead of separated multiple copies of each page.

Print Progress Window

The Printing window is shown during the time that Market System Analyzer is sending output to the printer. The page number indicates the progress of the printing.

To abort printing, click **Cancel**.

Print Preview Command

Use this command to display the active document as it would appear when printed. When you choose this command, the document window will be replaced with a print preview window in which one or two pages will be displayed in their printed format. The **print preview toolbar** offers you options to view either one or two pages at a time; move back and forth through the document; zoom in and out of pages; and initiate a print job. Press the escape ('Esc') key to exit the preview window.

Print Preview toolbar

The Print Preview toolbar offers you the following options:

Print

Opens the print window, to start a print job.

Next Page

Previews the next printed page.

Prev Page

Previews the previous printed page.

One Page / Two Page

Previews one or two printed pages at a time.

Zoom In

Takes a closer look at the printed page.

Zoom Out

Takes a larger look at the printed page.

Close

Returns from print preview to the document window.

Print Setup Command

Use this command to select a printer and a printer connection. This command opens a **Print Setup window**, where you specify the printer and its connection.

Print Setup window

The following options allow you to select the destination printer and its connection.

Printer

Specifies the printer you want to use. Choose the default printer; or choose the **Specific Printer** option and select one of the current installed printers shown in the pane. You install printers and configure ports using Control Panel.

Orientation

Specifies **Portrait** or **Landscape**.

Paper Size

Specifies the size of paper on which the document is to be printed.

Paper Source

Specifies the tray for the paper source, because some printers offer multiple trays for different paper sources.

Properties

Displays a window where you can make additional choices about printing, specific to the type of printer you have selected.

Network

Click this button to connect to a network location, assigning it a new drive letter.

Properties Command

Use this command to display properties for the currently selected document. Displayed properties include the file name, the full path, type of file (market system or portfolio), MSA file version number, file size, date created, and date last modified. For market system files, the name and path of the trades file is also shown.

1,2,3,...Command

Use the numbers and filenames listed at the bottom of the File menu to open the last 15 documents you opened. Select the number that corresponds to the document you want to open.

Exit Command

Use this command to end your MSA session. MSA prompts you to save any open document that has unsaved changes.

View Menu Commands

The View menu offers the following commands:

Equity Table	Shows or hides the equity table.
Performance Results	Shows or hides the window of performance results for the current sequence.
Monte Carlo Results	Displays the results of the Monte Carlo analysis.
Optimization Results	Displays the results of the position sizing optimization.
Randomize Trade Order	Randomizes the order of the trades.
Restore Original Order	Restores the sequence of trades to its original order.
Zoom In	Magnifies selected chart area
Zoom Out	Restores normal magnification
Format Chart	Opens the Format Chart window.
Equity Curve Selection	Allows selection of equity curve(s) to plot (portfolios only)
Getting Started Screen	Displays screen with help on getting started
Toolbar	Shows or hides the toolbar.
Summary Pane	Shows or hides the summary pane.
Status Bar	Shows or hides the status bar.
Customize	Provides options for customizing the menus.
Theme	Presents optional visual styles for the program.

Equity Table Command

Use this command to show or hide the Equity Table. The Equity Table is a tabular listing of the results represented by the equity curve in the main window. The Equity Table can be kept on the screen while working elsewhere in the program. The window can be moved out of the way by clicking and dragging the title bar. To reduce the size of the window, click and drag the lower right-hand corner of the window. The window can be closed at any time by clicking the close button in the upper right-hand corner or by selecting this command. Once closed, it can be reopened by selecting this command again or by pressing Alt+E. See Chapter 12, Viewing the Results, Equity Table, for more information.

Performance Results Command

Use this command to show or hide the window of performance results for the current sequence of trades. See Chapter 12, Viewing the Results, Performance Results, for more information.

Monte Carlo Results Command

Use this command to display the results of the most recent Monte Carlo analysis. See Chapter 12, Viewing the Results, Monte Carlo Results, for more information.

Optimization Results Command

Use this command to display the optimization results for the selected document. For market-system documents, the results are displayed for the currently selected position sizing method. If no optimization has been performed for the currently selected position sizing method or the trades and/or analysis settings have been changed since the last optimization, this item will be dimmed (unavailable). For portfolio documents, this command will display the results of the most recent optimization, if one has been performed. If no optimization has been performed for the portfolio, this command will be dimmed. For more information, see Chapter 12, Viewing the Results, Optimization Results.

Randomize Trade Order Command

Use this command to randomize the order of the current sequence of trades. Even if the statistical properties of a trading system or method remain the same in the future, the sequence of profits and losses is unlikely to repeat. Randomizing the trade order can provide insight into how the ordering of the profits and losses affects the performance results. If, for example, the historical sequence of trades contains an unusually beneficial series of profits and losses that results in a high rate of return with a low drawdown, then such favorable results should not be expected in the future. Randomizing the trade sequence repeatedly can show how the rate of return and drawdown, as well as other statistics, might differ with other possible orderings of the trades.

The **Restore Original Order** command restores the sequence of trades to its original order.

This command may also be accessed by right-clicking anywhere within the main window or by using the Randomize button on the toolbar of the main chart window.

Restore Original Order Command

Use this command to restore the current sequence of trades to its original order. If the sequence has not been randomized (**Randomize Trade Order** command), this command will be dimmed. For market-system documents, the original order of trades can be viewed at any time using the **Edit/Add** command of the Trades menu.

This command may also be accessed by right-clicking anywhere within the main window or by using the Restore button on the toolbar of the main chart window.

Zoom In Command

Use this command to magnify part of the chart window. When the command is selected, the cursor changes to a magnifying glass. Click the mouse at one corner of the rectangular area to be magnified and drag the cursor while keeping the mouse button down. As the zoom cursor is dragged across the chart window, a rectangle indicates the area that will be magnified. Release the mouse to complete the process. The process can be repeated to zoom in further. Select the **Zoom Out** command to restore the original magnification.

The **Zoom In** command is also available on the toolbar and in the context menu that can be accessed by right-clicking within the chart window.

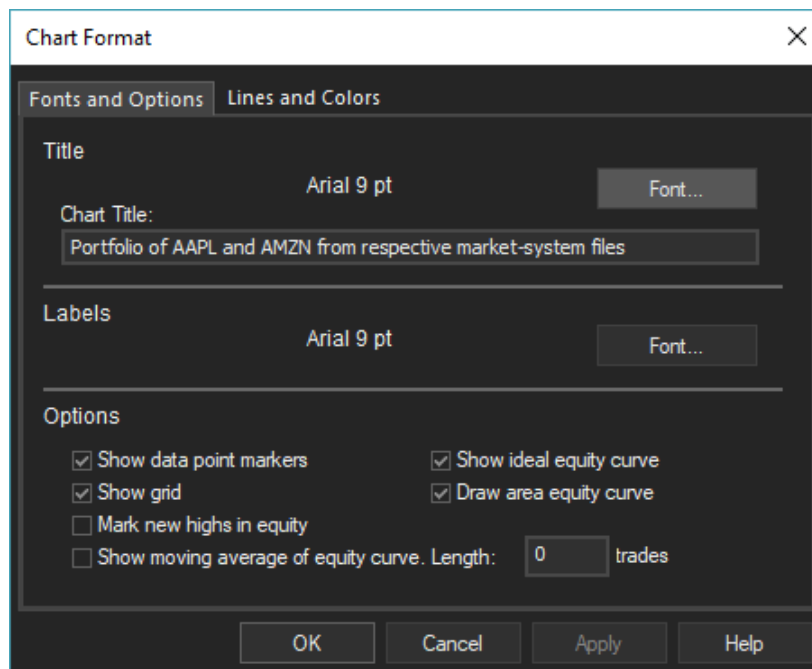
Zoom Out Command

Use this command to restore normal screen magnification for the main chart window after the chart has been magnified with the **Zoom In** command. A chart that has been magnified with **Zoom In** displays the label “Zoom on” in the upper left corner. Selecting **Zoom Out** restores normal magnification regardless of how many times the **Zoom In** command was used to magnify the screen.

The **Zoom Out** command is also available on the toolbar and in the context menu that can be accessed by right-clicking within the chart window.

Format Chart Command

Use this command to format the main window. Selecting this command opens a window with options for changing the chart title, chart fonts, line colors and widths, as well as various options for the plotting the equity curve.

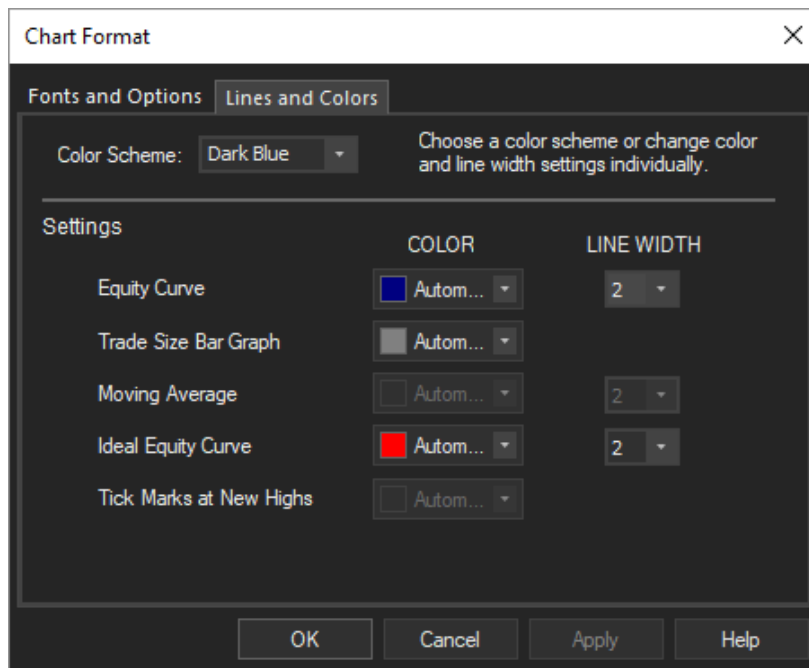


On the Fonts and Options tab, shown above, the Title section is used to enter the chart title, which appears above the main chart window. The font used for the title is shown in the font face and size currently selected. Click the “Font...” button to change the font face and/or text size. All other text on the chart is displayed using the font shown in the Labels section. Click the corresponding “Font...” button to change the font face and size for the label text.

The Options section provides options for showing or hiding the data point markers, the chart grid, the ideal equity curve, new highs in equity, and the moving average of the equity curve. There is also an option for drawing the equity curve as an area curve. If this option is chosen, the color currently selected for the equity curve line is used to fill in the area below the equity curve. The number of trades comprising the moving average of the equity curve can be entered on this page as well.

The ideal equity curve is constructed as follows: for position sizing methods other than fixed size, each “ideal” trade is assigned the average percentage trade. For example, if the average trade is 0.5%, the ideal equity curve is constructed by incrementing the equity by 0.5% from trade to trade starting with the starting account equity value. On a linear chart, this produces an equity graph that curves upward (i.e., has increasing slope). On a logarithmic scale, this curve is a straight line because the rates of return for all periods (trades in this case) are the same. If the slope of the actual equity curve is close to that of the ideal equity curve when plotted on a logarithmic scale, it indicates that the trading system or method has uniform performance over different time periods.

For fixed size position sizing, the ideal equity curve is constructed by assigning each “ideal” trade the average trade in currency units (e.g., dollars). In this case, the equity curve is generated by incrementing the equity by the average trade amount from trade to trade, resulting in a straight-line equity curve on a linear chart. On a logarithmic chart, the ideal equity curve in this case will curve downward (i.e., has decreasing slope).



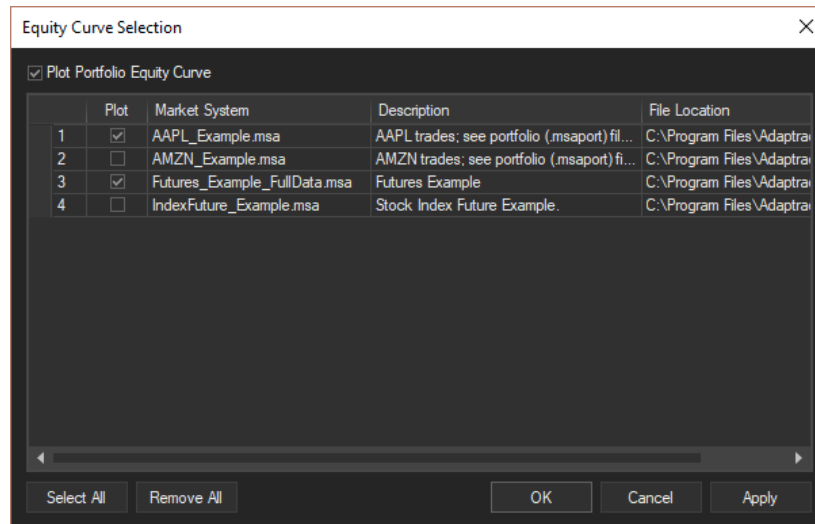
The Lines and Colors tab, shown above, allows you to set the line color and line width of the equity curve, trade size bar graph (color only), moving average, ideal equity curve, and tick marks at new equity highs. The color is chosen from a drop-down palette of standard colors. To choose a color not in the palette, select the “Other” option below the palette. This will bring up the color picker screen, which will enable you to choose any color available on your system. Alternatively, you can select one of the pre-defined color schemes from the Color Scheme pull-down menu at the top of the page. This will set colors for each component. Line widths are unaffected by the color scheme choice.

Line widths are also chosen from a drop-down list, which provides widths from 1 to 20 pixels. The Apply button can be used to try different choices before closing the window. Click OK to apply the chosen selections.

The **Format Chart** command may also be accessed by right-clicking anywhere within the main window.

Equity Curve Selection Command (portfolios only)

For portfolio documents, this command opens the Equity Curve Selection window, as shown below. This allows you to select which equity curves to plot in the main chart window. Click the check box above the table to plot the portfolio equity curve. Click the check boxes in the Plot column of the table to plot the equity curves for the market systems you want to plot.

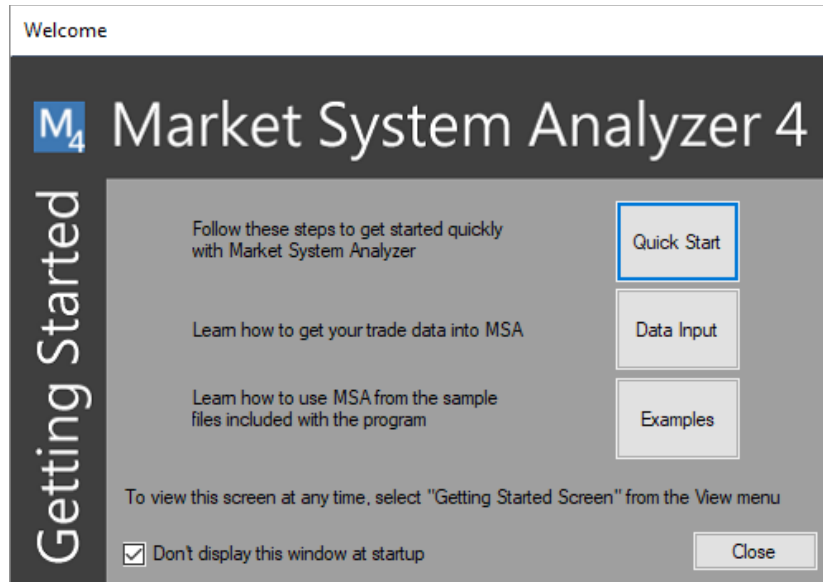


Note that the individual market-system equity curves are not the same as the equity curves displayed in the corresponding market-system (.msa) documents. When a market system is part of a portfolio, the position sizing for the market system depends on the total account equity, which includes equity contributions from all the market systems in the portfolio. Also, profits and losses from different market systems in a portfolio often offset one another, which tends to reduce the variance or volatility in the portfolio equity curve. It's not uncommon to see large drawdowns in individual market systems while the drawdown in the portfolio is quite modest.

The **Equity Curve Selection** command is also available in the context menu that can be accessed by right-clicking within the chart window.

Getting Started Screen Command

The getting started screen, shown below, normally appears when the program starts up. Use this command to display the getting started screen at any time. If the box "Don't display this window at startup" has been checked, the startup screen will not be displayed unless this command is used. The getting started screen has three buttons that bring up basic help topics. Click the Close button in the lower right-hand corner to close the window.



Toolbar Command

Use this command to display and hide the toolbar, which includes buttons for some of the most common commands in MSA, such as **File Open**. A checkmark appears next to the menu item when the Toolbar is displayed.

See Toolbar below for help on using the toolbar.

Toolbar

The toolbar is displayed across the top of the application window, below the menu bar. The toolbar provides quick mouse access to File menu functions (**New, Open, Save, Print**), as well as common analysis functions, such as Setup, Position Size, Optimize, Randomize, etc. Place the mouse cursor over a button (without clicking) to display a brief description of the button. The small, downward-pointing button at the right edge of the toolbar provides options for adding or removing toolbar buttons and for opening the Customize menu (see below).

To hide or display the toolbar, click **Toolbar** from the View menu.

Summary Pane Command

Use this command to display and hide the summary pane, which displays summary performance results corresponding to the equity curve displayed in the main chart. A checkmark appears next to the menu item when the summary pane is displayed.

Select a performance statistic in the summary pane to see a description of it in the area below the pane. To change the metrics displayed in the summary pane, right-click anywhere in the pane and click "Select Metrics." To view the complete performance report, right-click anywhere in the summary pane and select "View Full Results". The summary pane results can be copied to the clipboard by right-clicking and selecting "Copy".

Status Bar Command

Use this command to show or hide the status bar, which displays a brief description of the action to be executed by the selected menu item or depressed toolbar button as well as equity curve information when the user clicks the left mouse button within the equity curve chart window. A checkmark appears next to the menu item when the status bar is shown.

See **Status Bar** below for help on using the status bar.

Status Bar

The status bar is displayed at the bottom of the MSA main window. To show or hide the status bar, click **Status Bar** from the View menu.

The left area of the status bar describes actions of menu items as you use the arrow keys to navigate through menus. This area similarly shows messages that describe the actions of toolbar buttons as you select them, before releasing them. If after viewing the description of the toolbar button command you decide not to execute the command, then release the mouse button while the pointer is off the toolbar button. When the left mouse button is clicked over the equity curve, the left area of the status bar displays the following information for the trade at the cursor location: equity value at cursor location, trade number, market-system number (portfolios only), date/time, account equity value, drawdown (% drawdown), and position size.

The right areas of the status bar indicate which of the following keys are latched down:

Indicator	Description
CAP	The Caps Lock key is latched down.
NUM	The Num Lock key is latched down.
SCRL	The Scroll Lock key is latched down.

Customize Command

Use this command to customize the menus, toolbars, and keyboard shortcuts. The right-click context menus for the main chart window can be customized using the Menu tab. On the right-hand side of the menu tab, select the context menu under “Context Menus”. Then switch to the Commands tab, select a command from the list, and drag and drop it onto the context menu. To remove a command from the context menu, drag it off the menu.

Theme Command

Use this command to change the visual style of the menus, toolbars, and other visual elements of the user interface of the MSA program. To change the theme, select one of the options from the popup menu. Themes are available to emulate various Windows programs, such as Office 2007, Office 2010, Visual Studio 2012 Black, Office 2016, among others. The default is Office 2016, Black. Once the style has been changed, it will be stored locally, and the program will continue to use that style until a new style is selected.

Trades Menu Commands

The Trades menu offers the following commands, which facilitate entering and editing the trade data needed by MSA:

Data Source	Opens the Data Source window for specifying the text file of trades (trades file) on which the market system’s equity curve is based.
Edit/Add	Opens the Edit/Add Trades window for entering and editing trade data.
Import	Reads trade data from the selected text file.
Export	Exports the trade data to a text file.
Create Trades From Statistics	Synthetically generates a series of trade profit/losses from statistics.

Specify Trade Risks	Presents options for defining the risks for a series of trades.
Clear All	Deletes all trade data from the open file.
Reload From File	Reads the trades from the trades file and recalculates the equity curve.

The Trades menu is only applicable to market-system (.msa) documents and is not present when a portfolio (.msaport) document is active.

Data Source Command

Use this command to select or name the trades file. The trades file is the text file containing the trade data (profit/loss, entry and exit prices, etc.) for the market system. This command opens the Data Source window, which displays the name of the current trades file if one has been selected. Use this window to select a new trades file. After a trades file is selected, the trades will be read into the document. If the document already contains trade data, MSA will prompt you to either over-write the existing trades, append the new trades to the existing ones, or ignore the trade data in the new trades file. See Chapter 3, Getting Data Into the Program, for more information on using the **Data Source** command.

Edit/Add Command

Use this command to edit, add, and delete trades. This command opens the Edit/Add Trades window, which lists the trades in their original order. When restricting the current sequence of trades to a subset of the original sequence using the toolbar, use the trade numbers listed in the Edit/Add Trades window. See Editing Input Data in Chapter 3 for details on using the Edit/Add Trades window.

Import Command

The **Import** command on the Trades menu is used to read in a series of trades from a text file. This command can be used instead of the **Data Source** command to enter trade data into MSA. Selecting the **Import** command prompts you to select a text file containing the trade data. As with the **Data Source** command, after the file is selected, the data are read in from the file and displayed in the Trades File Format window (see Chapter 3, Input Data, Getting Data into the Program). The Trades File Format window enables you to identify the columns of data in the file, including the columns to read and the ones to ignore. The Trades File Format window is not displayed (and is not necessary) when reading trade data from RINA xml files.

Two pre-set formats, available on the Preset column format pull-down menu of the Trades File Format window, are designed to simplify this process. The first predefined format is the TradeStation Trades List. Select this format to import trade data from a text file generated from the Trades List portion of a TradeStation performance report. The file should be in text format, either as a .txt or .csv file. TradeStation software, version 8 or newer, is required. To create the file, view the TradeStation performance report from within TradeStation. Save the report as an Excel (.xls) file, then open the saved file in Excel. Go to the Trades List sheet and “save as” the spreadsheet as a .txt or .csv text file. Only the Trades List sheet will be saved. Also see Chapter 3, Input Data, Getting Data into the Program.

The other predefined format is the WriteTrades3 file format. Use this format to import trades from a text file generated by the WriteTrades TradeStation function, which is included with MSA. The WriteTrades function is designed to be called as the last line in a TradeStation strategy. It generates a text file that contains the trade data needed by MSA. See Chapter 3, Input Data, WriteTrades EasyLanguage Function.

As explained in Getting Data into the Program (see Chapter 3, Input Data), you can also save your own formats, which will then be available in the pull-down menu alongside the other pre-set formats.

Export Command

Use this command to export the trade data currently in MSA to a file. This command opens the Export Trades window, which allows you to choose an existing file or name a new file to contain the exported trades. For each trade, the following data are written: symbol, entry date, entry price, exit date, exit price, stop price, trade direction (1/-1), profit/loss, risk, trade size, ATR, currency conversion factor, and trade type (0 – 2). The trades can be saved to any of the following formats: tab-delimited text (.txt), comma-delimited text (.csv), unformatted Word (.doc), or html (.htm). To import a .csv or .txt file created with the Export command, select the WriteTrades3 preset format on the Trades File Format window and use the option to skip the first two lines. Also see Chapter 3, Input Data.

Create Trades from Statistics Command

Use this command to synthetically generate a series of trade profit/losses from the following set of performance statistics: percent profitable, average winner, largest winner, average loss, largest loss. The command can be used to create any specified number of trades. The trades can replace the existing trades, if any, or be appended to the existing set of trades. See Chapter 3, Input Data, Creating Trades from Statistics.

Specify Trade Risks Command

Use this command to define the risk for each trade. The trade risk is defined as the amount that would be lost per share/contract if the trade were a loss. Options include specifying the risk as the largest loss, the average loss, the average loss plus N standard deviations, or a specified value per share/contract. The specified risk value can either replace all existing risks, if any, or it can be used to define any currently undefined values. See Chapter 3, Input Data, Specifying a Risk Value for All Trades.

Clear All Command

Use this command to delete all trade data from the current document. If a trades file has been selected, the data will be deleted from the trades file the next time the .msa file is saved.

Reload From File Command

Use this command to force a reload of the trades file. The trades file, as specified under **Data Source**, will be read into the document, the equity curve and associated performance results will be recalculated, and the equity curve will be redrawn. To instruct MSA to execute this command automatically at specified intervals, use the **Setup** command of the Analysis menu.

Analysis Menu Commands

The Analysis menu contains commands for analyzing the current market-system document. The Analysis menu is only applicable to market-system (.msa) documents. For portfolios, please refer to the Portfolio menu, described below. The following commands are available on the Analysis menu:

Setup	Opens a window for entering analysis settings and options.
Position Sizing	Presents methods for position sizing.
Dependency Rules	Presents optional rules for exploiting trade dependency.
Monte Carlo Analysis	Performs a Monte Carlo analysis on the current

	sequence of trades.
Parameter Studies	Opens a window for plotting position sizing parameters.
Optimize Position Sizing Trade Size	Finds the optimal position sizing parameter.
	Calculates the position size for the next (upcoming) trade.

Setup Command

Use this command to enter analysis settings and options. The Analysis Setup window has four tabs: Input Data, Account Settings, Options, and Monte Carlo Settings. See Chapter 4, Basic Settings, for a detailed description of each tab. Briefly, the Input Data tab allows you to control how the input data are interpreted. Settings include the trading vehicle (stocks/forex or futures), the point value (futures only), whether the profit/loss and risk amounts are determined from price inputs or from the P/L and risk amounts themselves, the default trade size, and several options specifying whether trading costs are included in the data. There is also an option on this tab to reload the file of trade data at specified intervals.

The Account Settings tab allows you to set basic options related to your trading account, such as the starting account equity value, margin requirements, and trading costs. You can also select the locale for your trading account on this tab. The locale determines the currency unit used for display purposes (dollar, Yen, Euro, etc.) as well as the number format. There is also an option on this tab to set up a schedule of regular account withdrawals within the simulation. If you plan to regularly withdraw money from your trading account, this option will make the simulation more accurate.

The Options tab contains a number of options for position sizing, dependency analysis, and the significance test. The position sizing options include the ability to specify a minimum position size, the option to trade a fixed size until the account equity reaches a specified threshold, and the option of trading in multiples of a fixed size, such as 100 shares.

The Monte Carlo Settings tab contains options for the Monte Carlo analysis, including the number of Monte Carlo samples, confidence level, and two optional analyses.

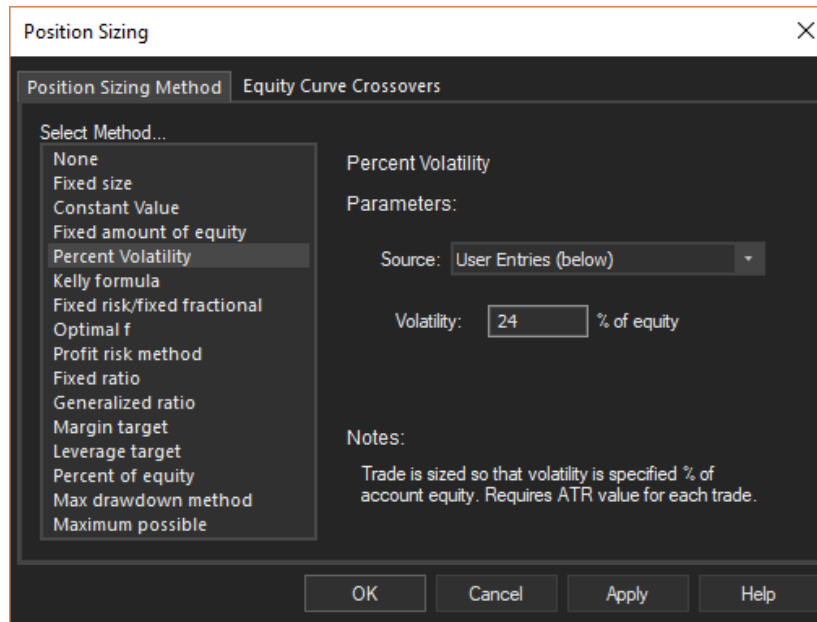
Position Sizing Command

Use this command to select the position sizing method and associated options. The Position Sizing window, as shown below, consists of two tabs, Position Sizing Method and Equity Curve Crossovers, described below.

Position Sizing Method tab

The Position Sizing Method tab presents a list of the different position sizing methods available in MSA. See Chapter 5, Position Sizing, for a description of each method. When a method is selected from the list, the name of the method is displayed to the right of the list. Below that, in the Parameters section, the method's parameter values can be entered, such as the percentage of equity to risk per trade in the fixed risk method.

The drop-down Source menu in the Parameters section is used to tell MSA where to obtain the position sizing parameter values. There are four choices: "User Entries (below)," "Optimization, All Trades," "Sliding Window Opt, In-sample," and "Sliding Window Opt, Out-of-sample."



If the first option is chosen, the parameter values for position sizing are obtained from the values entered by the user on the Position Sizing Method tab for the currently selected position sizing method. If the second option is selected, MSA uses the optimal value of the position sizing parameter for the currently selected method, as determined from the optimization over all trades. If the optimization has not been performed for the currently selected position sizing method, the values entered by the user will be used instead.

If the third or fourth option is chosen, the position sizing parameter values obtained from optimizing over a sliding window of trades will be used. If the sliding window optimization has not been performed for the currently selected position sizing method, the values entered by the user will be used instead. There are two ways to use the sliding window parameter values: in sample (as optimized), or out-of-sample (walk-forward). Selecting the third option from the drop-down list ("...in-sample") means that the parameter values will be applied to the same trades that were used in the optimization. For example, suppose the optimization window was 30 trades in length, and the optimized parameter was the delta (fixed ratio method). The optimization would have used trades 1 - 30 for optimization window #1. Applying the optimal delta in-sample means that trades 1 - 30 will use the optimal delta from window #1. Trade 31 will use the optimal delta from window #2 (trades 2 - 31). Trade 32 will use the optimal delta from window #3 (trades 3 - 32), and so on.

If the fourth option ("...out-of-sample") is selected, the optimized parameter value will be assigned to the trade following the optimization window. In the example above, the delta value for trade 31 will be the optimal value from window #1 (trades 1 - 30). The delta value for trade 32 will be the optimal value from window #2 (trades 2 - 31), and so on. Trades 1 - 30 will have a position size of zero because there is no out-of-sample value to assign to trades in the first window. Selecting this option provides a way to test the optimized parameter values on data not used in the optimization. This is known as out-of-sample testing.

The Notes section on the bottom right of the Position Sizing Method tab provides a brief description of the selected position sizing method.

When the OK button is clicked, the chart will be redrawn to employ the selected position sizing method. All subsequent analyses will employ the selected method. The chosen position

sizing method will also determine the parameter optimized during position sizing optimization; e.g., for fixed fractional position sizing, the optimized parameter will be the fixed fraction (percent risk). See Chapter 8, *Optimizing Position Sizing, Optimization Objectives*, for a list of the parameters optimized for each position sizing method. You can use the Apply button to try different methods before closing the window.

Equity Curve Crossovers tab

MSA includes an equity crossover feature that enables you to modify your trading based on crossovers of a moving average of the equity curve. Use this tab to select the equity curve crossover rules and options.

See Chapter 5, *Position Sizing, Equity Curve Crossovers*, for further information.

Dependency Rules Command

Use this command to select the dependency rules. The dependency rules are intended to take advantage of any trade dependency found in the current sequence of trades, such as determined by the runs test. Selecting this command opens the Dependency Rules window, which presents the available dependency rules. Once a rule is selected, click Apply to apply the rule to the current sequence of trades. Click OK to close the window and apply your selections, which will be reflected in the main chart window and in all subsequent analyses.

See Chapter 9, *Trade Dependency, Setting Dependency Rules*, for a description of each dependency rule.

Monte Carlo Analysis Command

Use this command to perform a Monte Carlo analysis on the current sequence of trades. The analysis will be performed using the settings and options specified on the Monte Carlo Settings tab of the Analysis Setup window. When the analysis is complete, the results will be presented in the Monte Carlo Results window.

Also see Chapter 6, *Monte Carlo Analysis, Overview*.

Parameter Studies Command

Use this command to plot position sizing parameters against performance measures. This command opens the Parameter Studies window, which allows you to select a position sizing parameter on the X axis and a performance measure on the Y axis. You can also specify the range of X values to plot, the number of points to plot, and whether to calculate the performance measure using the current sequence of trades or with Monte Carlo analysis. Click the PLOT CURVE button at the bottom of the window to plot the curve. Selections made in this window have no affect on the main chart window or in any subsequent analyses.

See Chapter 7 for further details.

Optimize Position Sizing Command

Use this command to find the value of the position sizing parameter for the currently selected position sizing method that maximizes a chosen objective. Selecting this command opens the Optimize Position Sizing window, which presents a list of choices for the performance measure to maximize and an optional limit on the maximum percentage drawdown. You can choose to optimize over all trades in the current sequence or using a sliding window of trades. You can optimize using the current sequence of trades or with Monte Carlo analysis. There is also a choice of search methods for performing the optimization.

See Chapter 8 for further details.

Trade Size Command

Use this command when trading on a day to day basis to calculate the position size for the next (upcoming) trade. Selecting this command (or pressing F11) opens the Trade Size window. Enter the current value of your account equity and, if not dimmed out, the trade risk (in currency units, such as dollars) per share/contract/unit and the expected entry price or current market price. Click the “Calculate” button to determine the position size, required margin, and other results for the next trade based on the entered data and using the currently selected position sizing method, parameters, and related settings.

Also see Chapter 5, Position Sizing, Real Time Position Sizing.

Portfolio Menu Commands

The Portfolio menu contains commands for analyzing the current portfolio document. The Portfolio menu is only applicable to portfolio (.msaport) documents. For market-system documents, please refer to the Analysis menu, described above. The following commands are available on the Portfolio menu:

Setup	Opens a window for entering analysis settings and options.
Position Sizing	Presents methods for position sizing.
Dependency Rules	Presents optional rules for exploiting trade dependency.
Monte Carlo Analysis	Performs a Monte Carlo analysis on the current sequence of trades.
Optimize Position Sizing	Finds the optimal position sizing parameters for the portfolio.
Trade Size	Calculates the position size for the next (upcoming) trade for each market system in the portfolio.
Reload	Reads in the data for each market system and recalculates the portfolio equity curve.

Setup Command

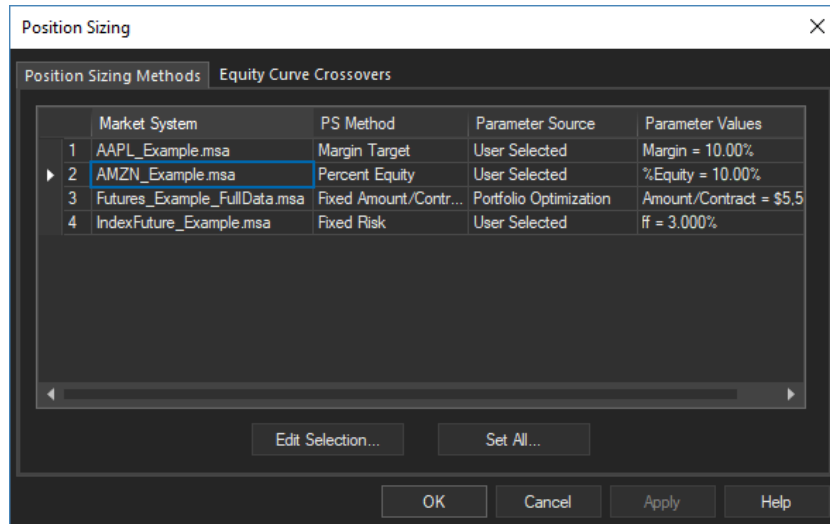
Use this command to enter analysis settings and options for a portfolio. The Portfolio Setup window has three tabs: Market Systems, Settings and Options, and Monte Carlo Settings. See Chapter 4, Basic Settings, for a detailed description of each tab. Briefly, on the Market Systems tab, the Add Market System(s)... button can be used to select any number of existing market-system (.msa) document files. The selected market systems will be added to the portfolio. To change the composition of the portfolio, use the check boxes in the Include column of the table to include or exclude market systems. Click the Apply button to see the effect of any changes while the window is still open. A market system can be removed from the table using the Remove Market System(s) button. To open one of the market-system documents comprising the portfolio, either double-click on the market-system name in the table or use the Open File(s) button. The check box at the bottom of this tab can be used to automatically reload the chart data at specified time intervals.

The Settings and Options tab allows you to set basic options related to your trading account, such as the starting account equity value and options for dependency analysis and the significance test. You can also select the locale for your trading account on this tab. The locale determines the currency unit used for display purposes (dollar, Yen, Euro, etc.) as well as the number format.

The Monte Carlo Settings tab contains options for the Monte Carlo analysis, including the number of samples, confidence level, and optional analyses.

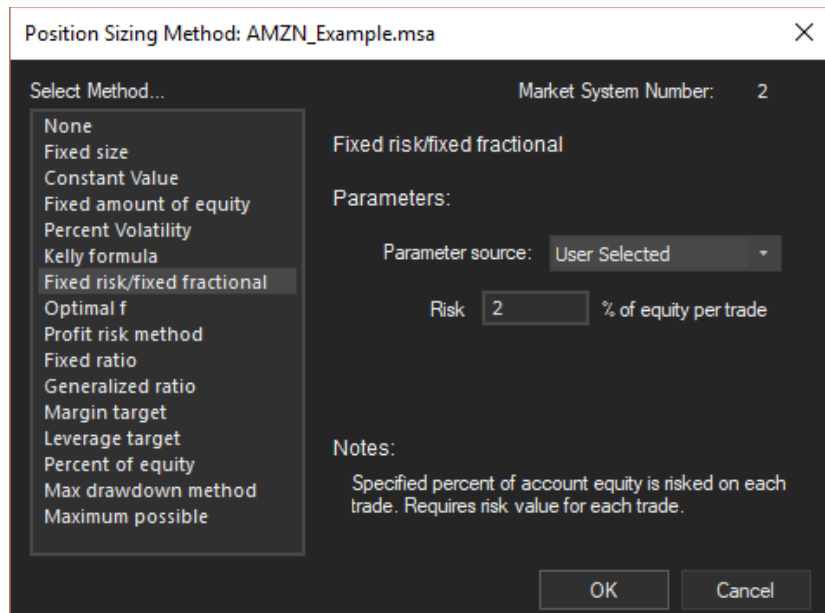
Position Sizing Command

Use this command to select the position sizing methods and associated options for each market system in the portfolio. The Position Sizing window, as shown below, consists of two tabs, Position Sizing Methods and Equity Curve Crossovers, described below.



Position Sizing Method tab

This tab lists each market system with its default position sizing settings. To change the position sizing method and/or parameters, double-click on the market system or select the market system from the list and click the Edit Selection button. This brings up the Position Sizing Method window, shown below.



By default, the settings are retrieved from the market-system file. To change a parameter value, change the Parameter Source to User Selected in the Parameters section then enter the new value in the space provided.

The Position Sizing Method window lists the different position sizing methods available in MSA. See Chapter 5, Position Sizing, for a description of each method. When a method is selected from the list, the name of the method is displayed to the right of the list. Below that, in the Parameters section, the method's parameter values can be entered, such as the percentage of equity to risk per trade in the fixed risk method.

The drop-down Parameter source menu in the Parameters section is used to tell MSA where to obtain the position sizing parameter values. There are three choices: "User Selected," "Market System File" and "Portfolio Optimization."

If the first option is chosen, the parameter values for position sizing are obtained from the values entered by the user in the Parameters section for the currently selected position sizing method. If the second option is selected, MSA retrieves the position sizing parameter value from the market-system file. If the last option is chosen, the value of the position sizing parameter for the currently selected method is obtained from the most recent portfolio optimization if one has been performed.

The Notes section on the bottom right of the Position Sizing Method tab provides a brief description of the selected position sizing method.

Equity Curve Crossovers tab

MSA includes an equity crossover feature that enables you to modify your trading based on crossovers of a moving average of the equity curve. Use this tab to select the equity curve crossover rules and options. These rules apply to the portfolio equity curve. There may be other equity curve crossover rules selected for individual market systems. To disable these market-system rules, check the box "Deactivate all crossover rules currently active in individual market system files".

See Chapter 5, Position Sizing, Equity Curve Crossovers, for further information.

Dependency Rules Command

Use this command to select the dependency rules. The dependency rules are intended to take advantage of any trade dependency found in the current sequence of trades, such as determined by the runs test. Selecting this command opens the Dependency Rules window, which presents the available dependency rules. Once a rule is selected, click Apply to apply the rule to the current sequence of trades. Click OK to close the window and apply your selections, which will be reflected in the main chart window and in all subsequent analyses. These rules apply to the portfolio equity curve. There may be other dependency rules selected for individual market systems. To disable these market-system rules, select the option "Deactivate all dependency rules currently active in individual market system files" on the Portfolio Setup window, Settings and Options tab.

See Chapter 9, Trade Dependency, Setting Dependency Rules, for a description of each dependency rule.

Monte Carlo Analysis Command

Use this command to perform a Monte Carlo analysis on the current sequence of trades. The analysis will be performed using the settings and options specified on the Monte Carlo

Settings tab of the Portfolio Setup window. When the analysis is complete, the results will be presented in the Monte Carlo Results window.

Also see Chapter 6, Monte Carlo Analysis, Overview.

Optimize Position Sizing Command

Use this command to find the optimal values of the position sizing parameters for the portfolio. The optimization is based on the currently selected position sizing methods, as shown in the Position Sizing window. Selecting this command opens the Optimize Position Sizing window, which presents a list of choices for the performance measure to maximize and an optional limit on the maximum percentage drawdown for the portfolio. You can optimize over the current sequence of trades or using Monte Carlo analysis. You can optionally start the optimization at the current position sizing parameter values or at values randomly selected by the program.

See Chapter 8 for further details.

Trade Size Command

Use this command when trading on a day to day basis to calculate the position sizes for the next (upcoming) trade for each market system in the portfolio. Selecting this command (or pressing F11) opens the Trade Size (Portfolio) window. Enter the current value of your account equity and, if not dimmed out, the trade risk (in dollars) per share/contract/unit and the expected entry price or current market price for each market system. Use the Next MS and Previous MS buttons to move between market systems. Click the “Calculate Position Sizes” button to determine the position sizes, required margins, and other results for the next trades based on the entered data and using the currently selected position sizing methods, parameters, and related settings.

Also see Chapter 5, Position Sizing, Real Time Position Sizing.

Reload Command

This command reconstructs the portfolio by reading each individual market-system file and adding it to the portfolio. When each market-system file is read, the trades file is loaded. As a result, the **Reload** command updates the portfolio with the latest trade data from each market system. To instruct MSA to execute this command automatically at specified intervals, use option on the Market Systems tab of the Portfolio Setup window.

Window Menu Commands

The Window menu offers the following commands, which enable you to arrange multiple views of multiple documents in the application window:

New Horizontal Tab Group	Splits the chart window horizontally into two panes
New Vertical Tab Group	Splits the chart window vertically into two panes
New Window	Creates a new window that views the same document.
Split	Splits the chart window into either two or four user-sized panes.
Window 1, 2, ...	Goes to specified window.

New Horizontal Tab Group Command

Use this command to divide the chart window into two horizontal panes. The currently active tab will occupy the new pane. To remove a pane, click and drag the tab from the pane you want to remove to the other pane.

New Vertical Tab Group Command

Use this command to divide the chart window vertically into two panes. The currently active tab will occupy the new pane. To remove a pane, click and drag the tab from the pane you want to remove to the other pane.

New Window Command

Use this command to open a new window with the same contents as the active window. You can open multiple document windows to display different parts or views of a document at the same time. If you change the contents in one window, all other windows containing the same document reflect those changes. The new window appears in a tab with the file name followed by a colon and the copy number; e.g., Example2.msa:2 represents the second copy of file Example2.msa.

Split Command

Use this command to split the active window into additional panes, with a copy of the active document in each pane. When this command is selected, the mouse cursor changes to crosshairs that span the active window. Move the cursor to divide the window into four panes. Move the cursor all the way to the bottom or top of the window to split the window vertically. Move the cursor all the way left or right to split the window horizontally. To remove the split, drag the split line to the edge of the window.

Window 1, 2, ... Command

MSA displays a list of currently open document windows at the bottom of the Window menu. A checkmark appears in front of the document name of the active window. Choose a document from this list to make its window active.

Help Menu Commands

The Help menu offers the following commands, which provide assistance with this application:

Help Topics	Offers an index to topics on which you can get help.
About	Displays information about this application.

Help Topics Command

Use this command to display the table of contents for Help. From the table of contents, you can open various topics for using Market System Analyzer, look up topics in the index, and perform word searches using Find. Press F1 at any time to open a help topic related to the selected command or open window. The help system contains the complete contents of this user's guide.

About MSA Command

Use this command to display information about Market System Analyzer, such as the copyright notice and version number.

Chapter 15

FAQ (Frequently Asked Questions) List

Market System Analyzer uses closed trade equity. Won't this underestimate the true drawdown?

In some cases, using closed trade equity for drawdown calculations will underestimate the drawdown. This is usually only a concern for long-term system, which may have large swings in equity during the trade. Even with these types of systems, however, only a fraction of the trades generally experience intra-trade drawdowns that completely reverse before the trade exits. If, on the other hand, a trade exits at its worst intra-trade drawdown, the closed trade equity will also accurately represent the intra-trade drawdown.

If you want to use MSA for long-term trading, consider using the daily, weekly, or monthly returns as input data in place of trades. For example, if you enter the daily changes in equity as trade data, each day's equity change will be considered to be a trade.

How can I handle pyramiding in Market System Analyzer?

In Market System Analyzer, each trade is assumed to have one entry and one exit. As such, MSA is not designed to explicitly handle pyramiding. The reason for this is that pyramiding is not a true position sizing method. In pyramiding, additional shares/contracts are added after the initial entry. For example, in a long-term trend following system, pyramiding may be used to add to a long position as the market continues to trend upward.

There's more to adding additional shares/contracts than position sizing. Because these subsequent entries take place at different times and under different conditions than the original entry, they should be viewed as comprising an additional trading system. This other "system" may have the same exit as the original system, but it has a different entry, effectively making it a different system. Viewed this way, position sizing in pyramiding should be applied separately to the original entry and to the subsequent, pyramided entries. In fact, the original entries and the pyramided entries could be analyzed as separate trading systems in a portfolio.

How can I handle scaling in/scaling out in MSA?

This is the same basic issue as pyramiding, discussed above. Scaling in is the process of adding shares/contracts after the initial entry to build a position. Scaling out removes shares/contracts during the trade to reduce the position size. As with pyramiding, any buy or sell during a trade can be viewed as another trade. These other trades could be analyzed in combination with the original entry/exit using portfolio analysis.

Can I use the program with options?

Market System Analyzer is not specifically designed for complex option trades, such as straddles, spreads, covered call writing, and so on. However, it can be used with relatively simple option trades. For example, to use MSA for long stock option trades, select "stocks/forex" as the trading vehicle and select the "trade in units of ..." option with a unit size equal to the number of shares the option represents, such as 100 shares. The entry and exit prices for the trade will be the option prices. For example, if a call option on stock XYZ with a strike price of 50 is purchased for \$3 and later sold for \$4, the trade data would be

entered using an entry price of 3, an exit price of 4, a unit size of 100 shares, and a trade direction of "long" or 1. The margin percentage should be set to 100%, which implies that the full price of the option ($\$3 \times 100$ shares or $\$300$) would be required to purchase the option. The resulting trade would be a profit of $\$100$ (net option profit of $\$1 \times 100$ shares). Each "unit" would represent one option.

A futures option trade would be entered in MSA the same way as a futures trade. You would select "futures" as the trading vehicle and enter the point value for the underlying futures in the Point Value field of the Analysis Setup window. Enter the required option margin on the Account Settings tab of the Analysis Setup window. Futures options are generally priced for one contract, so the trade size should be one contract.

The margin requirements for naked option writing are more difficult to represent in MSA. For example, to write a naked equity index option might require a margin of 15% of the index value. The total cost of the trade would be the margin amount plus the option premium minus any out-of-the money amount. There is no easy way to account for this in MSA.

Can I use MSA for forex trading?

Yes, you can use MSA for forex trading. Since forex is highly leveraged, position sizing and money management are particularly important for forex. Although there is no "forex" trading vehicle in MSA, the program can be used for forex by selecting "stocks/forex" as the trading vehicle. Enter the trades in terms of the entry and exit prices. Set the percentage margin to the percentage you use for forex, such as 1%. The position size will be given in "shares." For example, a full-size lot would be 100,000 shares; a mini lot would be 10,000 share, and so on. All calculations are performed in the currency in which the symbol is denominated. To obtain the results in a different currency, use the currency conversion data input field.

Can I use MSA for spread betting?

In most respects, MSA works well for spread betting. Spread betting is a highly leveraged form of trading popular in the UK. To apply MSA to spread betting, you could select "futures" as the trading vehicle. In some cases, the margin requirements for spread betting are based on a percentage of the price of the underlying asset, rather than a fixed amount, as with futures. In this case, you would need to enter an approximate margin amount in MSA. Alternatively, you may use "stocks/forex" as the trading vehicle using the same approach as for forex.

I only have a small sample of trades. Will I still get good results?

Many of the analyses in Market System Analyzer will be compromised if you start from a small number of trades. For statistical reliability, you should have at least 30 trades. If you have fewer trades but you believe the trades are an accurate representation of your trading system or method, you might want to expand your list of trades using one of the methods described in Chapter 6, Monte Carlo Analysis, Overview. The more trades available to the program, the more accurate calculations such as the worst-case drawdown will be.

What's the best way to find information on a particular command or feature?

The fastest and best way to find information on a command or feature of Market System Analyzer is via the built-in help system, which can be accessed by pressing F1. The complete user's guide is included in the help system. Moreover, the F1 command is context sensitive. If you highlight a menu command then press F1, a help topic will open for that menu command if available. If a window is open when you press F1, a help topic related to that window will open. To bring up the complete help index, press F1 while the cursor is over the main chart window and no other windows are open. Once any help topic is open, you can access all other help topics via the Contents and Index buttons or by entering a term in the Search box. In addition, many windows in the program have a "Help" button that opens the relevant help topic.

The optimization can't find a solution. What should I do?

When the optimization fails to find a solution, it's often because the number of trades is too small. Even if the number of trades appears to be large enough, the number of trades participating in the analysis might be reduced by a dependency rule or an equity crossover rule. Try turning these rules off to increase the number of trades in the analysis. Also try performing the optimization with Monte Carlo analysis. This will take longer but generally provides more reliable results.

If the optimization is over a sliding window of trades and the number of trades in the window is too small, some windows might lie within a drawdown, making it impossible for the optimization to find a profitable result over that window. Increasing the number of trades until the window exceeds the length of the drawdown should eliminate this problem. Monte Carlo analysis for sliding window optimization is also usually a good idea.

Lastly, if you're optimizing a single market system, try the other search method (see Chapter 8, *Optimizing Position Sizing, Search Methods*). Adaptive search is usually preferable except when using fixed size position sizing. However, if adaptive search is unsuccessful, try exhaustive search. It may take longer but may be more likely to find a solution.

When I apply the sliding window optimization results, why don't they match the results in the optimization results window?

Even if the optimization results for every sliding window appear to be good, the resulting equity curve when the optimal parameter values are applied may not be as good. This is due to the cumulative effect of building the equity curve from successive sliding windows. In particular, while the optimization may limit the drawdown to a reasonable percentage -- say, 30% -- the cumulative drawdown in adjacent windows may be greater than this. For example, window #5 may end in a drawdown of 25%, and window #6 might start off with a drawdown of 20%, resulting in a combined drawdown of 45%, which exceeds the optimization limit of 30%.

Similar problems can occur when the optimal parameter values are applied out-of-sample; i.e., walk-forward. For example, suppose the optimal fixed fraction for window #10 was 0.08 (8%). This might be the result of maximizing the rate of return subject to a drawdown constraint of 20%, which means that the drawdown in each sliding window was limited to 20%. However, if window #11 has a less favorable sequence of trades than window #10, that 8% fixed fraction could result in a drawdown much larger than 20% when applied "forward" in window #11.

To eliminate or at least minimize these problems, try increasing the size of the sliding window. Using Monte Carlo analysis will also help by producing more consistent optimal values from window to window.

What can I do to speed up the optimization?

If you're using Monte Carlo analysis and the optimization is too slow, reduce the number of Monte Carlo samples (see Chapter 14, *Menu Commands, Analysis Menu Commands, Setup Command, Monte Carlo Settings tab*). The default is 500. Try 200 or even 100. If the optimization is satisfactory, go back and repeat with a larger number of samples. The time to complete the optimization will be proportional to the number of Monte Carlo samples, so if it takes 10 minutes with 200 samples, you'll know to expect 25 minutes with 500 samples.

If you're optimizing a single market system, try using the alternative search method (see Chapter 8, *Optimizing Position Sizing, Search Methods*).

As an alternative to position sizing optimization for single market systems, try using the Parameter Studies feature (see Chapter 7, Parameter Studies). By plotting the rate of return followed by the worst-case drawdown, it's usually possible to find a good parameter value fairly quickly.

For optimizing portfolios, the option of starting the optimization at values chosen by the program can increase the optimization time considerably. This is because MSA evaluates the portfolio at a series of randomly selected starting points prior to beginning the main optimization. If you've entered a drawdown constraint, it may take additional time to find random trial values that meet the constraint. In this case, to speed up the optimization, you can either use a less restrictive drawdown constraint or start the optimization at the current position sizing parameter values.

How do I add a trade to the bottom of the list of trades in the Edit/Add Trades window?

Normally, a new trade is added above the one currently selected in the table. To add a trade to the bottom of the table, you need to deselect any trade that may be selected (highlighted). To do this, click the mouse in the margin outside the table of trades but still within the window. If you then click the Add Trade button, the trade will be added as the new last row in the table.

When I apply the moving average equity crossover rule, why don't the crossovers on the chart seem to match where the program adjusts the position size?

This can be a little confusing, but the program is working correctly. The equity crossover rules change the position sizing based on crossovers of the equity curve with its moving average. However, when you plot the moving average on the screen, the crossovers probably won't match up exactly with the trades that have had their position sizing changed by the crossover rule. This is because the equity curve is actually calculated twice. In the first pass, the crossover locations are determined, but the crossover rule is not used to change the position size. During the second pass, the crossover locations are used to apply the crossover rule and adjust the number of shares/contracts. This is necessary because applying the crossover rule to change the position size alters the equity curve and thereby changes the crossover locations. The moving average that is plotted on the equity curve is the moving average of the equity curve that you see on the chart, which includes the effect of the crossover rule. If you want to see the moving average and the crossover points that were used to adjust the position sizing, turn off the equity crossover rule but leave the moving average plotted on the chart.

Appendix: Performance Metrics

The performance metrics listed in the Performance Results windows for both market-system and portfolio documents are described below. The metrics are listed in the order in which they appear in the performance reports. A subset of these metrics is listed in the Monte Carlo Results. In cases where a different name is used for the portfolio results, the metric name for the portfolio results is shown in parentheses.

Total Net Profit: Gross profit plus gross loss (where gross loss is a negative number).

Gross Profit: The sum of the winning trades.

Gross Loss: The sum of the losing trades.

Profit Factor: Gross profit divided by the absolute value of gross loss. Profit factors of 1.5 or more suggest a strong system. A trading system or method with a low profit factor could become unprofitable with just a slight change in market dynamics.

Pessimistic Return Ratio: Similar to profit factor but discounted by the number of trades. As the number of trades approaches infinity, the pessimistic return ratio approaches the profit factor. See Vince, Ralph. "Portfolio Management Formulas," John Wiley & Sons, New York, 1990, p. 46.

Trading Period: The time period over which trading occurred, spanning the first trade displayed in the equity curve to the last trade shown.

Starting Account Equity: The value of account equity at the start of the simulation.

Highest Closed Trade Equity: The greatest value of account equity on a closed trade basis over all trades in the current sequence.

Lowest Closed Trade Equity: The lowest value of account equity on a closed trade basis over all trades in the current sequence.

Additions to Equity: Total value of all additions to account equity during the trading period.

Withdrawals from Equity: Total value of withdrawals from account equity during the trading period.

Final Account Equity: Value of account equity on the last trade, as shown on the equity curve in the chart window.

Return on Starting Equity: Percentage change in account equity from the first to last trade relative to the starting account equity.

Total Number of Trades: Total number of trades, including those with zero numbers of shares/contracts.

Number of Winning Trades: Number of trades with a profit/loss greater than zero.

Number of Losing Trades: Number of trades with a profit/loss less than or equal to zero.

Trades Not Taken: Number of trades with zero position size.

Percent Profitable: The winning trades expressed as a percentage of the total number of trades excluding trades not taken.

Max Number of Shares/Contracts (Max Position Size): Largest number of shares/contracts for any one trade.

Minimum Number of Shares/Contracts (Minimum Position Size): Smallest number of shares/contracts of any trade, excluding trades with zero shares/contracts.

Average Number of Shares/Contracts (Average Position Size): Average number of shares/contracts per trade, excluding trades with zero shares/contracts.

Total Number of Shares/Contracts: Total number of shares/contracts traded over all trades.

Max Number of Open Positions: Maximum number of positions open at the same time.

Ave Number of Open Positions: Average number of positions open at the same time.

Largest Winning Trade: Largest winning trade, where the winners are expressed in currency units. On the next line, the value of this trade expressed as a percentage of account equity at the time the trade was taken is shown.

Largest Winning Trade (%): Largest winning trade, where each winner is expressed as a percentage of account equity at the time the trade was taken. On the next line, the value of this trade in currency units is shown.

Average Winning Trade: Average of the winning trades, where the winners are expressed in currency units.

Average Winning Trade (%): Average of the winning trades, where each winner is expressed as a percentage of account equity at the time the trade was taken.

Average R-Multiples, Wins: The R-multiple is the trade profit/loss divided by the risk of the trade, including trading costs. See Tharp, Van K. "Trade Your Way to Financial Freedom," 2nd ed., McGraw-Hill, New York, 2007. This metric is the average of the R-multiples for winning trades.

Average Length of Wins: Average duration of winning trades in days, hours, minutes, seconds.

Max Number Consecutive Wins: Largest number of winning trades in a row.

Largest Losing Trade: Largest losing trade, where the losses are expressed in currency units (e.g. dollars). On the next line, the value of this trade expressed as a percentage of account equity at the time the trade was taken is shown.

Largest Losing Trade (%): Largest losing trade, where each loss is expressed as a percentage of account equity at the time the trade was taken. On the next line, the value of this trade in currency units is shown.

Average Losing Trade: Average of the losing trades, where the losses are expressed in currency units.

Average Losing Trade (%): Average of the losing trades, where each loss is expressed as a percentage of account equity at the time the trade was taken.

Average R-Multiples, Losses: The R-multiple is the trade profit/loss divided by the risk of the trade, including trading costs. See Tharp, Van K. "Trade Your Way to Financial Freedom," 2nd ed., McGraw-Hill, New York, 2007. This metric is the average of the R-multiples for losing trades.

Average Length of Losses: Average duration of losing trades in days, hours, minutes, seconds.

Max Number Consecutive Losses: Largest number of losing trades in a row.

Average Trade (Expectation): Average of all trades, where the trades are expressed in currency units. This is also known as the expectation.

Average Trade (%): Average of all trades, where each trade is expressed as a percentage of account equity at the time the trade was taken.

Trade Standard Deviation: Standard deviation of the trades, where the trades are expressed in currency units. The standard deviation is a measure of variability or dispersion. 68% of normally distributed values are within one standard deviation of the average. 99.7% are within three standard deviations of the average.

Trade Standard Deviation (%): Standard deviation of the trades, where each trade is expressed as a percentage of account equity at the time the trade was taken.

Win/Loss Ratio: Ratio of average winning trade to average losing trade, where the trades are expressed in currency units.

Win/Loss Ratio (%/%): Ratio of average winning trade to average losing trade, where each trade is expressed as a percentage of account equity at the time the trade was taken.

Return/Drawdown Ratio: Return on starting equity divided by the maximum percentage peak-to-valley closed trade drawdown.

Profit/Drawdown Ratio: Ratio of Total Net Profit to the maximum peak-to-valley closed trade drawdown, where both the net profit and drawdown are expressed in currency units (e.g., dollars).

Sortino Ratio: Average monthly return minus the target return, all divided by the so-called downside deviation. The downside deviation is similar to the standard deviation except that positive deviations are set to zero, whereas in the standard deviation, both positive and negative deviations are included. The Sortino ratio is an alternative to the Sharpe ratio and is sometimes preferred because it doesn't penalize positive returns that exceed the target value. In MSA, the target rate of return is set to zero. The Sortino ratio is generally higher than the Sharpe ratio.

MAR Ratio: Average annual compounded rate of return divided by the maximum percentage peak-to-valley closed trade drawdown. The MAR ratio is often used to evaluate and compare

hedge funds and commodity trading advisors (CTAs). MAR ratios between 0.5 and 1.0 over long histories are generally considered excellent.

Modified Sharpe Ratio: Average of all trades, where each trade is expressed as a percentage of account equity, divided by the standard deviation of the trades in percent. The modified Sharpe ratio is a measure of risk adjusted return. Higher values are better.

Sharpe Ratio: Average monthly return minus the risk-free interest rate, all divided by the standard deviation of the monthly returns. The risk-free interest rate is the monthly rate of interest, as entered on the Options tab of the Setup window (Settings and Options tab of the Portfolio Setup window for portfolios). This is a classic measure of risk-adjusted return. Higher values are better.

Average Risk: Average of position risks over all trades. The position risk is the risk per contract/share multiplied by the number of contracts/shares for the position. The average risk includes trading costs for the position.

Average Risk (%): Average position risk where the risk of each position is expressed as a percentage of account equity at the time the trade is taken.

Max Risk (%): Maximum risk value over all trades, where the risk of each position is expressed as a percentage of account equity at the time the trade is taken. On the next line, the value in currency units is shown.

Date of Max Risk: Entry date of the trade for which the Max Risk (%) occurs.

Average R-Multiple (Expectancy): The R-multiple is the trade profit/loss divided by the risk of the trade, including trading costs. See Tharp, Van K. "Trade Your Way to Financial Freedom," 2nd ed., McGraw-Hill, New York, 2007. This metric is the average of the R-multiples for all trades, both wins and losses. Tharp refers to this as the expectancy.

R-Multiple Standard Deviation: Standard deviation of R-multiples over all trades, both wins and losses.

Total R-Multiple: Sum of the R-multiples over all trades, both wins and losses. This is essentially the risk-normalized net profit.

Van Tharp SQN: SQN® is Van Tharp's System Quality Number; see for example, Tharp, Van K. "Van Tharp's Definitive Guide to Position Sizing," International Institute of Trading Mastery, Inc., North Carolina, 2008, p. 28. This metric is calculated as the Average R-Multiple divided by the R-Multiple Standard Deviation multiplied by the square root of the number of closed trades.

Average Margin: Average value of total margin required at each trade. This might include margin from multiple trades if two or more trades are open at the same time.

Average Margin (%): Average of margin values, where each value is expressed as a percentage of the account equity at the time the trade was taken.

Max Margin (%)/Margin Value: Maximum value of margin requirement, where the margin is expressed as a percentage of the account equity at the time the trade was taken. The margin value in currency units (e.g., dollars) corresponding to the maximum percentage values is also listed.

Date of Max Margin: Entry date of the trade for which Max Margin (%) occurs.

Average Account Leverage: Average value of account leverage over all positions. Account leverage is defined as the value of all open positions divided by the account equity at trade entry.

Max Account Leverage: Maximum value of account leverage over all positions.

Date of Max Account Leverage: Entry date of the trade for which Max Account Leverage occurs.

Risk of Ruin: Probability of account depletion. See Vince, Ralph. "Portfolio Management Formulas," John Wiley & Sons, New York, 1990, p. 136, equation R3. The equation for risk of ruin assumes (1) unequal wins and losses, (2) a fixed number of contracts/shares per trade, and (3) ruin is defined as 100% account depletion.

Average Annual Profit/Loss: Average of all yearly profits (losses), including partial years.

Ave Annual Compounded Return: Average annual rate of return assuming annual compounding.

Average Monthly Profit/Loss: Average of all monthly profits (losses), including partial months.

Ave Monthly Compounded Return: Average monthly rate of return assuming monthly compounding.

Average Weekly Profit/Loss: Average of all weekly profits (losses), including partial weeks.

Ave Weekly Compounded Return: Average weekly rate of return assuming weekly compounding.

Average Daily Profit/Loss: Average of all daily profits (losses).

Ave Daily Compounded Return: Average daily rate of return assuming daily compounding.

In Market System Analyzer, drawdown is defined as a decline from the highest prior peak in closed trade equity. The drawdown is measured from the highest prior peak to the lowest closed trade equity value.

Number of Closed Trade Drawdowns: This is the total number of drawdowns over the current sequence of trades, as shown in the chart window.

Average Drawdown: Average value of the drawdowns expressed in currency units (e.g., dollars).

Average Drawdown (%): Average value of the drawdowns expressed as percentage declines from the prior highest peak in equity.

Average Length of Drawdowns: Average duration of drawdowns.

Average Trades in Drawdowns: Average number of trades from the start of a drawdown until the first trade that makes a new equity high.

Worst-Case Drawdown: Largest drawdown, where the drawdowns are expressed in currency units. On the next line, the value of this drawdown expressed as a percentage decline from the prior peak in equity is shown.

Date at Trough: The exit date of the trade at the lowest equity point during the worst-case drawdown.

Trade Number at Trough: The number of the trade at the lowest equity point during the worst-case drawdown. The trade number corresponds to that shown on the equity curve.

Length of Drawdown: Duration of worst-case drawdown, from the start of the drawdown to the trade that makes a new equity high.

Trades in Drawdown: The number of trades from the start of the worst-case drawdown until the trade that makes a new equity high.

Worst-Case Drawdown (%): Largest value of the drawdowns expressed as percentage declines from the prior highest peak in equity. On the next line, the value of this drawdown in currency units is shown.

Date at Trough: The date of the trade at the lowest equity point during the worst-case percentage drawdown.

Trade Number at Trough: The number of the trade at the lowest equity point during the worst-case percentage drawdown. The trade number corresponds to that shown on the equity curve.

Length of Drawdown: Duration of worst-case percentage drawdown, from the start of the drawdown to the trade that makes a new equity high.

Trades in Drawdown: The number of trades from the start of the worst-case percentage drawdown until the trade that makes a new equity high.

Longest Drawdown: Duration of longest drawdown, from the first trade in the drawdown to the trade that makes a new equity high.

Start of Drawdown: Date of trade that marks the start of the longest drawdown.

End of Drawdown: Date of trade that marks the end of the longest drawdown.

Percent of Equity: Depth of longest drawdown, expressed as a percentage decline from the prior equity peak.

Appendix: Position Sizing Code for TradeStation and MultiCharts

Although Market System Analyzer (MSA) is designed as a stand-alone program, users of TradeStation or MultiCharts may want to perform their position sizing calculations within their trading platform. To make this easier, the EasyLanguage function, PSCalc, implements the position sizing methods of MSA. After the function is discussed, an example illustrates the use of PSCalc in a simple trading system. The example also demonstrates how the PSCalc function can be used to optimize trading system and position sizing parameters simultaneously in the trading platform.

The PSCalc EasyLanguage function is designed to be called from the code of an existing trading system. It calculates and returns the number of shares/contracts based on the account equity and the selected position sizing method. The position sizing method and associated parameter values are determined from the input parameters of the function.

PSCalc can be used either to back-test trading systems or in day to day trading to determine the number of shares/contracts for the next trade. In back-testing mode, the function accumulates the account equity after each trade and bases the position size on the accumulated equity (or accumulated profit for fixed and generalized ratio trading). For day to day trading purposes, the function uses the input value of the trader's current account equity to calculate the number of shares/contracts for the next trade.

You can find the function in the files PSCalc32.eld (TS 8 or newer and MultiCharts), PSCalc32.els (for TS 2000i) or in the text file PSCalc32.txt, which are included with licensed (paid) version of MSA. PSCalc is not available in the trial version of MSA.

The input parameters of the function are listed below. A value should be provided for each parameter unless it corresponds to a position sizing method that you do not plan to use. In that case, a value of zero can be used.

Input	Description
PSMeth	position sizing method, as defined in the table below.
Param1	1st position sizing parameter. See table below.
Param2	2nd position sizing parameter. See table below.
BackTest	true/false; true means account equity is accumulated; false means CurEqty is used as total equity.
StEqty	initial account size (starting equity) in dollars.
CurEqty	current value of account equity in dollars; only used when BackTest = false.
TrRisk	risk for current trade, per share/contract/unit
MxLoss	largest 1-share/contract/unit loss
MaxDD	largest 1-share/contract/unit drawdown
Stocks	true if vehicle is a stock; false if futures.
UseUnits	true/false. If true, number of shares/contracts is a multiple of UnitSize; e.g., 100 shares per unit.
UnitSize	size of trading unit; e.g., 100 shares.

UseMinN	true/false. If true, the number of shares/contracts is always at least equal to MinN. In other words, if the number of shares/contracts would otherwise be less than MinN because of a small account size or high trade risk, this sets the number of shares/contracts equal to MinN.
MinN	Minimum number of shares/contracts; applied if UseMinN is true.
MaxN	maximum allowable number of shares/contracts. If the calculated number is more than this value, this value will be returned.
InitMarg	initial margin required per contract for futures trades, \$.
MargPer	margin requirement for stocks; percent of equity (e.g., 50%).
NATR	Averaging period for average true range calculation.

The position sizing method is determined by the value of the first parameter, PSMeth. Inputs Param1 and Param2 are the parameters for the selected position sizing method. The correspondence between the position sizing method and Param1 and Param2 is shown in the following table:

PSMeth	Description	Param1	Param2
1	fixed size	# shares/contracts/unit	NA
2	fixed \$ per share/contract	\$ per share/contract/unit	NA
3	fixed fractional/fixed risk	fixed fraction, %	NA
4	fixed ratio	delta	Initial size
5	generalized ratio	delta	exponent
6	Classic f	fixed fraction, %	NA
7	Profit risk method	% profit at risk	% init equity
8	Margin target	% equity used for margin	NA
9	Leverage target	leverage	NA
10	Percent equity	% of equity traded	NA
11	Max drawdown method	% of max drawdown	NA
12	Max possible	NA	NA
13	Constant Value	position value	NA
14	Percent Volatility	volatility as % of equity	NA

Except for the “Classic f” method (#6), these methods are the same as described in Chapter 5, Position Sizing. The classic f method is the same as the fixed risk method except that the risk of the trade is taken as the largest historical loss, as given by parameter MxLoss. The fixed risk method (#3), by contrast, uses the value of TrRisk as the trade risk, which may be different for each trade. If the classic f method is selected, then Param1 will be the fixed fraction. If, for example, Param1 is set to the optimal f value, as calculated by MSA, then the position sizing will be the optimal f method.

The fourth parameter, BackTest, is used to select between back-testing mode (BackTest = true) and day to day trading mode (BackTest = false). If BackTest = false, the parameter CurEqty should be set to the current value of account equity. If BackTest = true, CurEqty is ignored. The next parameter, StEqty, is the starting account equity. If BackTest = false, StEqty is only used for fixed and generalized ratio trading, where it's used to calculate the total profit (total profit = CurEqty - StEqty).

TrRisk is the risk amount for the current trade on a per-share/contract/unit basis. This is used for fixed risk and profit risk position sizing. The next parameter, MxLoss, is the largest loss (on a 1-share/contract/unit basis) among all trades in the trade history. This is used for the “Classic f” position sizing method, discussed above. The MaxDD parameter is the largest peak-to-valley drawdown in the trade history on a 1-share/contract/unit basis. This is used in the Max Drawdown method.

The Stocks parameter is a true/false value that is true if the trading vehicle is stocks and false if the trading vehicle is futures. To trade in multiples of a fixed number of shares or contracts, set the UseUnits parameter to true and set the UnitSize parameter to the fixed number of shares or contracts. For example, with UnitSize equal to 100, the position size will be a multiple of 100 shares. The UseMinN parameter allows you to force the position size equal to MinN in cases where it would otherwise be less than that. MaxN is the maximum allowable number of shares or contracts. This is provided to keep the position size from getting unrealistically large during back testing.

The next two parameters are for setting the minimum margin requirement. InitMarg is the initial margin requirement per contract for futures trading. For stock trading, set MargPer to the minimum percentage margin requirement (e.g., 50%).

The last parameter, NATR, is used to set the number of bars over which the average true range (ATR) is calculated. This is only used when the percent volatility position sizing method is selected.

To illustrate the use of the PSCalc function, the following EasyLanguage system code is provided. This system, called **PSEExample3**, is a simple breakout system intended primarily for the E-mini S&P 500 futures. The EasyLanguage code can be found in the files PSEExample3.eld, PSEExample3.els, or in the text file PSEExample3.txt.

The first two inputs to the system relate to the trading rules of the system. The remaining inputs relate to the PSCalc function. The system enters at a fraction of the prior day's range from the prior day's high. The fraction of the prior day's range is given by the first input. The second input is the size of the money management stop in dollars. The remaining inputs are the same as the parameters of PSCalc, except that the TrRisk parameter is a variable rather than an input to the system. TrRisk, the dollar value of the trade risk per contract, is set to the size of the money management stop.

```
{
  PSEExample3 strategy
  This simple system is designed to illustrate the use of the PSCalc
  function for position sizing.

  System: Buy at a fraction of yesterday's range from yesterday's high. Hold
  1 day then look to exit on the first profitable open. Use a fixed money
  management stop (nominally $1000 in the e-mini S&P).

  The number of contracts for each trade is determined using function
  PSCalc.

  Adaptrade Software
  www.Adaptrade.com

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}

Input: EntFrac      (0.75),      { multiple of prior day's range for entering }
      StopSz       (1000),      { size of money management stop in dollars }
      PSMeth       (3),         { position sizing method, 1 - 14 }
      Param1       (5.0),      { Position sizing parameter #1 }
```

```

Param2      (0),      { Position sizing parameter #2 }
BackTest    (true),   { true for back testing }
StEqty      (50000),   { starting account size, $ }
CurEqty    (50000),   { current account size, $ }
MxLoss      (1000),   { largest 1-contract/share/unit loss, $ }
MaxDD       (2000),   { largest 1-contract/share/unitdrawdown, $ }
Stocks      (False),  { true if trading vehicle is a stock }
UseUnits    (False),  { true for trading in even units }
UnitSize    (1),      { # shares/contracts per unit }
UseMinN     (true),   { true --> # shares/contracts at least MinN }
MinN        (1),      { Minimum # of shares/contracts }
MaxN        (1000),   { max allowable number of shares/contracts }
InitMarg    (4000),   { initial margin per contract for futures }
MargPer     (100),    { margin requirement in percent for stocks }
NATR        (10);     { period for average true range }

Var:  EntPr    (0),      { Entry target price }
      XitPr    (0),      { mm stop exit price }
      TrRisk   (0),      { trade risk, $ }
      NCon     (0);      { number of contracts }

TrRisk = StopSz;

{ Entry conditions }
NCon = PSCalc32(PSMeth, Param1, Param2, BackTest, StEqty, CurEqty, TrRisk,
               MxLoss, MaxDD, Stocks, UseUnits, UnitSize, UseMinN, MinN,
               MaxN, InitMarg, MargPer, NATR);

EntPr = H + EntFrac * (H - L);

If C > C[1] then
    Buy NCon contracts next bar at EntPr Stop;

{ Exit conditions }
Sell("MMStop") next bar at EntryPrice - TrRisk/BigPointValue stop;
If BarsSinceEntry >= 1 and open of next bar > EntryPrice then
    Sell("ProfOpen") next bar at market;

{ Value99 = WriteTrades32(TrRisk, 0, 0, NATR, 1, "C:\PSEExample3-ES-WriteTrades3.csv");}

```

Placing the function parameters as inputs to the system enables you to optimize the position sizing within TradeStation or MultiCharts using the built-in optimization feature of the platform. You can even optimize the system and position sizing parameters simultaneously. For example, in fixed fractional position sizing, the position size depends on the trade risk. In this system, the trade risk is equal to the size of the money management stop. To illustrate, the size of the money management stop, StopSz, and the risk percentage, RiskPer, were optimized together using PSMeth = 3 (fixed fractional position sizing). BackTest was set to true for these tests.

The symbol was @ES (E-mini S&P 500 futures, continuous contract). The period was 1/2/2003 to 8/20/2004 with a look-back length of 1 bar. The initial account size (StEqty) was \$30,000, and \$75 was deducted per contract for slippage and commissions. For comparison, the system parameters were first optimized by themselves on a fixed contract basis. Three

contracts were taken per trade. Based on net profit, the optimal parameter values were EntFrac = 0.8 and StopSz = 1700. These parameters produced the following results:

Net profit: \$14,887.50
 Return on account: 49.6%
 Profit factor: 2.29
 Number of trades: 36
 Percent profitable: 66.7%
 Average trade: \$413.54
 Max. consecutive losses: 2
 Max. closed trade drawdown: 12.6%

Next, the stop size and the fixed risk (Param1) were optimized together with the entry fraction, EntFrac, set at the value of 0.8 from the prior, fixed contract optimization. In this case, a very different optimal stop size was found. With fixed risk position sizing, the best stop size was \$700 (compared to \$1700 with fixed contract position sizing) using a fixed risk percentage of 18%. The optimal results using these parameter values were:

Net profit: \$26,012.50
 Return on account: 86.7%
 Profit factor: 1.42
 Number of trades: 39
 Percent profitable: 61.5%
 Average trade: \$666.99
 Max. consecutive losses: 2
 Max. closed trade drawdown: 40.2%

In practice, a risk percentage of 18% is far too high (notice the drawdown of 40%). However, even with smaller risk percentages, the optimal stop size was different than \$1700 using fixed risk trading. This illustrates that position sizing can interact with a system's trading rules, and suggests that there may be merit in setting system parameter values and position sizing parameter values together.

In this example, the money management stop size was optimized. However, using the PSCalc function as illustrated here, any system input can be optimized together with any position sizing parameter. If you go through this type of analysis with your own trading system, it's recommended that you run the results through MSA's Monte Carlo analysis to confirm that your chosen position sizing parameter values are reasonable. In general, to utilize the capabilities of both MSA and TradeStation/MultiCharts when optimizing a trading system, consider following the steps below:

1. Optimize the system and position sizing parameters together in TradeStation or MultiCharts, as in the last example above.
2. Use the WriteTrades function to write out the trade results.
3. Import the trades into Market System Analyzer.
4. Apply your desired position sizing method and parameter values and run the Monte Carlo analysis in MSA.
5. If the results are not satisfactory, re-optimize the position sizing within MSA using Monte Carlo analysis.

As with any optimization, you should have a sufficient number of trades to avoid over-fitting the system to the market data. You can use the significance test feature of MSA to help determine if this is the case. In addition, out-of-sample testing is recommended after optimization.

To calculate the position size for day to day trading purposes, set `BackTest = false` and set `CurEqty` to the current value of your account equity. If using fixed or generalized ratio trading, make sure that `StEqty` is also set correctly so that the total profit ($\text{CurEqty} - \text{StEqty}$) will be correct. Before each new entry, make sure `CurEqty` is set to the current value of your account equity.

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