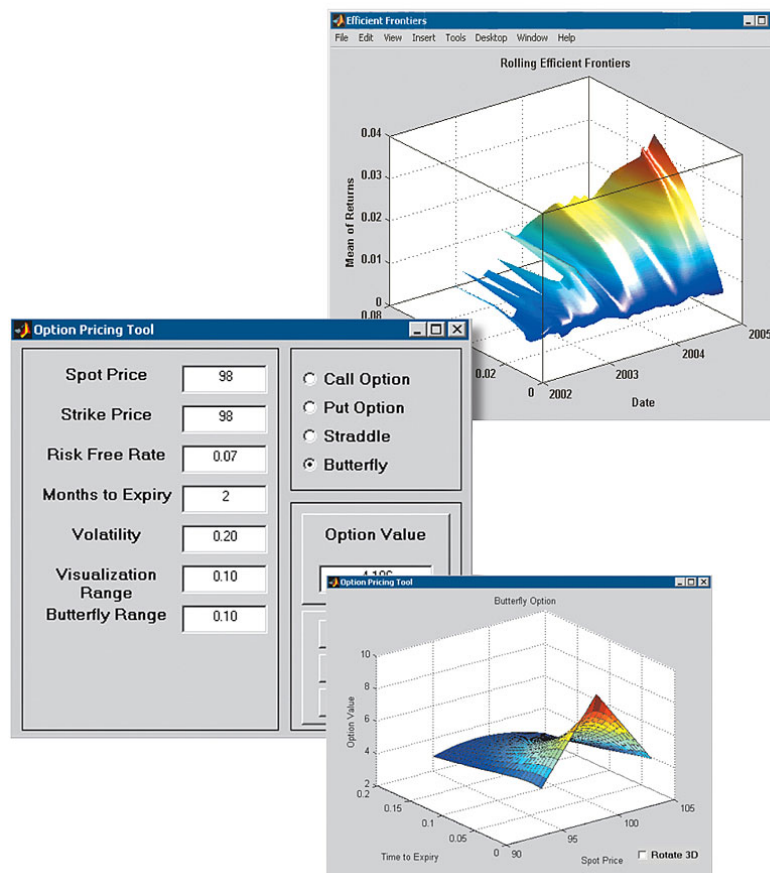# Financial Toolbox

Analyze financial data and develop financial algorithms

Financial Toolbox™ provides functions for mathematical modeling and statistical analysis of financial data. You can optimize portfolios of financial instruments, optionally taking into account turnover and transaction costs. The toolbox enables you to estimate risk, analyze interest rate levels, price equity and interest rate derivatives, and measure investment performance. Time series analysis capabilities let you perform transformations or regressions with missing data and convert between different trading calendars and day-count conventions.

Key Features

- Asset allocation, cash flow analysis, object-oriented portfolio optimization, and risk analysis

- Basic SIA-compliant fixed-income security analysis

- Basic Black-Scholes, Black, and binomial option pricing

- Financial time series, date math, and calendar math

- Basic GARCH estimation, simulation, and forecasting

- Regression and estimation with missing data

- Technical indicators and financial charts

Example financial modeling application for options and asset portfolios.

Asset Allocation and Portfolio Optimization

Financial Toolbox provides a comprehensive suite of portfolio optimization and analysis tools for performing capital allocation, asset allocation, and risk assessment. You can:

- Estimate asset return and total return moments from price or return data

- Compute portfolio-level statistics

- Perform constrained mean-variance optimization and analysis

- Examine the time evolution of efficient portfolio allocations

- Perform capital allocation

- Account for turnover and transaction costs in portfolio optimization problems
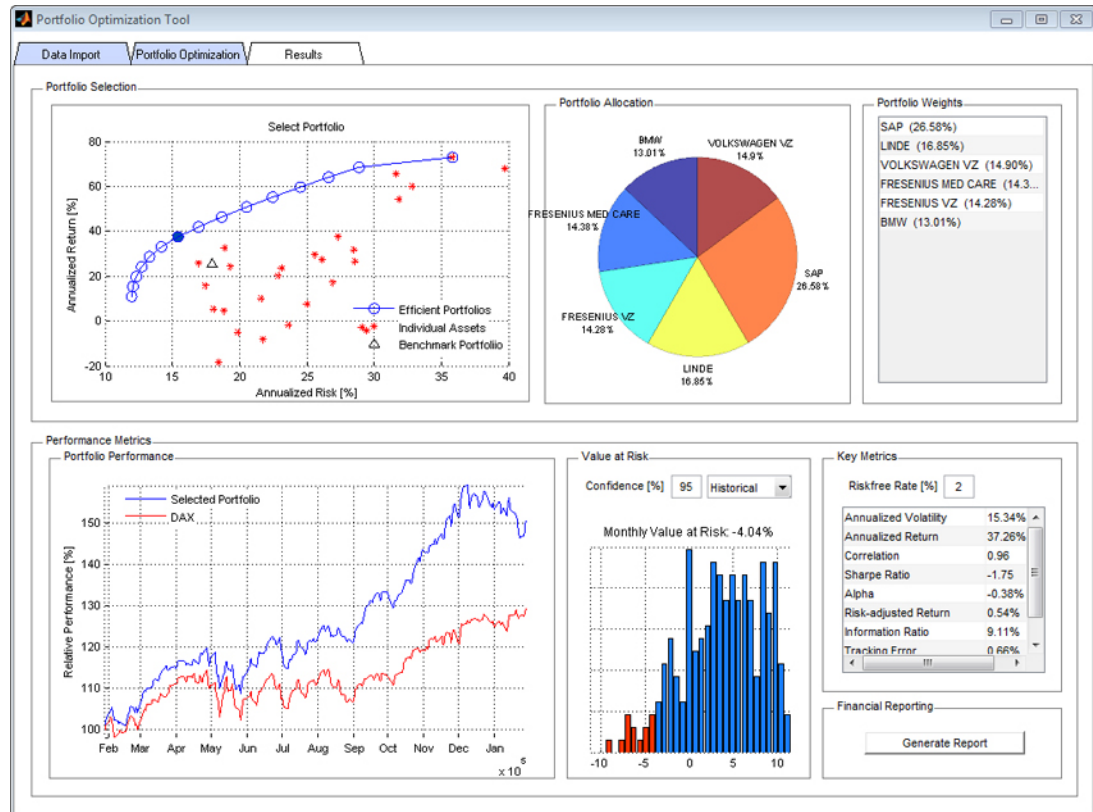
Example portfolio optimization application built using MATLAB, Financial Toolbox, and object-oriented design. The application enables the interactive selection of a portfolio, comparison to a benchmark, visualization, and reporting of key performance metrics.

Object-Oriented Portfolio Construction and Analysis

The toolbox provides portfolio optimization tools, which enable you to customize and extend the base behavior for your asset allocation or portfolio type using object-oriented programming. Two classes are provided: an abstract class for developing new portfolio types, and a mean-variance portfolio optimization class for traditional portfolio optimization problems. The portfolio object supports the entire workflow, from defining the portfolio problem to evaluating the efficient frontier, to setting up a record of purchase and sales.
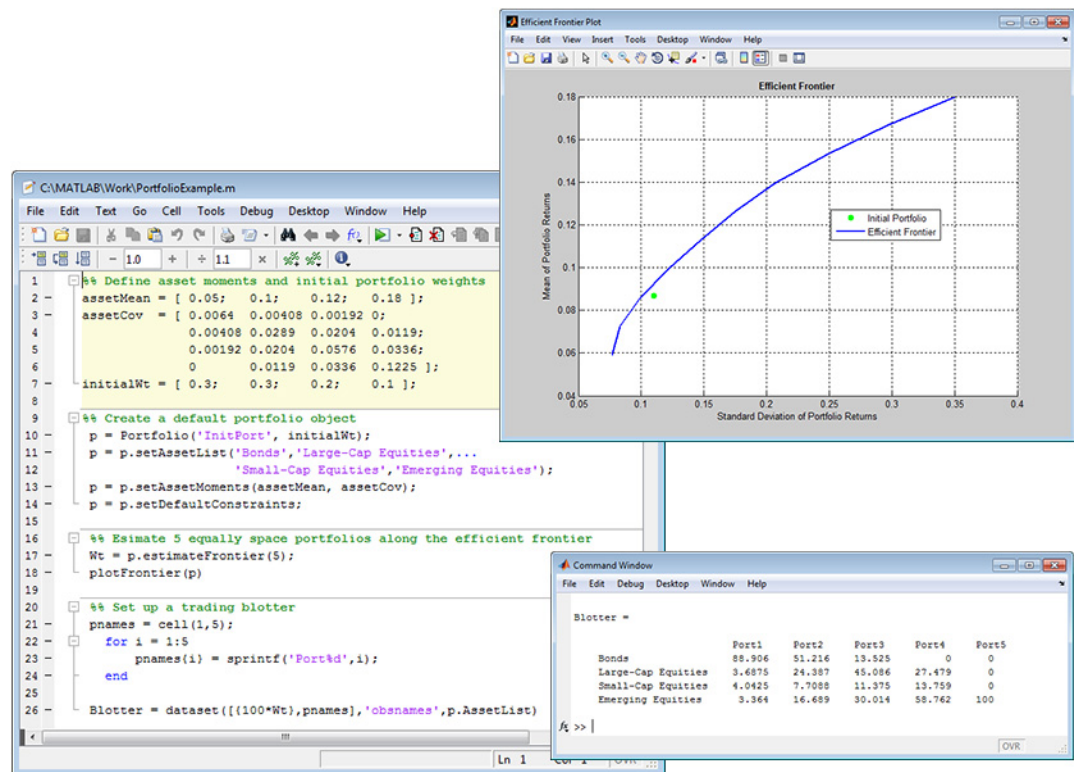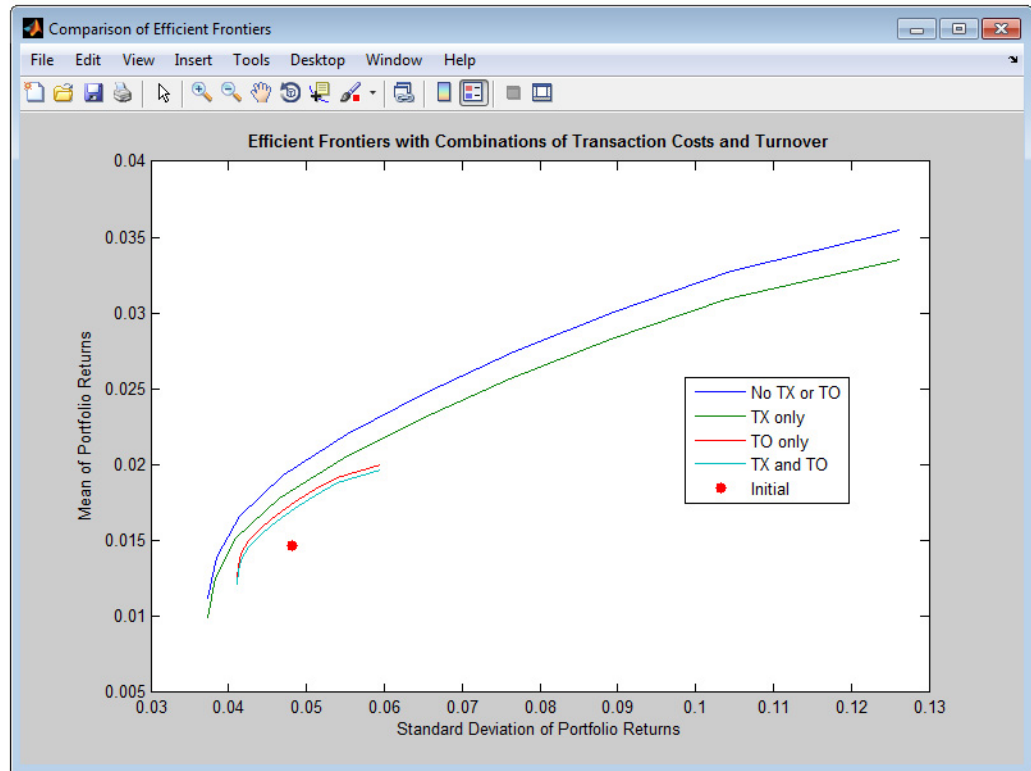
Solving an example portfolio optimization problem along the efficient frontier using the object-oriented portfolio optimization tools. The toolbox helps you construct and solve a portfolio optimization problem using the `Portfolio` *object (left), estimate the efficient frontier and the initial portfolio (top right), and create a blotter containing the asset weights for five equally spaced portfolios along the efficient frontier (bottom right).*

Defining the Portfolio Optimization Problem

The portfolio optimization object provides a simplified interface for setting up and solving portfolio optimization problems that include descriptive metadata. You can specify a portfolio name, the number of assets in an asset universe, and asset identifiers, and also define an initial portfolio allocation. For mean-variance optimization, you can define asset return moments either by defining them as arrays or by estimating them from the return time series in a matrix or financial time series objects. Supported constraints include:

- Linear inequality
- Linear equality
- Bound
- Budget
- Group
- Group ratio
- Turnover

You can also work with proportional transaction costs in the portfolio optimization problem definition, which enables both gross and net portfolio return optimization.

Plot of efficient frontiers for an example portfolio optimization problem with and without proportional transaction costs (TX) and turnover (TO) constraints.

Error Checking and Validating the Portfolio

The portfolio optimization object provides error checking during the portfolio construction phase. In some cases, you may want to validate your inputs to or outputs from the portfolio optimization to reduce the time-consuming error checking done prior to solving the optimization problem. Two methods are provided for estimating bounds and checking problem feasibility.

Efficient Portfolio and Efficient Frontiers

Depending on your goals, you can identify efficient portfolios or efficient frontiers. The portfolio optimization object provides methods for both. You can solve for efficient portfolios by providing one or more target risks or returns. You can also obtain optimal portfolios on the efficient frontier by specifying the number of portfolios to find, or solve for the optimal portfolios at the efficient frontier endpoints.

Postprocessing and Trade Reporting

Once you have identified a portfolio's risk and return, you can use the portfolio optimization object methods to troubleshoot results that seem questionable, adjust the problem definition to move toward an efficient portfolio, or set up an asset trading record. The portfolio object supports the generation of a trade record as a dataset array. You can use the dataset array to keep track of purchases and sales of assets and to capture trades to be executed.

Risk Analysis and Investment Performance

Financial Toolbox provides a comprehensive suite of analysis tools for analyzing and assessing risk and investment performance.

Performance metrics include:

- Sharpe ratio

- Information ratio

- Tracking error

- Risk-adjusted return

- Sample and expected lower partial moments

- Maximum and expected maximum drawdown
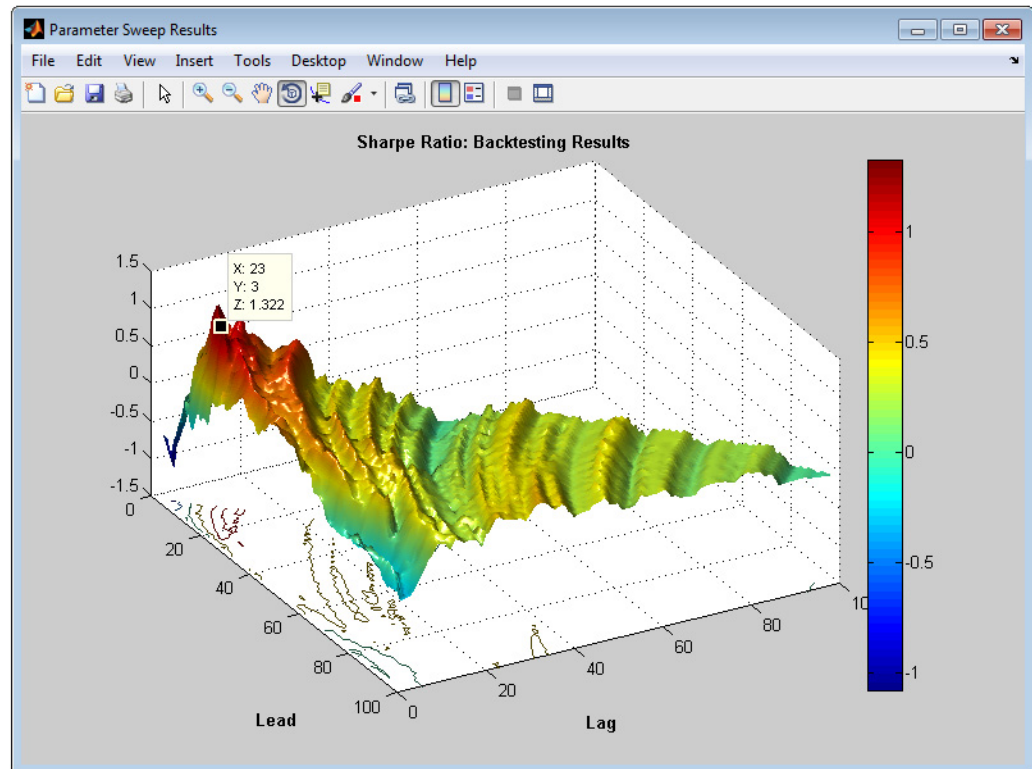
Surface plot showing Sharpe ratio results for backtesting of a leading-lagging, exponentially weighted, moving average trading strategy on daily returns data.

Fixed-Income Analysis and Option Pricing

Cash Flow Analysis

The toolbox offers time-value-of-money functionality that lets you:

- Calculate present and future values

- Determine nominal, effective, and modified internal rates of return

- Calculate amortization and depreciation

- Determine the periodic interest rate paid on a loan or annuity

Basic SIA-Compliant Fixed-Income Security Analysis

Securities Industry Association or SIA-compatible analytics are provided for pricing, yield, and sensitivity analysis for government, corporate, and municipal fixed-income securities. Specific analytics include:

- Complete cash flow date, cash flow amounts, and time-to-cash-flow mapping for a bond

- Price and yield maturity

- Duration and convexity

You can price stepped and zero coupon bonds with Fixed-Income Toolbox™.

Basic Black-Scholes, Black, and Binomial Option-Pricing

Financial Toolbox provides tools that let you:

- Use a standard market model of equity pricing with Black and Black-Scholes formulas

- Compute the sensitivities of option Greeks, such as lambda, theta, and delta

With Financial Derivatives Toolbox™, you can price equity and fixed-income derivatives using a range of models and methods, including Heath-Jarrow-Morton and Cox-Ross-Rubinstein models.
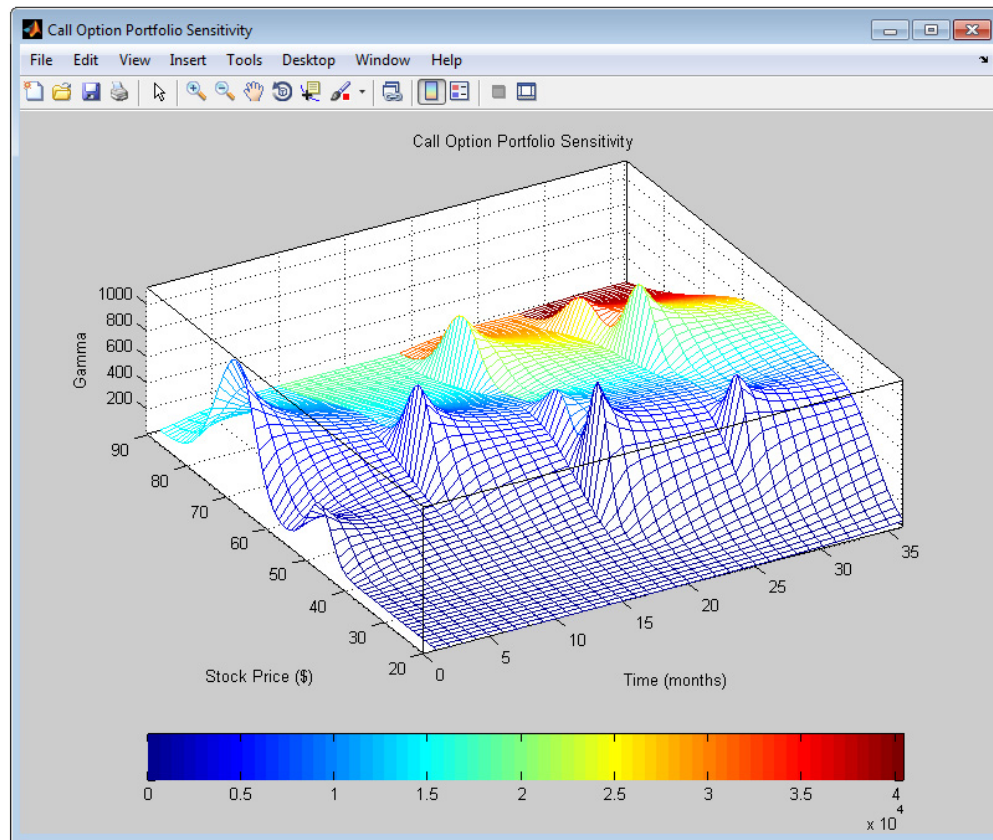
Plot showing the option Greeks gamma (z-axis height) and delta (color) for a portfolio of call options.

Financial Time Series Analysis

Financial Toolbox provides a collection of tools for the analysis of time series data in the financial markets. The toolbox includes a financial time series object that supports:

- Date math, including business days and holidays

- Data transformation and analysis

- Technical analysis

- Charting and graphics

The Financial Time Series tool provides a convenient interface for creating, managing, and manipulating financial time series objects including transforming to or from MATLAB® numeric arrays. You can also load data in the tool directly from a file, database (with Database Toolbox™), or financial datafeed provider (with Datafeed Toolbox™).
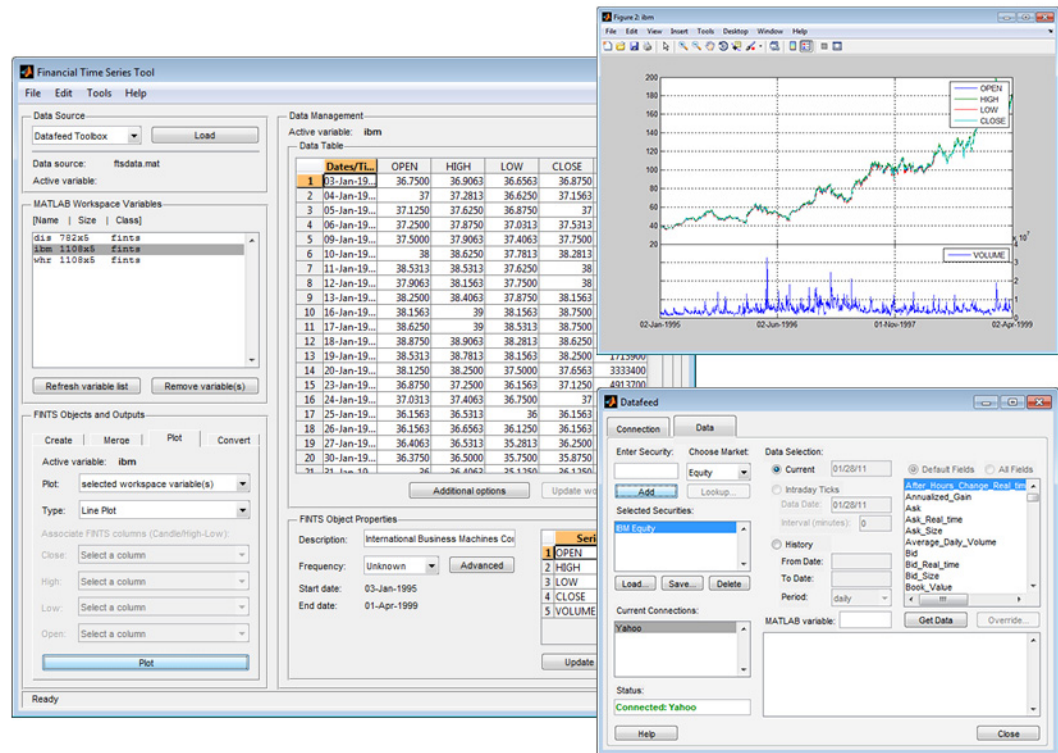
Importing and visualizing stock data using the Financial Time Series tool. You can import data, display selected time series objects (left), plot the selected times series object (top right), and access data from a datafeed provider (bottom right).

Basic GARCH Estimation, Simulation, and Forecasting

Financial Toolbox includes tools to work with univariate GARCH models. These tools let you:

- Estimate parameters of a univariate GARCH(p, q) model with Gaussian innovations

- Simulate univariate GARCH(p, q) processes

- Forecast conditional variances

Econometrics Toolbox™ lets you work with additional GARCH models.

Regression and Estimation with Missing Data

The toolbox provides tools for performing multivariate normal regression with or without missing data. These tools let you perform common regressions based on the underlying model, such as seemingly unrelated regression (SUR). You can estimate log-likelihood function and standard errors for hypothesis testing, and also perform complete calculations in the presence of missing data.

```
Command Window
File  Edit  Debug  Desktop  Window  Help
Separate regressions with daily total return data from 03-Jan-2000 to 07-Nov-2005 ...
        Alpha                  Beta                  Sigma
  ----  --------------------  --------------------  --------------------
  AAPL   0.0012 (  1.3882)    1.2294 ( 17.1839)    0.0322 (  0.0062)
  AMZN   0.0006 (  0.5326)    1.3661 ( 13.6579)    0.0449 (  0.0086)
  CSCO  -0.0002 (  0.2878)    1.5653 ( 23.6085)    0.0298 (  0.0057)
  DELL  -0.0000 (  0.0368)    1.2594 ( 22.2164)    0.0255 (  0.0049)
  EBAY   0.0014 (  1.4326)    1.3441 ( 16.0732)    0.0376 (  0.0072)
  GOOG   0.0046 (  3.2107)    0.3742 (  1.7328)    0.0252 (  0.0071)
   HPQ   0.0001 (  0.1747)
   IBM  -0.0000 (  0.0312)
  INTC   0.0001 (  0.1608)
  MSFT  -0.0002 (  0.4871)
  ORCL   0.0000 (  0.0389)
  YHOO   0.0001 (  0.1282)
fx >> |
```

```
Command Window
File  Edit  Debug  Desktop  Window  Help
Grouped regression with daily total return data from 03-Jan-2000 to 07-Nov-2005 ...
        Alpha                  Beta                  Sigma
  ----  --------------------  --------------------  --------------------
  AAPL   0.0012 (  1.3882)    1.2294 ( 17.1839)    0.0322 (  0.0062)
  AMZN   0.0007 (  0.6086)    1.3673 ( 13.6427)    0.0450 (  0.0086)
  CSCO  -0.0002 (  0.2878)    1.5653 ( 23.6085)    0.0298 (  0.0057)
  DELL  -0.0000 (  0.0368)    1.2594 ( 22.2164)    0.0255 (  0.0049)
  EBAY   0.0014 (  1.4326)    1.3441 ( 16.0732)    0.0376 (  0.0072)
  GOOG   0.0041 (  2.8907)    0.6173 (  3.1100)    0.0337 (  0.0065)
   HPQ   0.0001 (  0.1747)    1.3745 ( 24.2390)    0.0255 (  0.0049)
   IBM  -0.0000 (  0.0312)    1.0807 ( 28.7576)    0.0169 (  0.0032)
  INTC   0.0001 (  0.1608)    1.6002 ( 27.3684)    0.0263 (  0.0050)
  MSFT  -0.0002 (  0.4871)    1.1765 ( 27.4554)    0.0193 (  0.0037)
  ORCL   0.0000 (  0.0389)    1.5010 ( 21.1855)    0.0319 (  0.0061)
  YHOO   0.0001 (  0.1282)    1.6543 ( 19.3838)    0.0384 (  0.0074)
fx >> |
                                                                  OVR
```

Results of estimating CAPM model parameters with missing data. You can estimate with missing data (parenthetic values are the t-statistic) suggesting the GOOG Beta coefficient is not statistically different from zero (top left), and use seemingly unrelated regression to identify a statistically significant Beta coefficient for GOOG (bottom right).

The missing data estimation functionality enables you to determine the effect of data quality on your models and simulations. For example, you can account for the effects that missing data has on estimating coefficients of CAPM models or on calculating the efficient frontier of a portfolio of assets. Missing data effects can result in significantly different results.
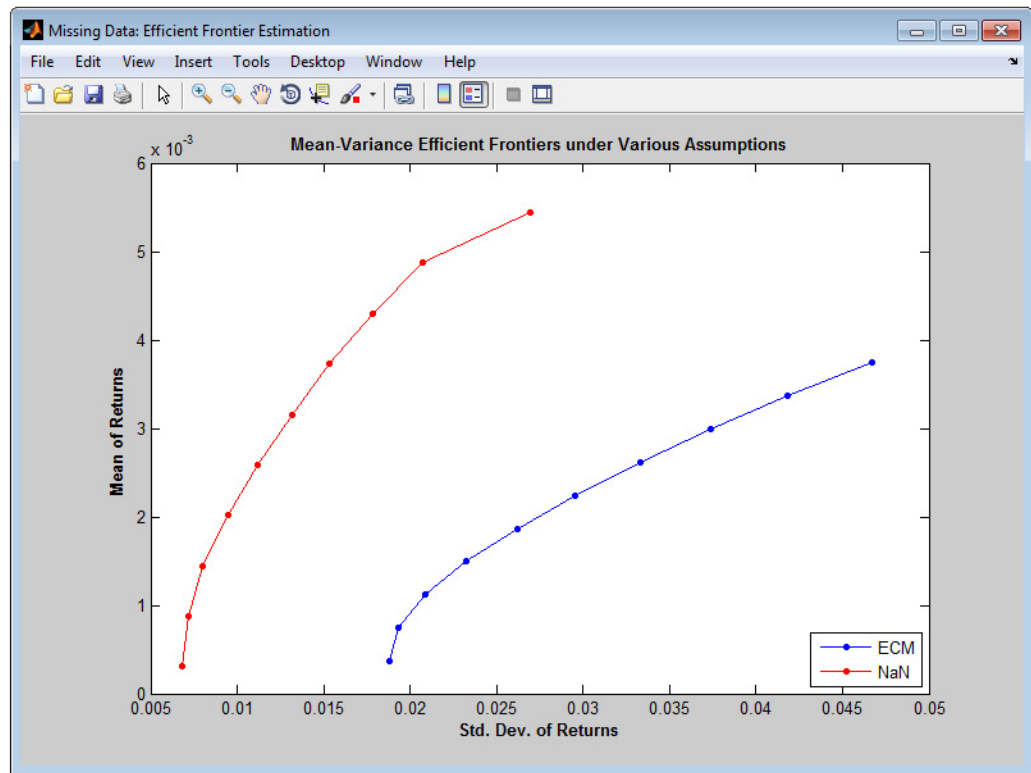
Plot showing the effect of missing data on the estimation of the mean-variance efficient frontier. The frontier in red was calculated by removing all time periods containing missing data in the sample data, and the frontier in blue was calculated using `ecmnmle` to estimate values for the missing data.

Technical Indicators and Financial Charts

The toolbox provides numerous well-known technical indicators and specialized plots, including:

- Moving averages

- Oscillators, stochastics, indexes, and indicators

- Tools for computing maximum drawdown and expected maximum drawdown

- Charting tools, including Bollinger bands, candlestick plots, and moving averages
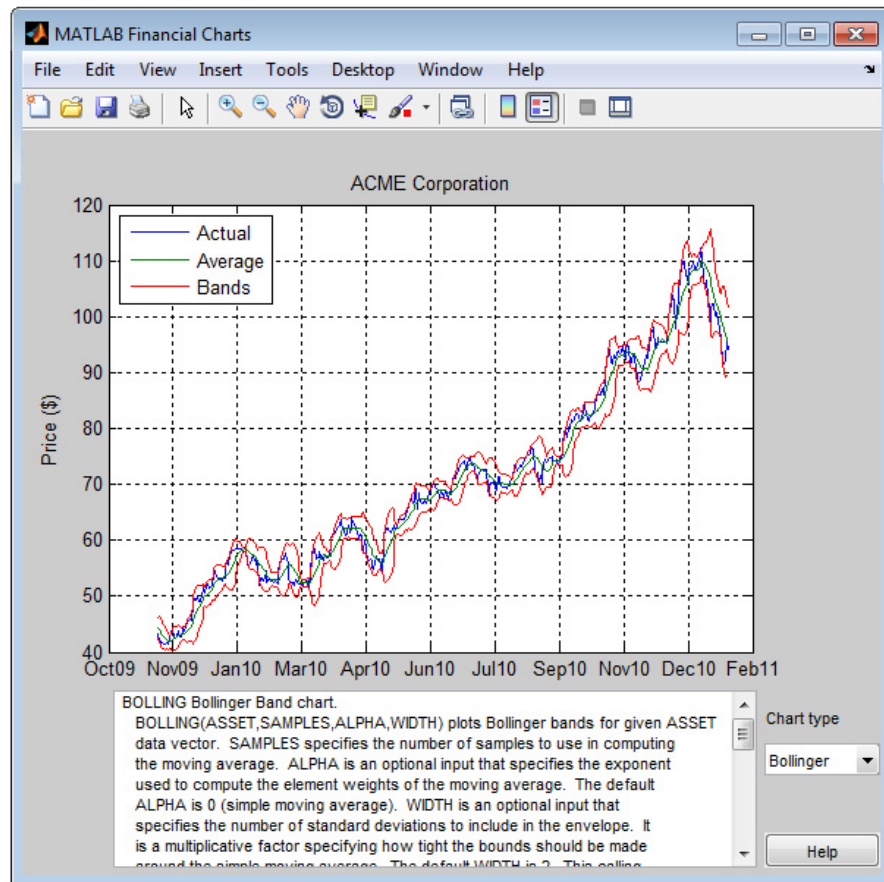
Graphical tool in Financial Toolbox for exploring different types of financial charts and technical indicators.

Resources

Product Details, Demos, and System Requirements
www.mathworks.com/products/finance

Trial Software
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