

FTS Real Time Client: Black-Litterman Model

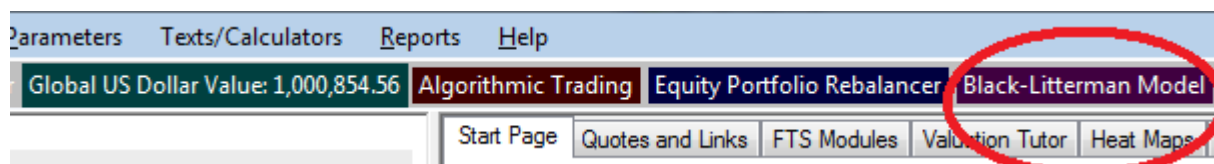
The Black-Litterman (BL) model allows you to incorporate your own views on stock performance and construct optimal portfolios. You can find lots of information about the model and its implementations at <http://www.blacklitterman.org>. The original Black-Litterman paper was published in the Financial Analysts Journal in 1992. The intuition behind the model is described in a paper by [He and Litterman](#).

The FTS implementation is fairly easy, and works as follows:

- You specify the stocks/ETF's you want to work with and data about these stocks.
- The FTS Real Time Client's "**Black-Litterman Model**" (BLM) calculator then constructs the optimal portfolio for you, and also allows you to automatically execute the trades required to rebalance your portfolio.
- It also shows you the cost of trading and the cash required to implement the trades, similar to the [Equity Portfolio Rebalancer](#).

We will explain the requirements for the Black-Litterman model in this note. The explanation of the costs of trading and so on is given in the documentation for the [Equity Portfolio Rebalancer](#).

- The calculator is currently only implemented in the Windows version.
- You can use it with any of the equity cases, including stocks and ETF's.
- You access it from the top of the FTS Real Time Client after you log in:



Background

We describe the model very briefly, and then discuss what is needed for the implementation. If you are interested in learning more about the model, you can consult the resources at <http://blacklitterman.org>, specially the paper "[The Black-Litterman Model in Detail](#)" by Jay Walters, and the [paper by Meucci](#) for technical derivations.

The Views

Suppose there are N stocks under consideration. You can have "views" about the absolute or relative performance of these stocks.

You can form views in many ways, including:

- A forecasting or regression model, where you relate the return on a market or of stocks on other variables. The other variables could be macroeconomic variables like economic growth rates, company variables like earnings, past returns, and so on.
- A model like the CAPM can be used to convert forecasts about a market to forecasts about individual stocks.
- Discounted cash flow, or intrinsic value, models also produce expected return forecasts.
- You could have an opinion that translates into a view. For example, the opinion is that “stocks in country A will outperform stocks in country B.” You then formalize that view by specifying by how much you expect country A to outperform, e.g. 1% or 2%.

Expressing your views

The views are expressed using a matrix called P and a vector called Q. If there only one view, P is a vector and Q is a number.

Example 1: There are 3 stocks. There is 1 view

- Stock 1 will have a return of 10%.
- $P = (1 \ 0 \ 0) \ Q = (.01)$

Example 2: There are 3 stocks. There are 2 views:

- View 1: Stock 1 will have a return of 10%.
- View 2: Stock 2 will outperform Stock 3 by 5%.
- $P = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & -1 \end{pmatrix} \ Q = \begin{pmatrix} 0.1 \\ 0.05 \end{pmatrix}$

Example 3: There are 3 stocks. The market cap of the stocks is \$5.2b, \$5.5b, and \$12.4b respectively.

There is one view:

- Stock 2 will outperform Stocks 1 and 3 by 5%.
- $P = (-.295 \ 1 \ .705) \ Q = (.05)$
- This view (based on an example in the He-Litterman paper) uses market caps: Stock 1 and Stock 3 have a total market cap of \$17.6b. Of this, Stock 1’s share is 29.5% and Stock 2’s share is 70.5%. So the view says that Stock 2 will outperform the total of the other stocks by 5%.

Uncertainty of the Views

You also have to specify a diagonal matrix, Ω expressing the uncertainty of your views. In Example 2, Ω is a 2x2 matrix, while in Example 3, it is a 1x1 matrix.

Formalization

Let μ denote the expected return of the stocks, and let Σ be the covariance matrix of the returns.

In the BL model, μ is also uncertain.

- It has an expected value π which is the “equilibrium” expected return on these stocks (i.e. the return implied by the covariance matrix, the prices of the stocks, and a risk aversion parameter called δ).
- It has a covariance equal to $\tau\Sigma$ where τ is a scalar.

Your views on the stock returns are expressed by a matrix P , a vector Q , and a matrix Ω expressing the uncertainty of your views. You do not have to have a view on every stock. Suppose you have a view on k stocks, with $k \leq N$.

- In the FTS implementation, we assume that Ω is diagonal. This means that the views are independent of each other. It reduces the amount of information you have to provide.

Given all this information, the Black-Litterman model calculates: the “equilibrium” expected returns, π , the expected returns based on your views, the covariance matrix of these expected returns, and the optimal portfolio weights, which we call the BL Weights. We show you the interface below, after showing you how to specify the inputs.

Specifying the Inputs to BLM

You need to provide, in an Excel worksheet, the following information

- The tickers of the stocks you are interested in
- The P matrix of views
- The Q vector that pertains to the views
- The diagonal elements of the Ω matrix
- The covariance matrix Σ
- The parameters τ and δ
- The number of shares outstanding for each stock

The information must be specified in a **specific format** in the worksheet. Here is an example (and you can download this workbook if you want from within the **BLM**):

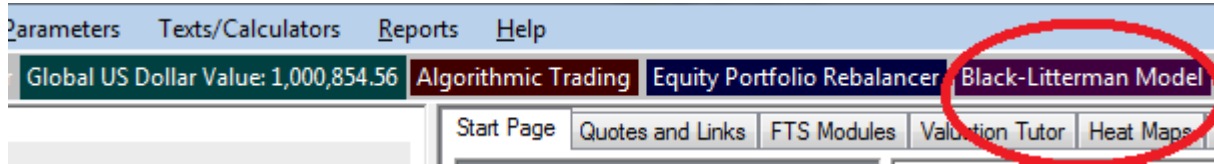
	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Tickers	BL Weights (written out)	View Col 1	View Col 2	View Col 3	View Col 4	View Col 5	View Col 6	View Col 7	Q	Omega (diagonal)	Delta	Tau
2	T		0	0	-0.295	1	0	-0.705	0	0.05	0.001065383	2.5	0.05
3	INTC		0	1	0	0	0	0	-1	0.03	0.000851738		
4	CSCO												
5	MSFT												
6	IBM												
7	WMT												
8	GE												
9			Covariance	Covariance	Covariance	Covariance	Covariance	Covariance	Covariance	Shares			
										Outstanding			
10			0.025600	0.015850	0.018967	0.022330	0.014750	0.016384	0.014691	5268000000			
11			0.015850	0.041209	0.033428	0.036034	0.013215	0.024685	0.029572	4971000000			
12			0.018967	0.033428	0.061504	0.057866	0.018488	0.038837	0.030979	5346617505			
13			0.022330	0.036034	0.057866	0.073441	0.020146	0.042113	0.033092	8347968348			
14			0.014750	0.013215	0.018488	0.020146	0.044100	0.017010	0.012017	1085854383			
15			0.016384	0.024685	0.038837	0.042113	0.017010	0.040000	0.024385	3235772430			
16			0.014691	0.029572	0.030979	0.033092	0.012017	0.024385	0.034969	10117369000			

- Row 1: headers
- Column A: the tickers, starting in row 2
 - A blank cell in this column tells **BLM** how many tickers there are
- Column B: leave it blank. After you calculate the weights based on your views, you can write out the weights into this column.
 - **Tip:** this lets you easily use the **Equity Portfolio Rebalancing** feature to easily rebalance your portfolio to these weights.
- The views (P matrix) are in the next N columns where N is the number of tickers.
 - The number of views is the number of rows. In our example, there are 2 views.
 - We will explain below how the views are expressed.
- The Q vector (see below) is in the next column
- This followed by the diagonal elements of the Ω matrix
- And the last two columns have the parameters needed by the model.
- The **Covariance matrix** is under the views, with one row used for the header, as shown.

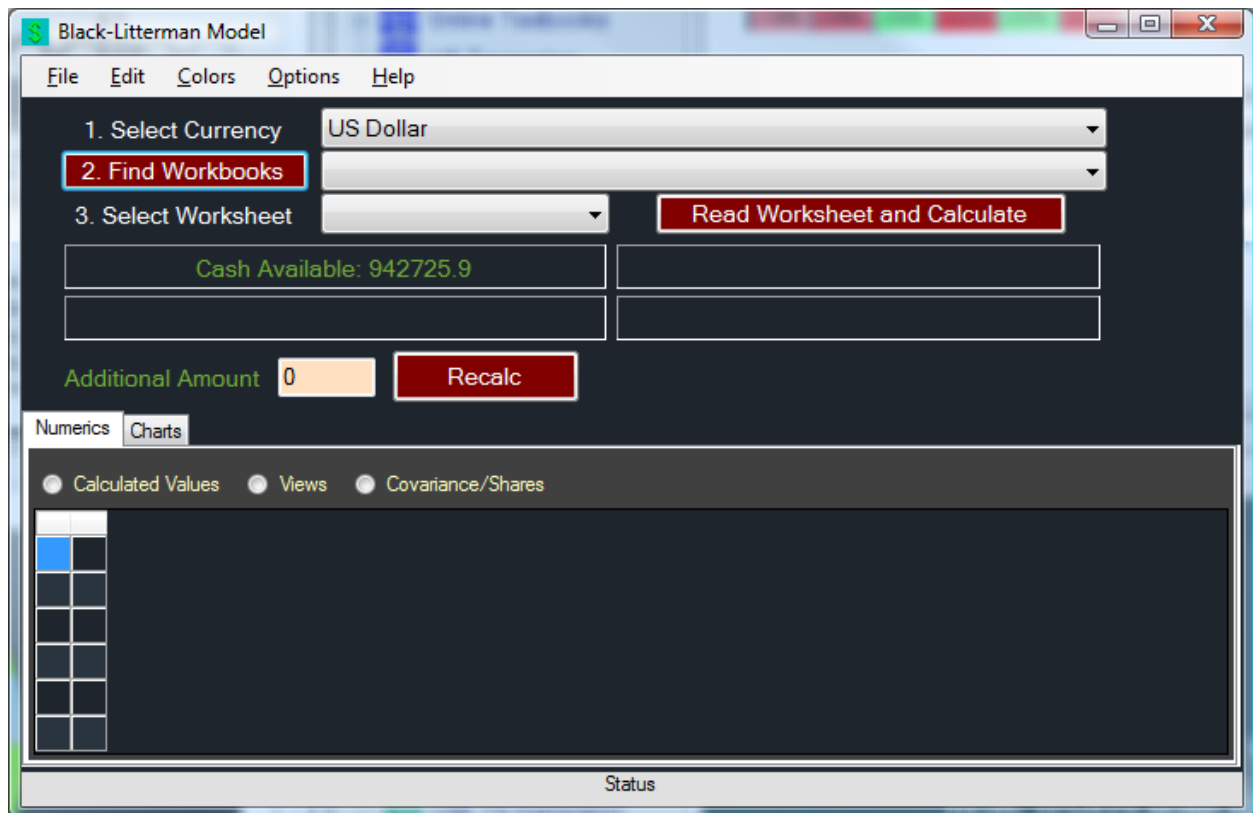
- The **Shares Outstanding** are in the column immediately afterwards.

Accessing the BLM Implementation

You access **BLM** it from the top of the FTS Real Time Client after you log in:



Click the button to get:



Now it is simple. First select the currency. You can then have views on any of the stocks and ETF's in that currency. Then, locate the Excel workbook with your inputs and select the worksheet. Then click the "Read Worksheet and Calculate" button. For our

For the inputs in our spreadsheet, you will see:

Include	Ticker/Name	Market Weight	Eq. Exp. Return	Position	Last Value	Raw Weight	BL Weight	New Position	New Value	New Weight
<input checked="" type="checkbox"/>	T	0.124543	0.01847	217	7,252.14	0.311289	0.047445	33	1,102.86	0.0473
<input checked="" type="checkbox"/>	INTC	0.087244	0.02752	71	1,761.51	0.075611	0.342783	322	7,988.82	0.3429
<input checked="" type="checkbox"/>	CSCO	0.083965	0.03772	0	0.00	0.000000	-0.072531	-76	-1,687.20	-0.0724
<input checked="" type="checkbox"/>	MSFT	0.217347	0.04261	-100	-3,680.50	-0.157981	0.437096	277	10,194.99	0.4376
<input checked="" type="checkbox"/>	IBM	0.137988	0.02005	100	17,964.00	0.771082	0.052567	7	1,257.48	0.0539
<input checked="" type="checkbox"/>	WMT	0.170346	0.03012	0	0.00	0.000000	-0.184885	-58	-4,316.36	-0.1852
<input checked="" type="checkbox"/>	GE	0.178568	0.02626	0	0.00	0.000000	-0.241522	-226	-5,638.70	-0.2420

The output is self-evident. We first calculate the market weights of the stocks, followed by the “equilibrium” expected return. Your current position is shown as is the current portfolio “raw” weight. Next to it is the BL weight.

- You can **verify** that the inputs were read in correctly by checking “Views” or “Covariances/Shares.” If not, you may have selected the wrong worksheet or net set it up correctly.
- **Since prices change in real time**, we “freeze” the calculation at a point in time. This allows you to actually do the calculations and implement the trades. You can recalculate everything by clicking the “**Recalc**” button at any time and execute the trades using the **Trade** button.
 - Even then, you will typically not be able to get exactly to your target weights because you can only buy or sell an integer number of shares. Please read the [Equity Portfolio Rebalancer](#) for details for this and the remaining columns.
 - You can check and uncheck the stocks to be traded. For example, if your current position is within a few shares of the new position, it may not be worth incurring the costs of trading that stock.
- When you **first implement** a portfolio, you must specify the “Additional Amount” to invest, which is the dollar-amount you want to invest in the stocks.
- Subsequently, you can adjust the **total amount** you invest in the stocks. The total amount invested used in the calculation of the number of shares is the current invested value and plus any additional amount. This total amount must be positive.
- You can **write out the weights** into your spreadsheet. This is important for several reasons.

- Since prices change, the BL weights change. So your calculation cannot be reproduced at a later time.
- Since prices change, your portfolio weights will change. You can use the Equity Portfolio Rebalancer to re-adjust your weights to the BL weights you previously calculated.
- If your views change, you should copy all the information into a new worksheet and use that in **BLM**; then you can compare how the weights changed with your views.