



## FTS Exchange Traded Fund Project: International Diversification

Note: this project requires use of Excel's Solver

**Question:** Can you outperform the S&P by investing in global exchange traded funds?

Many academic studies have documented a “home bias” in investing, which means that people are over-invested in their home country and under-invested internationally. Other studies document the benefits of diversifying your portfolio to include international assets. An overview is contained in most investment textbooks, for example the chapter on “International Diversification” in the text by Bodie, Kane, and Marcus. In this project, you will construct portfolios of exchange traded funds (ETFs) to understand the benefits of such diversification.

An international ETF, for example the MSCI Switzerland Index Fund (which trades under the ticker EWL) is a portfolio of Swiss stocks constructed to mimic (or “track”) a Swiss index (in this case the MSCI Switzerland Index). The ETF is traded in US Dollars, and embodies multiple sources of risk:

- Market risk in Switzerland, which reflect the ups and downs of the Swiss equity market
- Exchange rate risk (which arises if the US Dollar appreciates or depreciates against the Swiss franc)
- Basis risk, which measures the ability of the ETF to track its index
- Liquidity risk, which reflects changes in the demand for the ETF itself by investors. For example, if everyone wants to buy this ETF, its price can be greater than the value of the stocks it holds; in that case, it trades at a “premium.” If its price is lower, it is said to trade at a discount.

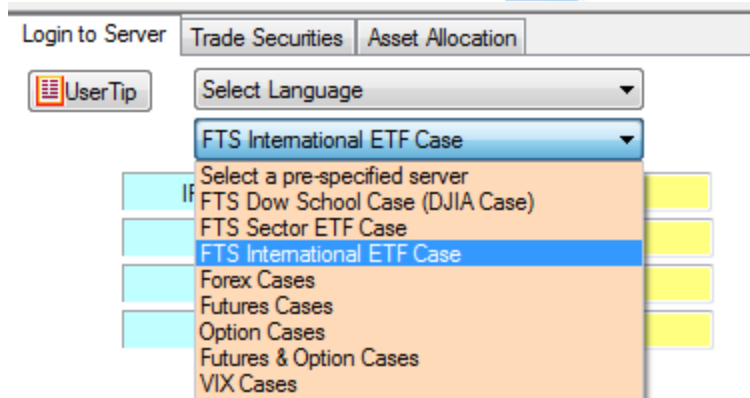
A big advantage of an ETF such as this is that it allows US investors to have easy access to the Swiss market without having to buy Swiss stocks. Since it is traded in US Dollars, you don't have to worry about managing a multi-currency portfolio (though the exchange rate risk remains).

There are close to 1000 ETF's that trade; these include ETF's that track stock indexes, the EWL, as well as sectors (e.g. portfolios of international bonds, international sector ETF's, bonds within a country, sectors within a country, etc.), and you can find a lists of them at many web sites, e.g. [www.ishares.com](http://www.ishares.com).

### Objective

The project objective is quite simple: see if you can achieve a higher return and a lower variance than the S&P500 over the time period of the project. The target is to beat the S&P 500 by 6% annually, which is 0.5% a month. So if you are running the project for 1 month, you must beat it by .5%, if over 2 months, then by 1%, and so on.

You will have to construct a portfolio that is designed to achieve this goal, implement it, track the results, and adjust your portfolio (“rebalance it”) over time. At the end, your report will compare the risk and return of your portfolio compared to the S&P500. You can trade 49 ETF's available to you in the FTS International ETF Case (listed in the appendix). From the FTS Real Time Client, select this case:



Enter your trading name and password (assigned by your instructor) and login. When you start, you have \$1m in cash, and you have to invest this in the ETF's.

Modern portfolio theory provides a technique for both measuring risk and return and determining the best way to diversify. In this project, you will use Excel's Solver to create an "optimal" diversified portfolio. The details of modern portfolio theory are described in most investments textbooks, and will not be given here; instead, we will focus on the implementation, though we will need the following terminology.

### Background

Let  $w_i$  denote the proportion of your money invested in ETF  $i$ . So if your total investment is \$1m, you hold 1000 shares of ETF  $i$ , and the price of ETF  $i$  is 25, then  $w_i = 0.025$ , i.e. you have invested 2.5% of your money in ETF  $i$ .  $w_i$  is also called a *portfolio weight*. Since there is a direct relationship between the number of shares and the weight, once you have determined the weight, you can easily calculate the number of shares you must hold (given the price and the total investment).

Let  $E(r_i)$  denote the expected return from ETF  $i$ . This is usually measured annually, so  $E(r_i)=10\%$  means you expect the ETF to return 10% over the year. There are many ways to estimate the expected return; default values are provided by the FTS Real Time Client, though you can override them via the "Parameters" menu item. Given the portfolio weights, the expected return of the portfolio is:

$$ER(w) = \sum_i w_i E(r_i)$$

Finally, we need to describe risk. Modern portfolio theory uses the variance of returns as a measure of risk (or equivalently, the standard deviation, which is also referred to as volatility). To calculate the risk of a portfolio, you also need the covariances between ETF returns. In notation, let  $\sigma_{ij}$  denote the covariance between the returns of ETFs  $i$  and  $j$ , so  $\sigma_{ii}$  is the variance of the return of ETF  $i$ . Then, given the portfolio weights, the variance of the portfolio return is:

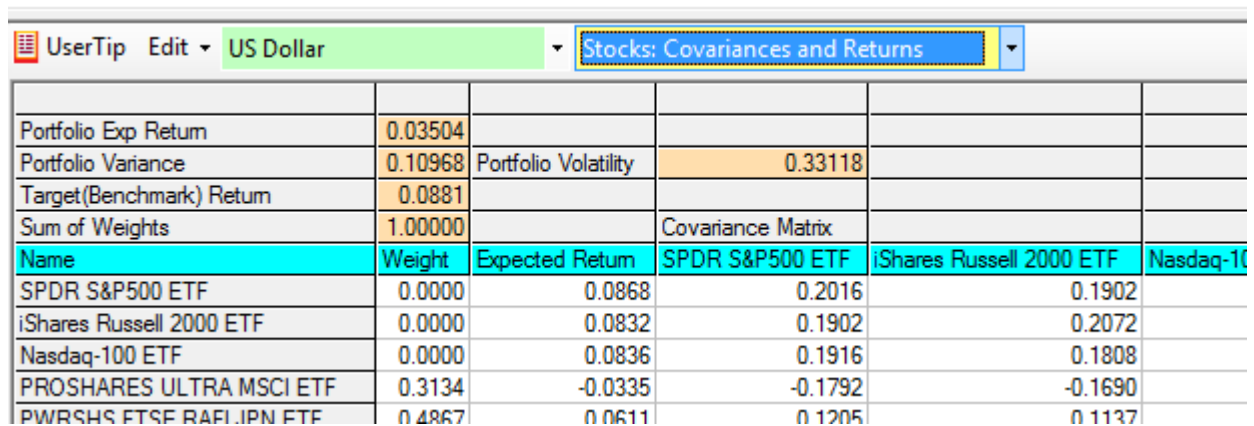
$$\sigma^2(w) = \sum_i \sum_j w_i w_j \sigma_{ij}$$

The FTS Real Time Client calculates all the covariances for you. The portfolio selection problem is to find weights that minimize the variance subject to some constraints. The first is that the sum of the weights equals 1; this simply means that you invest all the money you have allocated to ETF.s The second is that the expected return from the portfolio equals your target return. Beyond that, you can impose more conditions. For example, you may restrict short selling, either completely, which says  $w_i \geq 0$ . Or you may require that you will not invest more some amount in any one ETF; this says  $w_i \leq 0.1$ . Common constraints for this case would be that you do not invest more than 10% in any one ETF, and if there is no short selling, that you invest at least 1% in every ETF.

## Project

The objective of this project is to learn to apply modern portfolio theory by constructing portfolios, implementing the recommended portfolio, and tracking its performance over time. This is done by completing the following steps, and includes learning how to use Solver to calculate the portfolio weights.

1. From the RT Client, select “Covariances and Returns” in the Analytics area (at the bottom right):

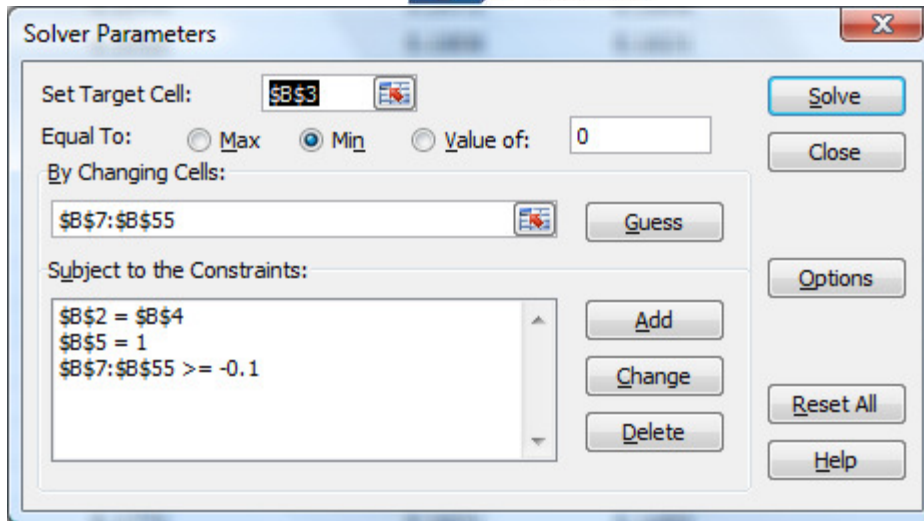


UserTip Edit		US Dollar		Stocks: Covariances and Returns		
Portfolio Exp Return	0.03504					
Portfolio Variance	0.10968	Portfolio Volatility	0.33118			
Target(Benchmark) Return	0.0881					
Sum of Weights	1.00000			Covariance Matrix		
Name	Weight	Expected Return	SPDR S&P500 ETF	iShares Russell 2000 ETF	Nasdaq-100 ETF	
SPDR S&P500 ETF	0.0000	0.0868	0.2016	0.1902	0.1808	
iShares Russell 2000 ETF	0.0000	0.0832	0.1902	0.2072	0.1808	
Nasdaq-100 ETF	0.0000	0.0836	0.1916	0.1808	0.1808	
PROSHARES ULTRA MSCI ETF	0.3134	-0.0335	-0.1792	-0.1690	-0.1690	
PWRSHS FTSE RAFI IPN ETF	0.4867	0.0611	0.1205	0.1137	0.1137	

you will see your portfolio weights and the expected returns and covariances of all the ETFs. In the Edit menu of the Analytics area, select “Export to Excel.” This will transfer the data into an Excel spreadsheet:

UserTip		Edit	US Dollar	Stocks: Covariances and Returns
Portfolio Exp		04		
Portfolio Vari		68	Portfolio Volatility	0.33118
Target(Benc		31		
Sum of Weig		00		Covariance Matrix
Name	Weight	Expected Return	SPDR S&P500 ETF	iShares Russell 20
SPDR S&P500 ETF	0.0000	0.0868	0.2016	
iShares Russell 2000 ETF	0.0000	0.0832	0.1902	

- In the spreadsheet, enter target expected return; the S&P500 expected return is automatically entered for you, so you simply have to enter the ½% per month (depending on your horizon) to that number.
- Choose what constraints you want to impose. You may want to consult your investments text (e.g. the chapter on Optimal Risk Portfolios in the text by Bodie, Kane, and Marcus) for suggestions.
- In your spreadsheet, implement the formulas for calculating the portfolio's expected return and variance (the values from the RT Client are entered, but you will have to replace these with formula s). You may want to use the SUMPRODUCT function in Excel as well as its matrix multiplication function MMULT. For example, for this case, the weights will be exported to cells B7:B55 and the expected returns in C7:C55. The covariance matrix is in the range D7:AZ55. So in cell B2, you should enter the formula **=SUMPRODUCT(B7:B55,C7:C55)**. In cell B3, you should enter **=SUMPRODUCT(B7:B55,MMULT(D7:AZ55,B7:B55))** to obtain the portfolio variance as a function of the weights. Now, as the weights change, both the expected return and the portfolio variance will be recomputed. Without this step of changing formulas, Solver will not be able to calculate the optimal portfolio weights.
- Add the formula for the sum of the weights in cell B5. In this example, you would enter **=SUM(B7:B55)**
- Run Solver, define the objective (which is to minimize the variance) and the constraints (the two basic constraints plus additional constraints you chose), and calculate the portfolio weights. Note that if your constraints are unreasonable, there may not be a solution. Sometimes, without additional constraints, there may not be a solution. To start with, you may want to restrict short selling to be no more than 10% of the total value, i.e.  $w_i \geq -0.1$  for all  $i$ . For this problem, the Solver dialog box for the ETF's looks like:



You should start with these constraints, and then experiment with others. This step requires some amount of experimentation. If you don't impose a constraint like the third one (a lower bound on the weights), Solver may not be able to find a solution.

7. Implement your trading strategy using the Real Time FTS Client. This means that you have to take the weights and using current prices, calculate the number of shares of each ETF to buy (or sell).
8. Wait a week. At that point, your actual portfolio weights will have changed because ETF prices will have changed. You now have to decide whether you want to "rebalance" your position. This means buying or selling to get back to the weights you had originally calculated. Or you may want to repeat steps 1-6 again since some of the return and covariance estimates may have changed. Note that the decision to rebalance is not that simple, since buying and selling ETFs will incur a transaction cost; so if your weights are not too far from where they should be, you may want to wait to rebalance. You can use the Portfolio Tracking function of the RT Client (described in the Appendix) to see how your position compares to your target weights.
9. After a few weeks, answer the following questions: What was the risk and return of your portfolio over the time horizon? Did it conform to what was expected? Did you have to rebalance frequently? You should calculate the realized return, the volatility of your returns, and the Sharpe ratio for your portfolio, and compare these to the S&P 500. The Reports menu allows you to do this quite easily. For example, it automatically calculates the performance of your portfolio compared to the benchmark:

Trading History

User Tip Edit Options Refresh History

Select Report Performance Report **Generate Report**  
Export Table to Excel

Last retrieved at: 1/14/2009 11:43:39 AM

Table

	Portfolio	Benchmark
Average Return	0.00001	-0.00694
Volatility	0.00000	0.01107
Alpha	0.00694	
Tracking Error	0.01107	
Sharpe Ratio	0.74599	-0.62708
Daily VaR (%)	0.00000	0.01827

And daily market values and returns:

Trading History

User Tip Edit Options Refresh History

Select Report End of Day Market Values **Generate Report**  
Export Table to Excel

Last retrieved at: 1/14/2009 11:43:39 AM

Table Graph

Date	Value	Return	Benchmark	Benchmark Return	Alpha
1/11/2009	1000000		890.35		
1/12/2009	1,000,010.00	0.00001	870.26	-0.02256	0.02257
1/13/2009	1,000,019.00	0.00001	871.79	0.00176	-0.00175
1/14/2009	1,000,029.00	0.00001	871.79	0.00000	0.00001

## Appendix 1: Using the “Portfolio Tracking” Capability

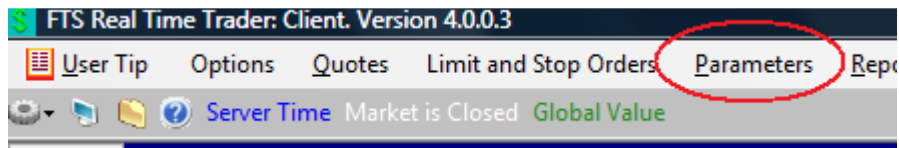
In the FTS Real Time Client, you can specify target weights (e.g. the result of the Solver calculation above) in the “Parameters” menu. In the stock analytics, you can then select “portfolio tracking” and the system will show you the difference between your weights and the target weights and the implied trade.

**Example:** Suppose you want your weights to be 25% in PROSHARES ULTRA MSCI ETF, 10% in PWRSHS FTSE RAFI JPN ETF, 5% in ISHARES JAPAN INDEX FUND, 30% in NETS TRUST TOPIX INX FD, and 30% in SPDR RUSS/NOM PRIME JPN.

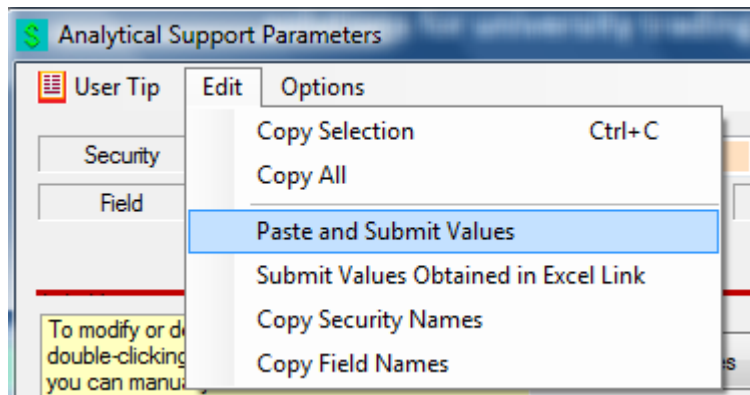
In a spreadsheet, create the following and **copy it**:

PROSHARES ULTRA MSCI ETF	TargetWeight	.25
PWRSHS FTSE RAFI JPN ETF	TargetWeight	.1
ISHARES JAPAN INDEX FUND	TargetWeight	.05
NETS TRUST TOPIX INX FD	TargetWeight	.3
SPDR RUSS/NOM PRIME JPN	TargetWeight	.3

Select the “Parameters” menu:



In the window that appears, select the Edit menu and then “Paste and Submit Values”



Then, check the box to use these in your analytical support. You will see:

To modify or delete a value, select a row by double-clicking, it. If the table is not up to date, you can manually retrieve the values ---->

Retrieve Values      Last retrieved at: 1/14/2009 10:37:04 AM

Delete Existing Value    Modify Existing Value    Cancel Selection    Delete All

Use these values in my analytical support

Trader	RealName	Date	Time	Security	Field	Value
ss1gintef	ss1gINTETF	1/14/2009	10:37:01 AM	PROSHARES ULTRA MSCI ETF	TargetWeight	0.25
ss1gintef	ss1gINTETF	1/14/2009	10:37:01 AM	PWRSHS FTSE RAFI JPN ETF	TargetWeight	0.1
ss1gintef	ss1gINTETF	1/14/2009	10:37:01 AM	ISHARES JAPAN INDEX FUND	TargetWeight	0.05
ss1gintef	ss1gINTETF	1/14/2009	10:37:01 AM	NETS TRUST TOPIX INX FD	TargetWeight	0.3
ss1gintef	ss1gINTETF	1/14/2009	10:37:01 AM	SPDR RUSS/NOM PRIME JPN	TargetWeight	0.3

Next, go to the analytical support area, at the bottom right, and select Portfolio Tracking:

UserTip Edit ▾ US Dollar ▾ Stocks: Portfolio Tracking ▾

		Value	Beta	Volatility	Exp Return	Sharpe	Treynor	Jensen	M2
Actual Position		1,311.58	0.1839	0.3312	0.0350	0.0958	0.1725	0.0473	0.0
Target Position			0.2235	0.2688	0.0376	0.1276	0.1534	0.0532	0.0
Name	Position	Last	Beta	Volatility	Exp Return	Actual Weight	Target Weight	Implied Trade	
SPDR S&P500 ETF	0	83.86	0.9796	0.4142	0.0868	0.00000	0.00000	0.0000	
iShares Russell 2000 ETF	0	45.31	0.9241	0.4552	0.0832	0.00000	0.00000	0.0000	
Nasdaq-100 ETF	0	28.64	0.9310	0.4000	0.0836	0.00000	0.00000	0.0000	
PROSHARES ULTRA MSCI ETF	5	82.22	-0.8703	0.8411	-0.0335	0.31344	0.25000	-1.0120	
PWRSHS FTSE RAFI JPN ETF	20	31.92	0.5855	0.5255	0.0611	0.48674	0.10000	-15.8910	
ISHARES JAPAN INDEX FUND	0	8.62	0.8637	0.4447	0.0792	0.00000	0.05000	7.6078	
NETS TRUST TOPIX INX FD	0	19.00	0.4085	0.5261	0.0496	0.00000	0.30000	20.7092	
SPDR RUSS/NOM PRIME JPN	0	33.81	0.7226	0.3865	0.0701	0.00000	0.30000	11.6363	
ISHARES S&P TOPIX150 ETF	7	37.44	0.8590	0.4047	0.0789	0.19982	0.00000	-7.0000	
NETS TR HS CHINAET INF	0	12.20	0.6741	0.5985	0.0669	0.00000	0.00000	0.0000	
ISHARES SWITZRLND INDEX	0	16.60	0.8809	0.3808	0.0803	0.00000	0.00000	0.0000	
ISHARES MSCI MALAYSIAETF	0	7.15	0.6978	0.3737	0.0684	0.00000	0.00000	0.0000	

This shows you your actual weights versus the target weights, and the performance measures for each. It also shows you the implied trades to re-balance your actual weights to the target weights.

## Appendix 2: The ETF's

ETF	Ticker
SPDR S&P500 ETF	SPY
iShares Russell 2000 ETF	IWM
Nasdaq-100 ETF	QQQQ
PROSHARES ULTRA MSCI ETF	EWV
PWRSHS FTSE RAFI JPN ETF	PJO
ISHARES JAPAN INDEX FUND	EWJ
NETS TRUST TOPIX INX FD	TYI
SPDR RUSS/NOM PRIME JPN	JPP
ISHARES S&P TOPIX150 ETF	ITF
NETS TR HS CHINAET INF	SNO
ISHARES SWITZRLND INDEX	EWL
ISHARES MSCI MALAYSIAETF	EWM
ISHARES MSCI S AFR ETF	EZA
ISHARES FTSE/XINHUA 25	FXI
SPDR S&P CHINA ETF	GXC
NETS TRUST HANG SNG INFD	HKG
ISHARES SPAIN INDEX FUND	EWP
NETS S&P/ASX 200 FD ETF	AUS
NETS TRUST S&P/MIB ETF	ITL
ISHARES HONG KONG INDEX	EWH
ISHARES FRANCE INDEX FD	EWQ
NETS DAX INDEX FUND ETF	DAX
ISHARES MEXICO INDEX FD	EWW
ISHARES MSCI CHLFD ETF	ECH
POWERSHARES ETF GLDN DRA	PGJ
NETS TRUST CA40 INDEX FD	FRC
ISHARES GERMANY INDEX	EWG
ISHARES SINGAPORE INDEX	EWS
NETS FTSE 100 INDEX FUND	LDN
ISHARES MSCI CANADA ETF	EWC
ISHARES UN KNGDM INDX FD	EWU
ISHARES MSCI TAIWAN ETF	EWT
NETS TRUST FTSE/JSE ETF	JNB
ISHARES ITALY INDEX FUND	EWI
NETS TR PSI 20 IDX-PRT	LIS
ISHARES SWEDEN INDEX FD	EWD
ISHARES NETHERLANDS INDX	EWN

NETS TR SINGAPRE STS ETF	SGT
ISHARES MSCI AUS INDXETF	EWA
ISHARES MSCI SOUTH KOREA	EWY
ISHARES MSCI BRAZIL ETF	EWZ
BARCLAYS BNK IPATH MSCI	INP
NETS TR TA-25 IDX-ISRL	TAV
NETS TR AEX IDX FD NET	AEX
NETS TR BEL 20 IXFD BE	BRU
ISHARES MSCI BELGIUM ETF	EWK
ISHARES MSCI AUSTRIA ETF	EWO
MARKET VECTORS RUS ETF	RSX
PROSHARES UL FTSE/X ETF	FXP