



FTS Real Time Project: International Diversification

Note: this project requires use of Excel's Solver

Question: Can you outperform the domestic market 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 IShares Switzerland Index Fund (which trades under the ticker EWL) is a portfolio of Swiss stocks constructed to mimic (or “track”) a Swiss 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).

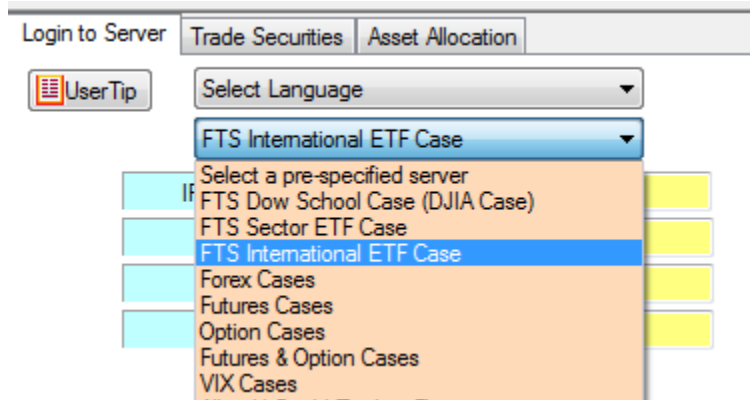
There are close to 1000 ETF's that trade; these include ETF's that track stock indexes, the EWL, as well as sectors (e.g. portfolios of international bonds, international sector ETF's, bonds within a country, sectors within a country, etc.), and you can find a lists of them at many web sites, e.g. www.ishares.com.

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 the ETF’s available to you in the FTS International ETF Case (listed in the appendix, the list changes sometimes as ETF’s stop trading or are replaced). 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.

Note:

- This project is a forward test of diversification. It is not a test of your ability to forecast price movements. If you incorporate your own views, and especially if these views change during the course of the project, then it will be hard to distinguish whether your performance was due to diversification techniques or because you were right or wrong in your view.
- Having said that, you can always override the parameters provided by the system, as described below, and implement your own views.

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).

Short Sales

If you only have long positions, then the concept of a portfolio weight is simple. It is not so simple when you short sell a stock. Let's modify the example. Suppose the price of stock 1 is 20 and you short sold 100 shares. Suppose the price of stock 2 is 40 and you hold 50 shares. What is the amount invested in stocks? If you simply add up the price times the position, you get zero: $-20 \times 100 + 40 \times 50 = -2000 + 2000 = 0$. What is the proportion in stock 1? It's not defined. In fact, if we short sold 200 shares of stock 1, the value calculated in this way would be $-20 \times 200 + 40 \times 50 = -2000$. If we simply divided, we would get a negative weight on stock 2 and a positive weight on stock 1.

The margin requirements for short sales complicate the picture a little bit more. When you short sell stock 1, the proceeds from the sale, \$2000 in our example, are held in an account and you have to put up 50% of that as a deposit. So in this case, your position is:

Stock 1: -100 shares, each share worth \$20, and \$2000 + \$1000 held in your account.

Stock 2: 50 shares, each worth \$40

If you closed out your positions (so covered the short sale of stock 1 and sold stock 2), you would get \$3000 back as follows: when you cover the short sale of stock 1, it costs \$2,000 to buy back the shares. You had \$3,000 in your account, so you get back \$1,000. And you get \$2,000 from the sale of stock 2.

Looking at it from the point of view, the dollar amount in your stock portfolio is \$3,000, made up of \$1,000 being the value of the position in stock 1 and \$2,000 being the value of the position in stock 2. On this basis, the portfolio weights are 33% and 67%. These weights are sometimes called "adjusted weights."

Practical note: The dollar amount you would get if you closed out your position is sometimes called the "Net Liquidation Value" in brokerage accounts.

Note that when we take the short sale deposits etc. into account, the position value will always be positive and so the weight calculated on this basis will always be well defined. But the weight is unintuitive: we have short sold stock 1 but its weight is a positive number!

So we have a dilemma: if we report weights in a "natural" way, they may be undefined and unintuitive; if we define them taking after properly taking into account the short sale account, they are well defined but are unintuitive for short positions.

To resolve this, the FTS Real Time Client reports two weights: the *weight* is what takes into account the short sale (and margin) accounts properly; the value is calculated on the basis of what you would get back if you covered your position. The *raw weight* is calculated without taking this into account; this

may not always be defined as we saw, but when the raw market value (summing up the prices times the positions) is positive, it is much more intuitive.

Constructing a diversified portfolio

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 σ_{ij} denote the covariance between the returns of ETFs i and j , so σ_{ii} is the variance of the return of ETF i . Then, given the portfolio weights, the variance of the portfolio return is:

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

Note: The FTS Real Time Client calculates all the covariances and expected returns for you based on the “single index” model. In this model, it is assumed that “beta works,” i.e. that the expected return of a stock is completely given by the expected return on the index and the stock’s beta.

- You can override these parameters in two ways:
- First, you can enter your own estimates of beta through the “parameters” functionality. In the FTS Real Time Client, click the Parameters menu, to get:

- Select the ETF, select the parameter type, enter the value and then **submit the value**.
- You **must check** “Use the values in my analytical support” for the calculations to be based on your parameters
- You can also override the parameters directly in the spreadsheet, as described below.

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 (CAPM)” in the Analytics area (at the bottom right):

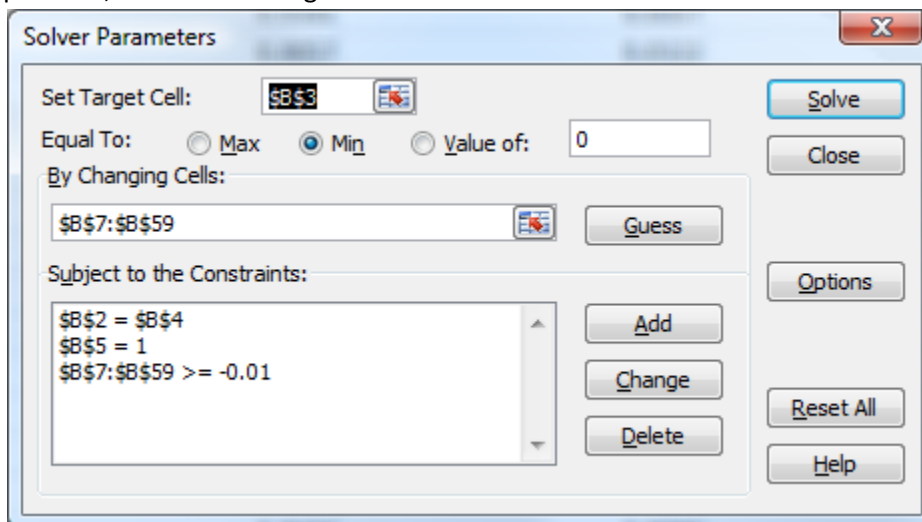
Edit		US Dollar	Stocks: Covariances and Returns (CAPM)	Parameters
Portfolio Exp Return	0.00000			
Portfolio Variance	0.00000	Portfolio Volatility		N/A
Target(Benchmark) Return	0.0821			
Sum of Weights	0.00000			Covariance Matrix
Name	Raw Weight	Expected Return	PROSHARES ULTRA MSCI ETF	
PROSHARES ULTRA MSCI ETF	0	0.2756		0.2370
ISHARES JAPAN INDEX FUND	0	0.1108		-0.0237
SPDR RUSS/NOM PRIME JPN	0	0.1131		-0.0225
ISHARES S&P TOPIX150 ETF	0	0.1093		-0.0244
ISHARES SWITZRLND INDEX	0	0.0904		-0.0340

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	0.04			
Portfolio Vari	0.08	Portfolio Volatility	0.33118	
Target(Benc	0.01			
Sum of Weig	0.00			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	

2. **Note: if you want to use your own covariance matrix and expected returns, you should replace the appropriate cells in the spreadsheet. For example,** you could calculate the historical covariance matrix by downloading
3. In the spreadsheet, enter target expected return; the S&P500 expected return is automatically entered for you, so you simply have to add the ½% per month (depending on your horizon) to that number.
 - Note that if the expected return on the S&P is higher than that of any ETF, you will have to short sell to achieve the target return.
4. 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.
5. 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:B59 and the expected returns to C7:C59. So in cell B2, you should enter the formula **=SUMPRODUCT(B7:B59,C7:C59)**.
 - The covariance matrix is in the range D7:BD59. In cell B3, you should enter **=SUMPRODUCT(B7:B59,MMULT(D7:BD59,B7:B59))** 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:B59)**
6. 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 1% of the total value, i.e. $w_i \geq -0.01$ 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.

Notes:

- One technical problem you may face is that the covariance matrix is close to being singular. In this case, Solver may not be able to find a solution without One way you will know that there is a problem is if Solver tells you that the "cell values fail to converge." This is more likely to happen with a large number of stocks. In that case, you will have to modify the covariance matrix in the spreadsheet to make it non-singular.
- The FTS Real Time Client overrides the inputs of a stock's volatility if it is inconsistent. Technically, it increases the volatility internally to make sure that all correlations across

stock returns are between -1 and 1. The covariance matrix that is exported to Excel contains this adjustment. If you want to use your own numbers, you can modify them directly in the spreadsheet.

- If you want to use fewer stocks, set the weights of the other stocks to zero, and in Solver, just below where it says “By Changing Cells,” enter the cells with the weights you want to use separated by commas, e.g., \$B\$7,\$B\$9,\$B\$15
 - Solver is more likely to find a solution with fewer stocks
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).
- You can execute the trades automatically using the [Equity Portfolio Rebalancer](#) It will also tell you the cost involved with establishing your position. You will have to tell it the dollar amount you want to invest, and it will calculate the number of shares and the cash required for the trades.
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.
- **Note:** rebalancing is costly because there is a transactions cost per trade of \$9.95. So if you trade a lot, you will pay a large amount in these costs.
 - The [Equity Portfolio Rebalancer](#) built in to the Windows version of the FTS Real Time Client lets you determine the costs of rebalancing and also can execute the trades for you.
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: Portfolio Tracking

The FTS Real Time Client shows you your portfolio weights so you can track your portfolio. These weights are shown in the “Stocks: Index Model” analytical support. It comes in two varieties: one uses CAPM expected returns, the other uses expected return you specify (through the Parameters menu item). The analytics are displayed as follows:

		Value	Beta	Exp Return	Volatility	Sharpe	Treynor	Jensen	M2
Overall Position		4,551.50	0.7912	0.0689	0.1813	0.2771	0.0635	0.0000	0.0532
Weight* (SS)			0.9920	0.0816	0.1355	0.4647	0.0635	0.0000	0.0765
Weight* (no SS)			0.9913	0.0816	0.1354	0.4647	0.0635	0.0000	0.0765
Eq Weighted			0.8432	0.0722	0.1220	0.4389	0.0635	0.0000	0.0733
Benchmark			1.0000	0.0821	0.1246	0.5096	0.0635	0.0000	0.0821
Position (Raw)			0.9344	0.0780	0.3558	0.1412	0.0635	0.0000	0.0394
Name	Benchmark	Value	Beta	Risk Free Rate	Equity Premium	Exp Return	Volatility	Weight	Raw Weight
PROSHARES ULTRA MSCI ETF	S&P 500 INDEX	0.00	-1.5600	0.0186	0.0635	-0.0804	0.4868	0.0000	0.0000
ISHARES JAPAN INDEX FUND	S&P 500 INDEX	986.50	0.6200	0.0186	0.0635	0.0580	0.2411	0.2167	0.4366
SPDR RUSS/NOM PRIME JPN	S&P 500 INDEX	0.00	0.5900	0.0186	0.0635	0.0561	0.1795	0.0000	0.0000
ISHARES S&P TOPIX150 ETF	S&P 500 INDEX	0.00	0.6400	0.0186	0.0635	0.0593	0.2588	0.0000	0.0000
ISHARES SWITZRLND INDEX	S&P 500 INDEX	2,801.00	0.8900	0.0186	0.0635	0.0751	0.2506	0.6154	1.2397
ISHARES MSCI MALAYSIAETF	S&P 500 INDEX	764.00	0.6500	0.0186	0.0635	0.0599	0.2497	0.1679	-0.6763
ISHARES MSCI S AFR ETF	S&P 500 INDEX	0.00	1.0400	0.0186	0.0635	0.0847	0.4568	0.0000	0.0000

The top part shows you the ex-ante performance measures (described in the Performance Measures project). The second part shows you data about the individual securities, including the betas, expected returns and volatilities. You will also see two columns called Weight and Raw Weight. These show you your portfolio weights; the difference between is due to short sales. The weight is calculated based on the dollar value invested in the position; the raw weight is based on whether you have a short or long position. In the display shown here, you will see that we have a long position in the Japan Index Fund and the Switzerland Index, but a short position in the Malaysia ETF (the raw weight is negative).

Based on whether you are setting weights or raw weights, you can use this analytic to track your portfolio.

Appendix : The International ETF's

Ticker	Name
EWV	PROSHARES ULTRA MSCI ETF
EWJ	ISHARES JAPAN INDEX FUND
JPP	SPDR RUSS/NOM PRIME JPN
ITF	ISHARES S&P TOPIX150 ETF
EWL	ISHARES SWITZRLND INDEX
EWM	ISHARES MSCI MALAYSIAETF
EZA	ISHARES MSCI S AFR ETF
FXI	ISHARES FTSE/XINHUA 25
GXC	SPDR S&P CHINA ETF
EWP	ISHARES SPAIN INDEX FUND
EWH	ISHARES HONG KONG INDEX
EWQ	ISHARES FRANCE INDEX FD
EWV	ISHARES MEXICO INDEX FD
ECH	ISHARES MSCI CHLFD ETF
PGJ	POWERSHARES ETF GLDN DRA
EWG	ISHARES GERMANY INDEX
EWS	ISHARES SINGAPORE INDEX
EWC	ISHARES MSCI CANADA ETF
EWU	ISHARES UN KNGDM INDX FD
EWT	ISHARES MSCI TAIWAN ETF
EWI	ISHARES ITALY INDEX FUND
EWD	ISHARES SWEDEN INDEX FD
EWN	ISHARES NETHERLANDS INDX
EWA	ISHARES MSCI AUS INDXETF
EWY	ISHARES MSCI SOUTH KOREA
EWZ	ISHARES MSCI BRAZIL ETF
INP	BARCLAYS BNK IPATH MSCI
EWK	ISHARES MSCI BELGIUM ETF
EWO	ISHARES MSCI AUSTRIA ETF
RSX	MARKET VECTORS RUS ETF
FXP	PROSHARES UL FTSE/X ETF
ILF	iShares S&P Latin America 40 Index Fund (ILF)
EPI	India Earnings Fund (EPI)
EIS	iShares MSCI Israel Capped Investable Market Index Fund (EIS)
THD	iShares MSCI Thailand Investable Market Index Fund (THD)
TUR	iShares MSCI Turkey Investable Market Index Fund (TUR)
INDY	iShares S&P India Nifty 50 Index ETF (INDY)
AFK	Market Vectors Africa Index ETF (AFK)

BRF	Market Vectors Brazil Small-Cap ETF (BRF)
EGPT	Market Vectors Egypt Index ETF (EGPT)
MES	Market Vectors Gulf States Index ETF (MES)
SCIF	Market Vectors India Small-Cap ETF (SCIF)
IDX	Market Vectors Indonesia Index ETF (IDX)
LATM	Market Vectors Latin America Small-Cap Index ETF (LATM)
VNM	Market Vectors Vietnam ETF (VNM)
GULF	Middle East Dividend Fund (GULF)
EPU	MSCI All Peru Capped Index Fund (EPU)
EWZS	MSCI Brazil Small Cap Index Fund (EWZS)
ECNS	MSCI China Small Cap Index Fund (ECNS)
FEFN	MSCI Far East Financials Sector Index Fund (FEFN)
EIDO	MSCI Indonesia Investable Market Index Fund (EIDO)
ENZL	MSCI New Zealand Investable Market Index Fund (ENZL)
EPHE	MSCI Philippines Investable Market Index Fund (EPHE)