FINAL PROJECT

ECON 424A, Summer 2014

ABSTRACT

This project analyzes 5 years of monthly closing price data from May 2009 through May 2014.

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0. Executive Summary

0.1 Abstract

This project analyzes 5 years of monthly closing price data from May 2009 through May 2014.

0.2 Data Set Descriptions

a. S&P 500 Index: VFINX

The mutual fund investment tracks the performance of S&P500 Index, a widely recognized benchmark of U.S. stock market performance, which is dominated by large U.S. companies.

b. European Stock Index: VEURX

The mutual fund invests in all return of stocks issued by companies located in the major markets of Europe.

c. Emerging Markets Fund: VEIEX

The mutual fund seeks to invest in stocks issued by companies located in emerging market countries, which substantially all of its assets are included in the FTSE Emerging Index.

d. Long-term Bond Fund: VBLTX

The mutual fund tracks the performance of the Barclays U.S. Long Government/Credit Float Adjusted Index that includes all medium and larger public issues of U.S. government, investment-grade corporate, and investment-grade international dollar-denominated bonds that have maturities of greater than 10 years.

e. Short-term Bond Fund: VBISX

The mutual fund tracks the performance of the Barclays U.S. Long Government/Credit Float Adjusted Index that includes all medium and larger public issues of U.S. government, investment-grade corporate, and investment-grade international dollar-denominated bonds that have maturities of between 1 and 5 years.

f. Pacific Stock Index: VPACX

The mutual fund employs an investment approach in investing substantially all of its assets in common stocks of FTSE Developed Asia Pacific Index.

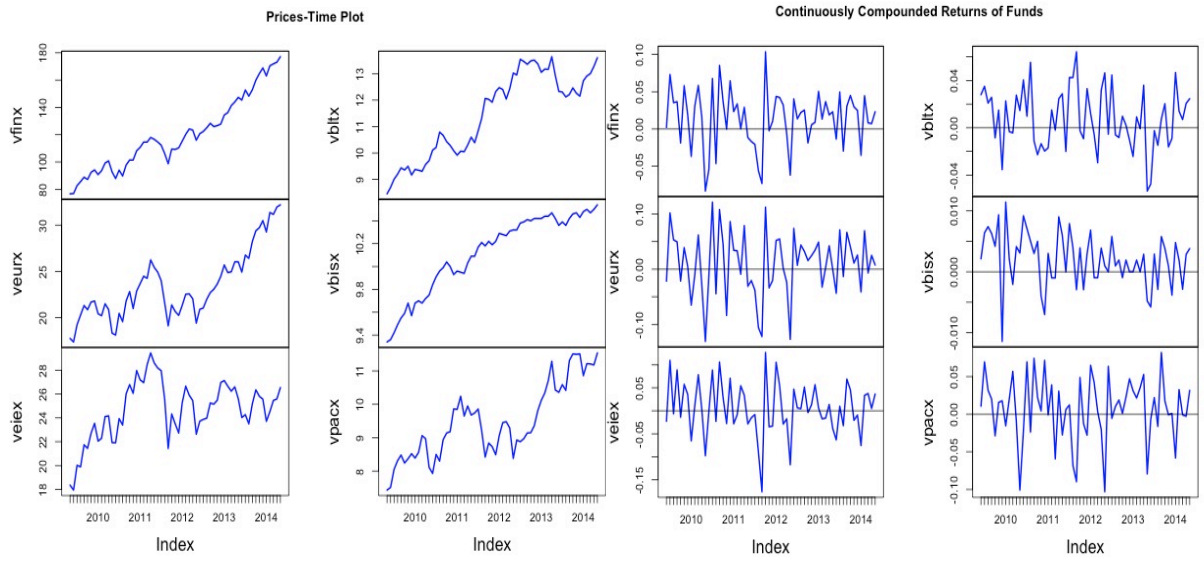
0.3 Main Findings

- The monthly prices of all six mutual funds had experienced a small peak around early 2011 and a subsequent fall in all six funds around mid-2011.
- None of the indexes has a Normal Distribution.
- S&P 500 Index (VFINX) yields the highest return, however Emerging Markets Fund (VEURX) has the highest risk.
- The trade-off between risk and return does not apply on the above funds mentioned. One has the highest return yet is less volatile; the other has a lower return yet has the highest risk, which means poor performance.
- Sharpe's Ratios of all individual funds suggest that VBISX has the highest slope, meaning the highest excess expected return per unit risk.
- It seems all geometrically related indexes (VFINX, VEURX, VEIEX, and VPACX) or Country Mutual Funds Indexes are positively correlated with one each other.
- Time-sensitive indexes (VBLTX and VBISX) are positively correlated with each other, but they act differently with locale-related indexes.
- Short-term Bond Fund (VBISX) has the least Value-at-Risk losses over investment horizon, while Emerging Markets Fund (VEIEX) has the highest Value-at-Risk losses.
- Rolling analysis suggests that despite of some stationary behaviors, none of the mutual funds has stable Expected Returns and Standard Deviations.

- Forming a portfolio gives a volatility that is much smaller than any individual asset because of the diversification effect that reduces the diversifiable firm's specific risks.
- Global Minimum Variance Portfolio with No Short-sales generates higher Monthly and Annual Expected Returns but also higher volatility than the Global Minimum Variance Portfolio with short-selling allowed scenario.
- Compare to the Tangency Portfolio allowing short-sales, the Tangency Portfolio without short-sales has a lower Sharpe's Slope, but generates a higher Expected Return and a higher risk.
- It is less risky to purchase the combination of Risk Free Asset and Risky Assets than an allocation of all risky assets to achieve the same Expected Returns and such combination has comparatively much less Value-at-Risk.

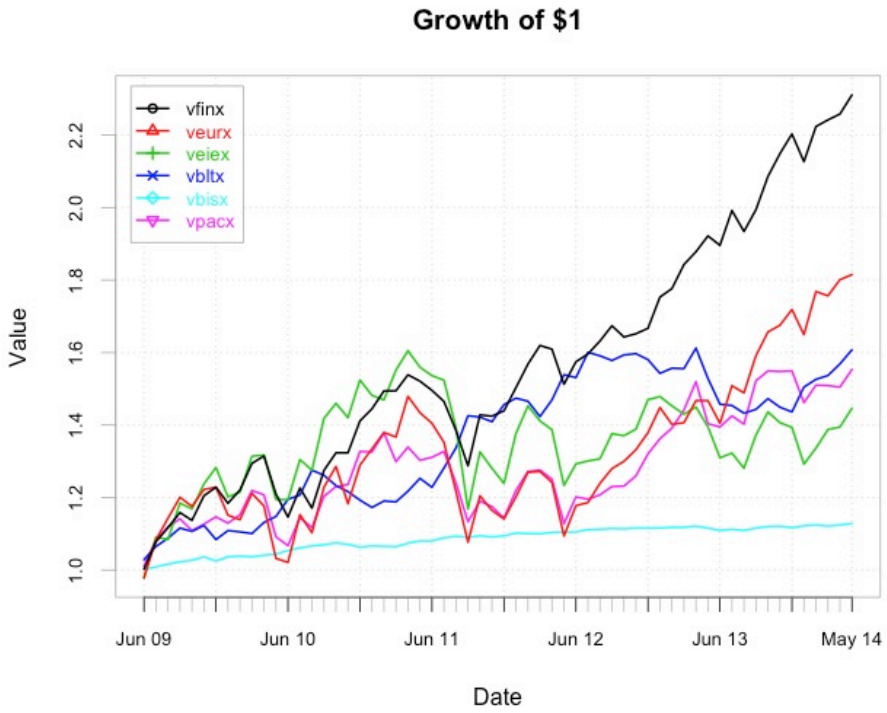
1. Return Calculations and Sample Statistics

1.1 Time Plots of Monthly Prices and Returns

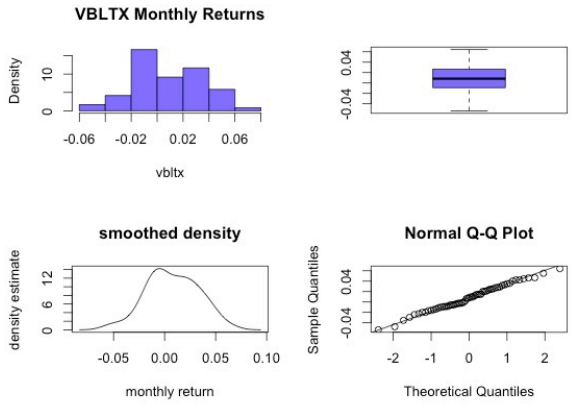


All six mutual funds in the above plots have presented synchronized trends as if they move together, regardless of countries. For instance, S&P 500 Index (VFINX) of the U.S., European Stock Index (VEURX) of European countries and Pacific Stock Index (VPACX) of Asian-Pacific countries. All monthly prices follow a general trend of increasing; experiencing a small peak around early 2011 and a subsequent fall in all six funds around mid-2011.

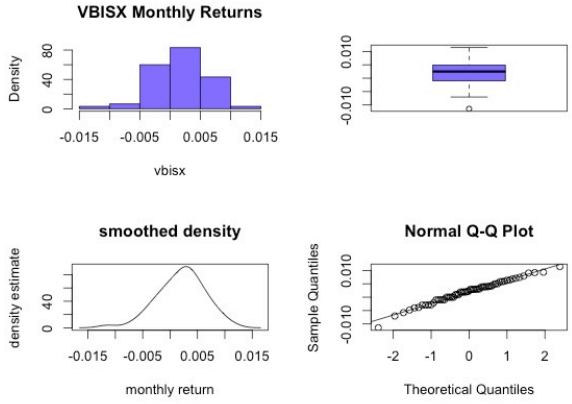
Such coherence is even more obvious in Continuously Compounded Returns of Funds-Time plot. Especially VFINX, VEURX, VEIEX, and VPACX that are almost identical. And VBISX and VBLTX on the other hand move together. For example, for the time period from mid-2010 to early 2011, these two have shown dramatic decreases in their Continuously Compounded Returns, which is a distinctive feature from other four funds.



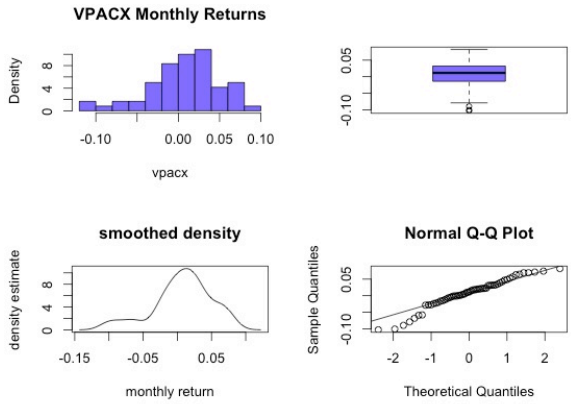
The above is a graph of an Equity Curve, which shows the growth of $1 in each of the six funds over the five-year period. Apparently, of all funds, VFINX (the black line) gives the highest value in five-year future from end of May in 2009, giving a value of over $2.2. The second best performing fund is VEURX, giving around $1.8. The find is a fine evidence of nice pay-off in investments in U.S. economy.



1. The histogram of VBLTX Monthly returns obviously is not a normal distribution, with a second small peak on the right side around 0.03.
2. The smooth density plot suggests appear-to-be-normal left and right tails but not showing symmetry.
3. The box plot seems normal.
4. Most dots are on the straight line in Q-Q plot, but most dots are tensed around 0.



1. The histogram of VBISX Monthly returns looks like a normal distribution.
2. The smooth density plot suggests an almost symmetry.
3. The box plot seems normal except for a very large negative extreme value.
4. Most dots are on the straight line in Q-Q plot but both left tail has a very large outlier and the there is one value on the right side might be too far from mean.



1. The histogram of VPACX Monthly returns does not look a normal distribution.
2. The smooth density plot suggests a long left tail and both tails are fatter than normal.
3. The box plot has several large negative outliers.
4. Left tail has some dots off the straight line (negative outliers) indicates a long fatter left tail which supports the smooth density plot. Most other dots are on the line.

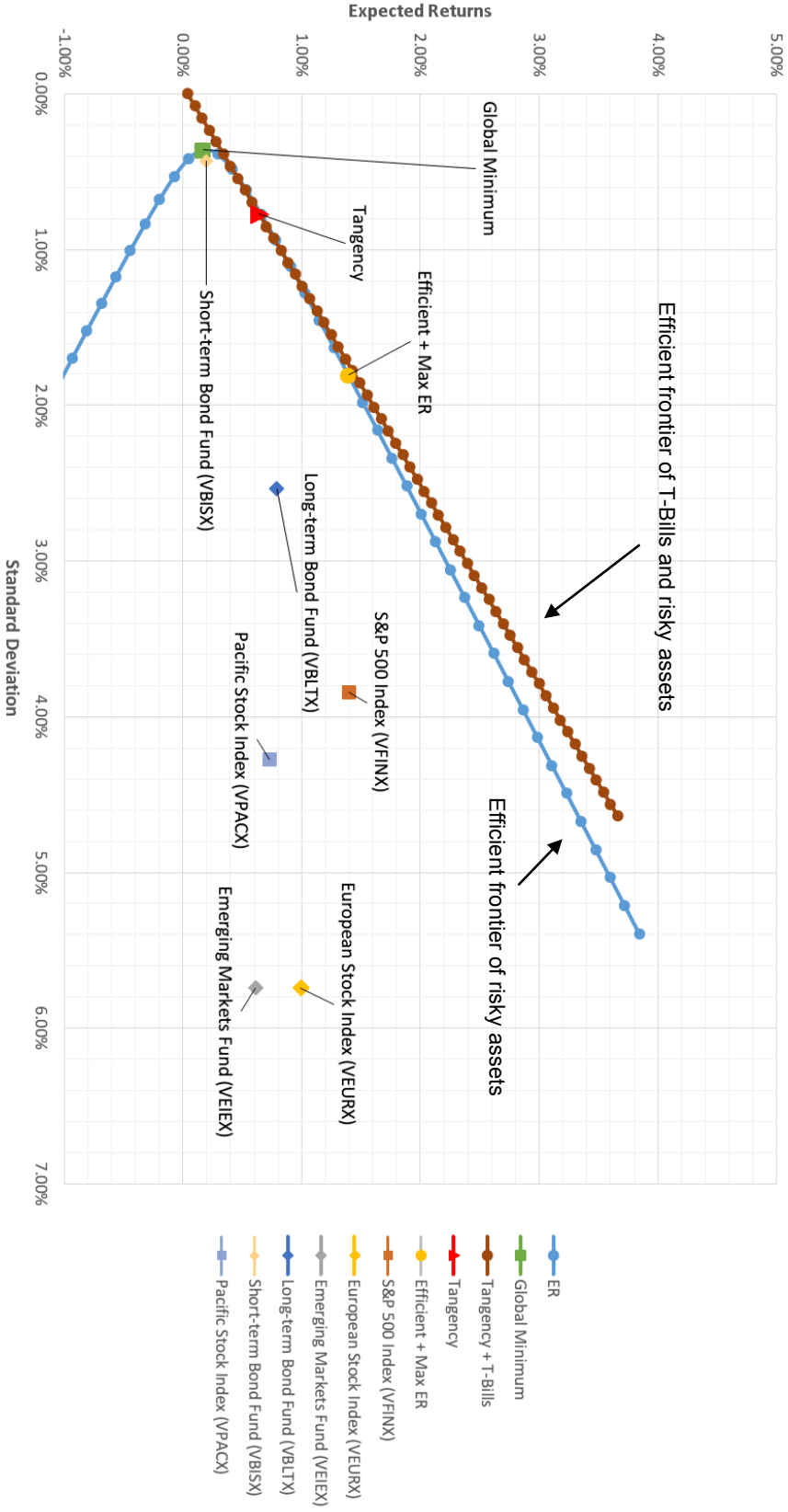
2. Value-at-Risk Calculations

2.1 Value-at-Risk Calculation

VaR of $100,000 Over a One Month Investment Horizon		
Asset	**VaR 1%**	**VaR 5%**
S&P 500 Index (VFINX)	-$ 7,272.10	-$ 4,809.80
European Stock Index (VEURX)	-$ 11,632.10	-$ 8,105.10
Emerging Markets Fund (VEIEX)	-$ 11,969.40	-$ 8,454.80
Long-term Bond Fund (VBLTX)	-$ 4,977.30	-$ 3,321.30
Short-term Bond Fund (VBISX)	-$ 806.30	-$ 512.50
Pacific Stock Index (VPACX)	-$ 8,800.80	-$ 6,104.50

VaR of $100,000 Over a One Year Investment Horizon		
Asset	**VaR 1%**	**VaR 5%**
S&P 500 Index (VFINX)	-$ 13,271.00	-$ 5,029.09
European Stock Index (VEURX)	-$ 29,076.00	-$ 18,778.50
Emerging Markets Fund (VEIEX)	-$ 32,235.00	-$ 22,392.83
Long-term Bond Fund (VBLTX)	-$ 10,348.00	-$ 4,818.52
Short-term Bond Fund (VBISX)	-$ 1,092.00	-$ 73.85
Pacific Stock Index (VPACX)	-$ 22,624.00	-$ 14,406.09

Short-term Bond Fund (VBISX) has the least Value-at-Risk losses over either investment horizon, while Emerging Markets Fund (VEIEX) has the highest Value-at-Risk losses.


Markowitz Bullet Plot
Expected Returns
Standard Deviation
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
-1.00%
0.00%
1.00%
2.00%
3.00%
4.00%
5.00%
6.00%
7.00%
Efficient frontier of T-Bills and risky assets
Efficient frontier of risky assets
Global Minimum
Tangency
Efficient + Max ER
Short-term Bond Fund (VBISX)
Long-term Bond Fund (VBLTX)
S&P 500 Index (VFINX)
Pacific Stock Index (VPACX)
European Stock Index (VEURX)
Emerging Markets Fund (VEIEX)
ER
Global Minimum
Tangency + T-Bills
Tangency
Efficient + Max ER
S&P 500 Index (VFINX)
European Stock Index (VEURX)
Emerging Markets Fund (VEIEX)
Long-term Bond Fund (VBLTX)
Short-term Bond Fund (VBISX)
Pacific Stock Index (VPACX)

5.3 Tangency Portfolio + T-Bills with Target Monthly Expected Return of 0.5% (No Short-sales)

Recall in Section 4.9 where the Tangency Portfolio with No Short-sales was computed.

Tangency Portfolio (Without Short-sales)							
Asset	**Share**	**t2vec**	**Constraint**	**E[Rp,t2]**	**var(Rp,t2)**	**SD(Rp,t2)**	**Slope**
VFINX	t2_vfinx	25.05%	1	0.69%	0.000118177	1.09%	0.5959
VEURX	t2_veurx	0.00%					
VEIEX	t2_veiex	0.00%					
VBLTX	t2_vbltx	32.07%					
VBISX	t2_vbisx	42.88%					
VPACX	t2_mpacx	0.00%					

Target Monthly ER = Risk Free Rate + $\mathbf{X}_{\mathbf{rangency}}$ * ($\mathbf{ER}_{\mathbf{Tangency}}$ – Risk Free Rate)

0.5% = 0.5%/12 + $\mathbf{X}_{\mathbf{rangency}}$ * (0.69% – 0.5%/12)

$\mathbf{X}_{\mathbf{tangency}}$ = 0.70694087

$\mathbf{X}_{\mathbf{T\text{-}Bills}}$ = 1 - 0.70694087 = 0.29305913

Tangency + T-Bills Weights (No Short)		
Asset	**Tangency Portfolio Weight**	**Efficient Portfolio Weight**
VFINX	25.05%	17.71%
VEURX	0.00%	0.00%
VEIEX	0.00%	0.00%
VBLTX	32.07%	22.67%
VBISX	42.88%	30.31%
VPACX	0.00%	0.00%
Tangency Portfolio		**70.69%**
T-Bills		**29.31%**

With weight of Tangency Portfolio taking 70.69% (17.71% of VFINX, 22.67% of VBLTX and 30.31% of VBISX), and the rest 29.31% of T-Bills, the combination can yield a Target Monthly Return of 0.5%, giving 6% in Expected Return annually. The corresponding volatility (SD) of the portfolio would be 0.77%.