Research of the Market Inefficiency

- Low-Volatility Anomaly in Hong Kong Stock Market

BY

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Finance Concentration

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Abstract

Traditional point of view is that higher return should be expected with higher risk. However, the empirical reality is that it is hard to find the positive relationship between risk and return. Ouwerkerk (2013) stated that portfolios comprised of high-volatility stocks have underperformed their lower-risk counterparts over the past 40 years in United States.\(^1\) This phenomenon is called the low-volatility anomaly. So how about the Hong Kong stock market? Does the low-volatility strategy also work in Hong Kong stock market? Robert A. Haugen verified that the location of stock market did not affect the effectiveness of low-volatility strategy. Thus, a research of the low-volatility anomaly in Hong Kong stock market can partly verify this statement.

The low-volatility anomaly is sustained with high probability and well supported by both structural characteristics of the marketplace and behavioral finance. In this study, the reason of low-volatility anomaly will be focused on human behavior.

Understanding such strategy is quite significant for investors because volatility reduction allows greater allocation of portfolios at the same level of risk contribution.\(^2\)

This study attempts to use a simple method to verify the low-volatility anomaly in comparison with the traditional method by using efficient frontier.

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Introduction

Statement of the Problems
Robert Haugen and A. James Heins (1975) stated that “over the long run stock portfolios with lesser variance in monthly returns have experienced greater average returns than their ‘riskier’ counterparts” in the paper titled “On the Evidence Supporting the Existence of Risk Premiums in the Capital Market” with the studying period from 1926–1971.¹

Low-volatility anomaly is that portfolios composed purely of low-volatility stocks tend to outperform the portfolios composed high-volatility stocks over the long run. This phenomenon implied that low-volatility portfolio has high return on average.²

Thus, this study will focus on the low-volatility anomaly and the low-volatility strategy to invest in Hong Kong stock market.

Objectives of the Study
This project will focus on the following three aspects of the low-volatility anomaly:
1. Whether the low-volatility portfolio outperformed the high-volatility portfolio over the past 10 years or not.
2. If the answer of the first question is yes, then, how much the return of low-volatility portfolio was higher than the return of high-volatility portfolio? What about the difference with the return of Hang Seng Index?
3. Under what circumstances this theory worked? Did the market up or down affect the result of the theory mentioned above?

Literature Review

Robert A. Haugen was an American Financial economist, and he put a lot of effort on overthrowing the Efficient Market Hypothesis in his life. In his last research, he found that the low-volatility portfolio outperform the high-volatility portfolio with 17% rate of return higher on average from 1990 to 2011. He tested 21 markets in the world including Hong Kong stock market, and the portfolio he chose could cover 99.5% of the market capitalization. He separated the portfolio into groups by ranking them from the highest volatility to the lowest volatility, then, compared the monthly return of them. The result shows that the location of stock market did not affect the effectiveness of low-volatility strategy.  

Baker and Wurgler (2011) indicated that low risk consistently outperformed high risk over the period they researched, regardless of whether they define risk as volatility or beta or whether they consider all stocks or only large caps. They obtained data from January 1968 to December 2008 from CRSP. Then, they combined the top 1,000 stocks by market capitalization into five groups for each month and then tracked the returns on these portfolios.  

Brennan (1993) proved that no leverage would tend to flatten the CAPM relationship, even with no irrational investors. He was based on the five assumptions that are sufficient to derive the CAPM: there are n stocks and a risk-free bond; two representative investors who are mean-variance utility maximizers over returns with a risk aversion parameter of v; these two investors make scalar investment decisions; the first investor employs an intermediary to help him or her to invest; the second investor chooses his or her portfolio. Brennan (1993) also showed that the second

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5Laolin, B. (2013). Farewell, the Grandmaster! Hong Kong Economic Journal, 4 February, B5.
investor would like to invest in lower volatility stocks. In addition, the intermediary would like to act as an arbitrageur only when the low-volatility anomaly works. Thus, the irrational individual investors who have the preference of high-volatility stocks may flatten the CAPM.

Li (2013) also stated that low-volatility portfolios offer an improved risk-return profile in comparison with traditional cap-weighted core investments. Furthermore, the low-volatility strategy is likely to result in greater diversification and a more attractive final portfolio for investors.8

**Hypotheses Development**

It is assumed that the low-volatility anomaly exists; thus, the low-volatility portfolio should have higher return than the high-volatility portfolio and also the Hang Seng Index.

**Procedures/Methodology**

This project is aim at researching the effectiveness of the low-volatility strategies over the last 10 years that is from April 1, 2003 to April 1, 2013. I chose all the 50 components of Hang Seng Index as the research objects.

**Primary Data**

The annual rates of return of all these 50 components of Hang Seng Index over the last 10 years are the dependent variables. The standard deviations of monthly return from 2003 to 2013 of all these 50 components of Hang Seng Index are the independent variables.

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**Regression Model**

The regression model is as follow:

\[ \text{Rate of Return} = C(1) + C(2) \times \text{Standard Deviation} \]

First, I will test the relationship between the standard deviation at year t and the rate of return at year t+1.

Second, I will test the relationship between the standard deviation at year t and the rate of return at year t.

**Findings and Analysis**

*Low-volatility portfolio outperformed the high-volatility portfolio?*

The hypothesis is as follow:

\[ H_0: C(2) = 0 \]
\[ H_1: C(2) < 0 \]
The result of the standard deviation at year \( t \) and rate of return at year \( t+1 \) is as follow:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.297714</td>
<td>0.026871</td>
<td>11.07934</td>
<td>0.0000</td>
</tr>
<tr>
<td>SD</td>
<td>-0.011609</td>
<td>0.004225</td>
<td>-2.747734</td>
<td>0.0062</td>
</tr>
</tbody>
</table>

As we can see from the table above, there are 453 observations in total, and this is because some of the components of Hang Seng Index went to the public after April 1, 2003. We can reject the null hypothesis, which we have mentioned above and prove that the coefficient of standard deviation is less than zero. The p-value is 0.0062 that is much lower than the significant level of 0.05, so the result is very significant.

The equation based on the regression model is as follow:

\[
\text{Rate of Return} = 0.297714 - 0.011609 \times \text{Standard Deviation1}
\]

The coefficient of standard deviation is -0.011609, which means that there is a negative relationship between rate of return and standard deviation. Thus, the low-volatility portfolio did outperform the high-volatility portfolio.
The result of both the standard deviation and rate of return at year $t$ is as follow:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.261754</td>
<td>0.027064</td>
<td>9.671639</td>
<td>0.0000</td>
</tr>
<tr>
<td>SD2</td>
<td>-0.002162</td>
<td>0.004245</td>
<td>-0.509221</td>
<td>0.6108</td>
</tr>
</tbody>
</table>

Therefore, the p-value of coefficient is 0.6108, which is much higher than the significant level of 0.05, so the result is not significant.

The equation based on the regression model is as follow:

$$\text{Rate of Return} = 0.261754 - 0.002162 \times \text{Standard Deviation}^2$$

The coefficient of standard deviation is -0.002162, which also means a negative correlation between rate of return and standard deviation. However, since the result here is not significant, then, we can just focus on the relationship between the standard deviation of the current year and the rate of return of the next year.
How much the return of low-volatility portfolio was higher than the return of high-volatility portfolio? What about the difference with the return of Hang Seng Index?

<table>
<thead>
<tr>
<th>Year</th>
<th>Return of Lowest SD (A)</th>
<th>Return of Highest SD (B)</th>
<th>Return of HIS (C)</th>
<th>A-B</th>
<th>A-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012-13</td>
<td>0.0870</td>
<td>0.1040</td>
<td>0.0436</td>
<td>-0.0169</td>
<td>0.0434</td>
</tr>
<tr>
<td>2011-12</td>
<td>0.0936</td>
<td>-0.1292</td>
<td>-0.1107</td>
<td>0.2228</td>
<td>0.2043</td>
</tr>
<tr>
<td>2010-11</td>
<td>0.1556</td>
<td>0.2312</td>
<td>0.1238</td>
<td>-0.0756</td>
<td>0.0319</td>
</tr>
<tr>
<td>2009-10</td>
<td>0.7722</td>
<td>0.3299</td>
<td>0.3600</td>
<td>0.4423</td>
<td>0.4122</td>
</tr>
<tr>
<td>2008-09</td>
<td>-0.2286</td>
<td>-0.2865</td>
<td>-0.3974</td>
<td>0.0579</td>
<td>0.1687</td>
</tr>
<tr>
<td>2007-08</td>
<td>0.4854</td>
<td>0.6260</td>
<td>0.2676</td>
<td>-0.1406</td>
<td>0.2178</td>
</tr>
<tr>
<td>2006-07</td>
<td>0.6898</td>
<td>0.2987</td>
<td>0.2195</td>
<td>0.3911</td>
<td>0.4703</td>
</tr>
<tr>
<td>2005-06</td>
<td>1.5509</td>
<td>0.1145</td>
<td>0.1979</td>
<td>1.4364</td>
<td>1.3530</td>
</tr>
<tr>
<td>2004-05</td>
<td>0.3035</td>
<td>0.1693</td>
<td>0.1646</td>
<td>0.1343</td>
<td>0.1389</td>
</tr>
<tr>
<td>Average</td>
<td>0.4344</td>
<td>0.1620</td>
<td>0.0965</td>
<td>0.2724</td>
<td>0.3379</td>
</tr>
</tbody>
</table>

Method | Probability |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>t-statistic</td>
<td>0.06343</td>
</tr>
</tbody>
</table>

The table above summarized the difference between return of low-volatility portfolio and high-volatility portfolio and also the Hang Seng Index. I chose the top 7 components of Hang Seng Index for each lowest standard deviation and highest standard deviation.

I also tested the results by using 4 components of Hang Seng Index for each lowest standard deviation and highest standard deviation, and I got the quite similar results with the above ones. Thus, it is does not matter that how many components I should choose to form the portfolio in this case.

Based on the table above, the average return of the portfolios with lowest standard deviation is 43.44%, while the average return of the portfolios with highest standard
deviation is 16.20%. Thus, the difference between these two is 0.2724, which means the average rate of return of the lowest volatility portfolios is 27.24% higher than the average rate of return of the highest volatility portfolios. Furthermore, the average difference between the portfolios with lowest standard deviation and Hang Seng Index is 0.3379, which means the average rate of return of the lowest volatility portfolios is 33.79% higher than the average rate of return of Hang Seng Index.

The return of year 2005-2006 and 2009-2010 is particularly high for the lowest standard deviation portfolios that are 1.5509 and 0.7722 respectively, thus, someone may doubt that these two return may result to error to the average difference between A and B. However, 6 out of 9 figures in the column of A-B are positive, while 3 out of 9 figures are negative. Hence, the positive result for average (A-B) is convictive.

The one-tailed critical t-value for the 10% significance level is 0.06343, thus, the results are significant. Appendix 1 is the one-tailed t-test by using the software R for this part.

In addition, appendix 3 is a table contains all the top 7 components of Hang Seng Index for both lowest standards deviation and highest standard deviation. We can see that almost half of the portfolios remained at next year for both highest SD and lowest SD, especially for recent years. Surprisingly, the stock quote of 3988 remained at the lowest SD for three years from 2010 to 2012, and the stock quote of 0700 remained at the highest SD for three years from 2010 to 2012. Therefore, the components for both lowest SD and highest SD are quite stable that can certify the stable strategy that low-volatility portfolios outperform high-volatility portfolios.
Under what circumstances this strategy worked? Did the market up or down affect the result of the strategy mentioned above?

I also did the regression analysis to see whether the circumstances of market up and down affected the effectiveness of this strategy. Appendix 1 is the data I used in the regression analysis.

The equation based on the regression model is as follow:

\[
\text{Return of Low-volatility Portfolio} - \text{Return of High-volatility Portfolio} = 0.221878 + 0.523431 \times \text{Return of Hang Seng Index}
\]

The p-value is quite high as 0.5169, thus, the result is not significant. Therefore, the circumstances of market up and down did not affect the effectiveness of the theory.
Interpretation of Results

Based on the analysis above, I got three results as follow:

1. The low-volatility portfolios outperform the high-volatility portfolios in the long run.
2. The rate of return of the low-volatility portfolio is about 27% higher than the high-volatility portfolios, and about 34% higher than the Hang Seng Index.
3. The effectiveness of the low-volatility strategy did not affect by the dynamic market.

The reasons for the low-volatility anomaly may be as follow:

1. Some investors acted as gamblers, and they are willing to invest in the high-volatility portfolios and expected for high return.
2. Some analysts tend to over estimate the growth of the return of high-volatility portfolios in the short run, and this behavior can push up their prices and correspondingly reduce returns in the future.

Limitation

The major limitation for this study is that the time frame may not be long enough as I only use the data of last 10 years.

Recommendation and Conclusion

The low-volatility strategy actually changed our previous viewpoint. Even though this strategy may help investors get less return in the bull market, the results are still quite good. The statement by Robert A. Haugen that the location of stock market did not affect the effectiveness of low-volatility strategy is partly verified by this study.
Thus, investors should consider an allocation to lower risk stocks and portfolios. However, once the low-volatility strategy become popular in the market, the low-volatility anomaly may disappear. Thus, investors should keep an eye on the rapidly changing market.
Reference


Appendix

1. Data used in the regression analysis to test the effectiveness of low-volatility strategy in dynamic market:

<table>
<thead>
<tr>
<th>(A-B) Year t+1</th>
<th>Return of HIS Year t</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.043435263</td>
<td>-0.110729777</td>
</tr>
<tr>
<td>0.204330872</td>
<td>0.123751515</td>
</tr>
<tr>
<td>0.031886299</td>
<td>0.360002809</td>
</tr>
<tr>
<td>0.41221203</td>
<td>-0.397368314</td>
</tr>
<tr>
<td>0.168727915</td>
<td>0.267551324</td>
</tr>
<tr>
<td>0.217845073</td>
<td>0.219531489</td>
</tr>
<tr>
<td>0.470256729</td>
<td>0.197881655</td>
</tr>
<tr>
<td>1.35303718</td>
<td>0.164616644</td>
</tr>
<tr>
<td>0.138921188</td>
<td>0.370042284</td>
</tr>
</tbody>
</table>

2. One-tailed t-test (R):

data:  x
t = 1.7036, df = 8, p-value = 0.06343
alternative hypothesis: true mean is greater than 0
90 percent confidence interval:
  0.04906182       Inf
sample estimates:
  mean of x
  0.2724082
3. The top 7 components of Hang Seng Index with Lowest SD and Highest SD:

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lowest SD</strong></td>
<td>3988</td>
<td>3988</td>
<td>3988</td>
<td>0151</td>
<td>3988</td>
<td>0003</td>
<td>0762</td>
<td>0135</td>
<td>1109</td>
</tr>
<tr>
<td></td>
<td>0386</td>
<td>1398</td>
<td>0386</td>
<td>0322</td>
<td>0494</td>
<td>0135</td>
<td>0494</td>
<td>0322</td>
<td>0135</td>
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<tr>
<td></td>
<td>0939</td>
<td>0992</td>
<td>0857</td>
<td>3988</td>
<td>0135</td>
<td>0992</td>
<td>1880</td>
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<tr>
<td></td>
<td>3328</td>
<td>3328</td>
<td>1398</td>
<td>0135</td>
<td>1398</td>
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<td>0688</td>
<td>0494</td>
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<tr>
<td></td>
<td>1398</td>
<td>0939</td>
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<td>0836</td>
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<td>3328</td>
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<td>0066</td>
<td>0992</td>
<td>0836</td>
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<td></td>
<td>0857</td>
<td>0003</td>
<td>0151</td>
<td>0494</td>
<td>0003</td>
<td>0857</td>
<td>0002</td>
<td>1109</td>
<td>0992</td>
</tr>
<tr>
<td><strong>Highest SD</strong></td>
<td>0700</td>
<td>0700</td>
<td>0700</td>
<td>0005</td>
<td>0388</td>
<td>0388</td>
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<td>0005</td>
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<td>0019</td>
<td>0388</td>
<td>0001</td>
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