Empirical Finance - Assignment 2

Isabel Schweizer, 15-720-949

Lutharsanen Kunam, 15-700-875

Pascal Laesser, 15-709-157

April 9, 2021

5.1 Estimating Betas

5.1.1

The beta is one of the estimated coefficients of the single index model. In this setting, its purpose is to measure the sensitivity of a given stock's return relative to the market's return. It tells us how much of the fluctuations in the stock return are due to fluctuations in the index' return (covariance scaled by the variance of the market).

If we already have a well-diversified portfolio resembling the market, the beta of a certain stock shows how much risk we would add to the portfolio if we include the stock into our portfolio (as we are at a point where we cannot further reduce the diversifiable risk and are only left with the systematic risk). A beta above one means that the stock carries more risk than the market. A beta lower than one supposedly reduces the risk of the portfolio.

5.1.2

Being a provider of human resource services and staffing, Adecco seems to be closely tied to the real economy. Therefore, its beta should be very close to 1.

As a globally operating bank and finance intermediary, Credit Suisse is known for taking on large risks. In that sense, we expect it to have a beta greater than 1.

LafargeHolcim, a producer of construction material, might also have a beta around 1. Unlike for example in the United States, Switzerland does not use infrastructure investments as economy boosters during times of recession. The infrastructure sector is rather much more tied to the cyclical movements of the economy.

The telecommunication services of Swisscom are needed no matter the state of the economy. Swisscom's beta could thus be lower than 1.

5.1.3

In the provided R code, the risk free interest rate is derived from the 1-year Swiss government bonds. While the data set at hand for this exercise states interest rates for every month, they still represent annual interest rates (as stated in the data set description). In order to compare them with monthly returns, we also need to transform them to monthly interest rates.

The resulting table with all the coefficients asked for can be found in Appendix A.

5.1.4

Adecco has a beta of 1.5697, which is clearly higher than 1, whereas we expected it to be rather close to 1. The same is the case for the beta of LafargeHolcim, which settles at 1.6505. The betas of Credit Suisse and Swisscom are pretty much in line with our expectations. Credit Suisse's beta of 2.0432 is much higher than 1, while Swisscom has a very modest beta of only 0.3286.

5.1.5

The table displaying the t-values for the estimated beta coefficients can be found in Appendix B.

The t-values are all rather high, meaning the betas are significantly different from 0. Swisscom's beta is statistically significant at the 5%-level while the other three are significant even at the 1%-level.

5.1.6

The R^2 tells us how much of the variation in the y-variable can be explained by the underlying model. In our case this is how much of the variation in the stocks' return can be explained by the variation in the SMI's return (while allowing for an individual intercept - the Alpha).

The table showing the adjusted beta for the four companies can be found in Appendix C. As they should by design, all betas are drawn more toward 1.

5.1.7

The table comparing the beta estimates for the two different time periods can be found in Appendix D.

Interestingly, the betas for all four companies are much more in line with our previously stated expectations in task 5.1.2. They have all been pulled towards 1. The beta of LafargeHolcim shows the greatest absolute change, closely followed be Adecco's and Credit Suisse's betas. Swisscom's beta exhibits a much smaller change.

Of course, these differences can be explained by the difference in sentiments the markets had during these two periods. With the exception of the uncertainties COVID-19 brought along, the past 5 years have shown a roughly constant economic growth. During these prosperous and calm times, company stocks might have been more prone to show risky behavior and decouple themselves from the market movement. Thus, they show larger betas. Swisscom is a special case here, as it is semi-publicly owned and cannot take excessively high risks.

Between July 2007 and March 2009 however, the worldwide economy was amid the Great Recession. There was much more uncertainty and most companies where highly dependent on the state of their country's economy. This could explain why these betas are closer to 1.

5.2 Predicting Betas

5.2.1

The solution of this exercise can be found in the table in Appendix E.

5.2.2

$\hat{a}$ can be interpreted as the β_0 in a linear regression model, which is also known as the y-intercept, while $\hat{b}$ can be interpreted as the β_1 which can also be called gradient or slope of the linear regression. Therefore, $\hat{a}$ tells us the value of the estimated β_{t+1} if β_{t} had been 0. Likewise, $\hat{b}$ tells us how much the estimated β_{t+1} is expected to grow if β_{t} increases by 1. A higher $\hat{b}$ implies a higher effect and influence of the known β_t on the forecast β_{t+1}.

5.3 Beta as risk measure

5.3.1

The table showing the mean returns and mean standard deviations of the portfolios can be found in Appendix F.

5.3.2

The Graph can be found in Appendix G.

Interpretation:

When we looked at the equivalent chart from class to the one produced here, which used standard deviation as a measure of risk, we didn't really observe a positive risk-return-relationship. In particular, the third most volatile portfolio was the worst in terms of cumulative returns, while the second safest portfolio perhaps even outperformed portfolio 5, which was the most volatile.

If we look at the same graph with beta as the risk measure to divide the portfolios, we can observe that the risk-return-relationship seems to be positive for the first four portfolios. Thus, each portfolio becomes slightly more volatile in terms of its beta (beta further away from zero), and the cumulative returns also become slightly higher. This is consistent with what we would theoretically expect with a positive risk-return-relationship. However, the fifth portfolio, which contains the stocks with the highest betas, actually performs worse in terms of cumulative returns than the first portfolio, which could be considered the safest.

To conclude, when using standard deviation as a risk measure we are faced with a few problems. Namely, it assumes that the volatility in the portfolio cannot be diversified away and we are not able to observe the covariance between stocks. Furthermore, standard deviation measures the total risk and we can't distinguish between systematic and non-systematic risk. If we use beta as a risk measure we are able to observe a stock's volatility in relation to the market or index. As higher betas are supposed to be riskier with higher return potential and stocks with lower betas are thought to be safer and yield lower returns, beta should be a more appropriate measure of risk to find a positive risk-return-relationship. However, our graphical result above does not provide evidence for this assumption, as Portfolio 5 should have the highest cumulative returns among beta-sorted portfolios according to a positive risk-return relationship.

5.3.3

Estimated betas can have several problems. Due to OVB, estimated betas can be systematically biased and in practice they tend to be too extreme. They also change over time, so the time horizon of the data is important. Another problem may be measurement error, which also introduces bias. To address these issues, we could take the following steps to improve the betas for our strategy:

To adjust extreme betas, an adjustment factor (AF) is often used to shrink them towards 1. A uniform AF such as the Bloomberg AF may be too simplistic since not all stocks need to be adjusted with the same factor. Another option would be a Vasicek (1973) shrinkage estimator, where the shrinkage toward the cross-sectional average beta depends on how accurate we think the estimated beta is. Levi and Welch (2017) suggest to start with a Vasicek-estimated beta and then shrinking it a second time dependent on a target to predict a beta for 1 year ahead.

To address the problem of the right time horizon, we could shorten the time period used to estimate the betas as old data might not be so relevant anymore. According to Hollstein, Prokopczuk, and Wese Simen (2017) we could also solve this problem by weighting the recent data more than old data.

To circumvent measurement error, Hollstein, Prokopczuk, and Wese Simen (2017) suggest that the betas could be shrunk towards cross-sectional averages. Higher frequency data can also improve measurement error, although in this case we are already using daily data, so this step would not be essential.

5.4

We were a little confused that the forecast β in task 5.2.1. was called β_{t-1}. We thought this was wrong as β_{t-1} is the beta from the last period while we want to forecast the beta from the next period. We therefore changed the nomenclature in the table to β_{t+1}.

References

Hollstein, Fabian, Marcel Prokopczuk, and Chardin Wese Simen (2017). *How to estimate beta?* Tech. rep. Hannover Economic Papers (HEP).

Levi, Yaron and Ivo Welch (2017). “Best practice for cost-of-capital estimates”. In: *Journal of Financial and Quantitative Analysis* 52.2, pp. 427–463.

Vasicek, Oldrich A (1973). “A note on using cross-sectional information in Bayesian estimation of security betas”. In: *The Journal of Finance* 28.5, pp. 1233–1239.

Appendix

Appendix A

Solution to task 5.1.3:

	Beta	Alpha	R2	Res. SD	SE Beta	SE Alpha
Adecco	1.5697	-0.0148	0.3431	0.0651	0.3042	0.0093
Credit Suisse	2.0432	-0.0170	0.4220	0.0776	0.3224	0.0107
LafargeHolcim	1.6505	-0.0097	0.4400	0.0604	0.2511	0.0083
Swisscom	0.3286	-0.0022	0.0943	0.0330	0.1373	0.0046

Appendix B

Solution to 5.1.5:

	Adecco	Credit Suisse	LafargeHolcim	Swisscom
Beta t-values	5.160657	6.3374	6.573219	2.393539

Appendix C

Solution to 5.1.6:

	Adecco	Credit Suisse	LafargeHolcim	Swisscom
adjusted Beta	1.379821	1.69547	1.433671	0.5524165

Appendix D

Solution to 5.1.7:

	Adecco	Credit Suisse	LafargeHolcim	Swisscom
Beta 31.03.2016 - 26.02.2021	1.569731	2.043206	1.650507	0.3286247
Beta 02.07.2007 - 31.03.2009	1.041547	1.527396	1.077820	0.5538494
absolute difference	0.5281847	0.5158095	0.5726869	0.2252247

Appendix E

Solution to 5.2.1

Company:	$\hat{a}$	$\hat{b}$	β_t	Forecast β_{t+1}
Credit Suisse:	0.059	0.966	2.021	2.013
Adecco:	0.022	0.981	1.481	1.476
Lafarge Holcim:	0.087	0.937	1.626	1.611
Swisscom:	0.010	0.970	0.332	0.332

Appendix F

Solution to 5.3.1:

Portfolio:	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4	Portfolio 5
Mean return:	0.000271	0.000347	0.000409	0.000577	0.000387
Mean SD:	0.009588	0.012685	0.014548	0.0162	0.019718

Appendix G

Solution to 5.3.2: