**IF-434 Financial Modelling**

**HW-2**

**Security Analysis**

I conduct my security analysis based on the stock in BIST-100 index. I, arbitrarily choose five different securities which are

* Alcatel
* Borusan
* Eczacibasi
* Koc
* Turkcell

The analysis period is from 01.01.2012 to 31.01.2017. Please see the appendix for the summary statistics. As a first step, I calculate the monthly return then I take the average of every single stock and subtract it from monthly return which is the basis of variance-covariance matrix. Based on the this I calculate the variance-covariance matrix. My source is Investing.com which is a global financial portal and internet brand composed of 28 editions in 21 languages.

Average of the returns of the stock are given below:

|  |  |  |
| --- | --- | --- |
|  | **Corporations** | **Returns** |
| 1 | Alcatel | 0,0281 |
| 2 | Borusan | 0,0191 |
| 3 | Eczacibasi | 0,0257 |
| 4 | Koc | 0,0186 |
| 5 | Turkcell | 0,0081 |
|  | BIST-100 | 0,0086 |

I start with the Characteristic Line which is an equation describing the linear dependence of stock’s excess return on changes in the excess returns of the market index (BIST-100 in our case). It is also used to illustrate a stock's alpha (the vertical intercept) and beta (the line's slope) and to show the difference between systematic and unsystematic risk.

As is said, Characteristic Line is an equation and can be defined following way

Ri (t)=αi+βiRm(t)+ei(t)

where intercept αi shows the rate of return over and above the risk-free return adjusted for the relative riskiness of the asset and shows the performance of the technical analyst. βi which is known as slope coefficient of the characteristic line and a measure of the correlated variability of a security or other asset’s price as compared to that of the market as a whole.

It is worth saying something more about beta because it is by far the most important element of the regression. If beta takes the value of 1 indicates that the security's price moves exactly the same with the market. A beta of less than 1 means that the security is less volatile than the market. A beta of greater than 1 indicates that the security's price is theoretically more volatile than the market.

Finally, R2 is the measure of how responsive is the dependent variable to the changes in the independent variables or put it differently it is a measure of how much of the variance in y is explained by the model. This measure should be treated with caution because it increases as new independent variable enters into the equation. So, adjusted R2 is more robust in this sense and this ranges from 0,74 (Turkcell) to 0,078 (Alcatel). Its magnitude shows something but not everything.

I run the above-given regression in excel and the results are given below in detail.

**Results of the Characteristic Line**

As a general remark, all estimated beta coefficients are statistically significant at 1% level. On the contrary, intercept term is statistically insignificant except for the stock of Koc. Intercept terms are all positive (except Turkcell) meaning that stock performs well in terms of technical analysis.

**Result for Alcatel**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Coefficients | Standard Error | t Stat | P-value |
| Intercept | 0,019901024 | 0,022862725 | 0,870457222 | 0,387701793 |
| Beta | 0,954006746 | 0,392215624 | 2,432352737 | 0,018164009 |

Beta is 0,95 (less than) which means that Alcatel is less volatile than the market. As for the intercept term, alpha is positive (0,02) telling us that Alcatel security is underpriced.

**Result for Borusan**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Coefficients | Standard Error | t Stat | P-value |
| Intercept | 0,009260749 | 0,011308612 | 0,818911191 | 0,416247831 |
| Beta | 0,715825048 | 0,194002002 | 3,689781753 | 0,000503196 |

Estimated beta (0,715) for Borusan is lower than the one in Alcatel case. It means that it is less responsive than the Alcatel against the market index . Likewise, intercept term is positive but again statistically insignificant. However, beta is statistically significant at 1% level.

**Result for Eczacibasi**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Coefficients | Standard Error | t Stat | P-value |
| Intercept | 0,018172391 | 0,01231122 | 1,476083687 | 0,145424771 |
| Beta | 0,589368583 | 0,211201983 | 2,790544742 | 0,007145113 |

Except for the magnitude of the coefficients, same interpretation works in the Eczacibasi case, too. The slope coefficient (0,59) is the lowest one among the five stock I picked.

**Result for Koc**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Coefficients | Standard Error | t Stat | P-value |
| Intercept | 0,010397013 | 0,004278045 | 2,430318881 | 0,018256388 |
| Beta | 1,228318563 | 0,0733909 | 16,73666026 | 1,15229E-23 |

Koc has the highest beta coefficient (1,22) and interpretation of it is quite different. Estimated beta coefficient in this case shows that Koc is more volatile than the market index. Security Market Line will be steepest one.

**Result for Turkcell**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Coefficients | Standard Error | t Stat | P-value |
| Intercept | -0,001774257 | 0,005505064 | -0,322295466 | 0,74840802 |
| Beta | 0,784486123 | 0,094440719 | 8,306651274 | 2,13205E-11 |

Aside from the negative intercept term, regression result of Turkcell is quite similar to the Borusan in terms of the magnitude of the beta.

**Security Market Line (SML)**

The Security Market Line (SML) is a line on a chart derived from the Markowitz Portfolio Theory. The Security Market Line is a graphical representation of the Capital Asset Pricing Model and it plots levels of risk against the expected return of the entire market at a given point in time.

The formula for the Security Market Line is:

Required Return = Risk Free Rate + ( Beta x [Market Return - Risk Free Rate])

SML, based on the Characteristic Line analysis, is plotted. In this setup, risk free interest rate is assumed to be 0.008 which I extract from Capital Market Line analysis to be detailed later.

Below graph is plotted for Alcatel.

**Capital Market Line (CML)**

The capital market line (CML) represents the rates of return for efficient portfolios subject to the risk level for a market portfolio and the risk-free rate of return which I take as 0,008. The CML extends linearly to a point where the CML is tangent to the efficient frontier. This point is referred to as the market portfolio. The market portfolio includes all risky assets. The market portfolio contains only systematic risk; all non-systematic risk has been diversified away which is the underlying assumption of the Markowitz’s “Portfolio Selection” theorem.

I assigned equal weight to calculate portfolio return and portfolio variance. Again to save space, I left the tedious calculation to the related excel sheet titled “CML”. According to the procedure, I described I found the portfolio return as 0,0199 and portfolio variance as 0,0025.

So, the line representing CML is basically the market portfolio consists of the combination of all risky assets and the risk-free asset. The intercept term represents the risk free rate of return and portfolio standard deviation amounts to the risk. Slope of the CML gives the celebrated Sharpe ratio.

**Optimum Portfolio**

To begin with, I assign equal weight to every stock and get the weighted return. Then with the help of portfolio return and variance-covariance matrix, then I find out the portfolio variance and corresponding standard deviation. Lastly, I compute the Sharpe ratio to find to run the optimization. Optimization based on the maximizing the Sharpe ratio and weights are defined as changing variables and the sum of weight is the constraint of the optimization problem. Please see the excel sheet named “Stocks and Optimal Portfolio”. According to the above given procedure, corresponding weights (optimum portfolio) are given in the below table:

|  |  |  |
| --- | --- | --- |
|  | Restricted to Positive Coefficients | Negative Coefficient allowed |
| **walcatel** | 0,0000 | -0,0190 |
| **wborusan** | 0,1828 | 0,2073 |
| **Weczacibasi** | 0,3786 | 0,3917 |
| **wkoc** | 0,4386 | 0,4879 |
| **Wturkcell** | 0,0000 | -0,0679 |

**Fixed Income Securities**

Securities that I select for fixed income analysis are:, AT&T, Morgan Stanley, Hyatt, Korea National Oil, Citigroup, Actavis, JP Morgan, Caterpillar, Apple, Sprint. I extract the data from <https://finra-markets.morningstar.com/BondCenter/Results.jsp>. Finra is a not-for-profit organization authorized by Congress to protect America’s investors by making sure the broker-dealer industry operates fairly and honestly.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **AT&T** | **Morgan Stanley** | **Hyatt** | **Korea National Oil** | **Citigroup** |
| **Annual Coupon** | 0,0630 | 0,05 | 0,03375 | 0,0275 | 0,03875 |
| **Face Value ($)** | 1000 | 1000 | 1000 | 1000 | 1000 |
| **Date offered** | May-17 | May-17 | Jul-17 | Jan-17 | Mar-17 |
| **Maturity Date** | May-28 | May-27 | Jul-23 | Jan-19 | Mar-25 |
| **Price ($)** | 114,64 | 108,21 | 100,759 | 100,927 | 100,37 |
| **Yield** | 0,055 | 0,03862 | 0,03234 | 0,02196 | 0,0382 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Actavis** | **JP Morgan** | **Caterpillar** | **Apple** | **Sprint** |
| **Annual Coupon** | 0,0245 | 0,0295 | 0,034 | 0,024 | 0,06 |
| **Face Value ($)** | 1000 | 1000 | 1000 | 1000 | 1000 |
| **Date offered** | Jun-17 | Oct-17 | May-17 | Aug-17 | Nov-17 |
| **Maturity Date** | Jun-19 | Oct-26 | May-24 | Aug-26 | Nov-22 |
| **Price ($)** | 100,71 | 96,01 | 103,639 | 95,466 | 104 |
| **Yield** | 0,0214 | 0,0345 | 0,02807 | 0,03105 | 0,05159 |

The procedure I embraced to calculate the macaulay and modified duration, price elasticity, and price volatility, I, firstly, find present value of the cash flow as given.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **AT&T** | **Morgan Stanley** | **Hyatt** | **Korea Nat. Oil** | **Citigr.** | **Actavis** | **JP Morgan** | **Caterp.** | **Apple** | **Sprint** |
| **PV of Cash Flow** | 8256,59 | 8107,82 | 5531,08 | 1973,23 | 7029,87 | 1976,08 | 8034,52 | 6346,10 | 8200,80 | 5032,93 |

The following step is to compute macaulay duration, modified duration, price elasticity, and price volatility.

Macaulay Duration isD= PV of CF/Face Value

Modified Duration is D/(1+yield)

Price elasticity with respect to interest rate is defined as:

dP/P dr/(1+r) = -D

Price volatility is defined as:dP/P= -D\*dr/(1+r)

According to these formula, results are presented:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **AT&T** | **Morgan Stanley** | **Hyatt** | **Korea National Oil** | **Citigroup** |
| **Macaulay Duration** | 8,25659696 | 8,107821676 | 5,531080901 | 1,97323601 | 7,029878662 |
| **Modified Duration** | 7,767259605 | 7,721734929 | 5,350501476 | 1,92042434 | 6,767632888 |
| **Price Elasticity (%)** | -7,767259605 | -7,721734929 | -5,350501476 | -1,92042434 | -6,767632888 |
| **Price Volatility** | -0,073069234 | 0,073540333 | 0,051758176 | 0,019204243 | 0,0651517 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Actavis** | **JP Morgan** | **Caterpillar** | **Apple** | **Sprint** |
| **Macaulay Duration** | 1,976085896 | 8,034521731 | 6,346100621 | 8,20080781 | 5,032935269 |
| **Modified Duration** | 1,928829571 | 7,804295028 | 6,137428067 | 8,008601377 | 4,74805214 |
| **Price Elasticity (%)** | -1,928829571 | -7,804295028 | -6,137428067 | -8,008601377 | -4,74805214 |
| **Price Volatility** | 0,018827033 | 0,075806654 | 0,059356171 | 0,078208998 | 0,044792945 |

Price elasticity is based on 1% increase in interest rate. For instance, 1% increase in interest rate lead to 7,76% price decrase in AT&T bond. In fixed income market, it is well known fact that interest rate and price are inversely related.

To form a portfolio from these bonds, I assign equal weight (10%) to duration and yield then I calculate the following variables:

|  |  |
| --- | --- |
|  | **Portfolio** |
| **Macaulay Duration** | 4,670699998 |
| **Modified Duration** | 4,511563615 |
| **Price Elasticity (%)** | -4,511563615 |
| **Price Volatility** | 0,043578492 |

Necessary details can be found in the excel sheet titled “Portfolio”.

**Immunization**

As the name suggests, immunization process is to use to immune the portfolio holder from the impact of any possible change in interest rate. Immunization is a technique that makes the bond portfolio holder to be relatively stream of cash flows.

I work with four different liabilities whose total value is 8.000.000$ with different maturities. In order to manage these liabilities, it is common application to fix the maturity of the assets and liabilities. Immunization basically depends on this fact.

I run an optimization by “solver” command in excel and find the corresponding weights. Details can be found in the excel sheet “immunization”.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Face Value ($)** | **Maturity** | **PV** | **Yield** | **Mduration** |
| 1.000.000 | 01/01/2018 | 970873,7864 | 0,03 | 0,970873786 |
| 2.500.000 | 01/01/2022 | 2209635,719 | 0,025 | 4,87804878 |
| 750.000 | 01/01/2027 | 506673,1266 | 0,04 | 9,615384615 |
| 3.750.000 | 01/01/2029 | 1863635,113 | 0,06 | 11,32075472 |
|  |  | **5550817,75** |  | **6,696265475** |

**Corresponding weights for the assets are:**

|  |  |
| --- | --- |
| **Corporations** | **Weights** |
| **AT&T** | 0,255751592 |
| **Morgan Stanley** | 0,100719261 |
| **Hyatt** | 0,08170288 |
| **Korea National Oil** | 0,048970503 |
| **Citigroup** | 0,090438073 |
| **Actavis** | 0,052570183 |
| **JP Morgan** | 0,103883572 |
| **Caterpillar** | 0,087262594 |
| **Apple** | 0,104379438 |
| **Sprint** | 0,074321904 |

**Appendix-A**

**Stock Data**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Date** | **Alcatel** | **Borusan** | **Eczacibasi** | **Koc** | **Turkcell** | **BIST-100** |
| Jan-17 | 7,44 | 9,38 | 9,17 | 14,88 | 11,34 | 86.295,72 |
| Dec-16 | 6,78 | 8,03 | 8,88 | 13,52 | 9,75 | 78.139 |
| Nov-16 | 6,30 | 7,75 | 8,55 | 12,20 | 9,03 | 73.995,20 |
| Oct-16 | 7,81 | 8,43 | 8,41 | 12,64 | 9,97 | 78.536,17 |
| Sep-16 | 7,58 | 8,96 | 7,93 | 12,63 | 9,71 | 76.488,38 |
| Aug-16 | 7,06 | 8,97 | 7,86 | 12,58 | 9,93 | 75.967,63 |
| Jul-16 | 5,12 | 7,49 | 7,55 | 12,54 | 10,36 | 75.405,53 |
| Jun-16 | 5,55 | 7,38 | 8,23 | 12,85 | 10,57 | 76.817,19 |
| May-16 | 6,01 | 7,43 | 8,03 | 12,84 | 10,76 | 77.803,41 |
| Apr-16 | 6,27 | 6,86 | 8,40 | 14,33 | 12,10 | 85.327,80 |
| Mar-16 | 6,72 | 6,4 | 7,70 | 13,73 | 11,85 | 83.268,04 |
| Feb-16 | 6,32 | 6,66 | 7,80 | 12,42 | 11,08 | 75.814,41 |
| Jan-16 | 5,53 | 6,14 | 7,43 | 11,34 | 10,52 | 73.481,09 |
| Dec-15 | 6,37 | 5,74 | 6,68 | 10,49 | 9,90 | 71.726,99 |
| Nov-15 | 7,73 | 5,82 | 6,12 | 11,51 | 11,10 | 75.232,79 |
| Oct-15 | 7,40 | 6,15 | 5,94 | 12,67 | 11,60 | 79.409,00 |
| Sep-15 | 7,65 | 5,92 | 5,82 | 11,32 | 10,55 | 74.205,47 |
| Aug-15 | 7,85 | 5,81 | 5,76 | 10,89 | 11,40 | 75.210,37 |
| Jul-15 | 7,82 | 6,09 | 5,90 | 11,80 | 12,70 | 79.909,68 |
| Jun-15 | 7,97 | 6,25 | 6,04 | 11,90 | 12,35 | 82.249,53 |
| May-15 | 9,26 | 6,45 | 6,51 | 11,42 | 11,60 | 82.981,15 |
| Apr-15 | 5,57 | 6,87 | 6,90 | 12,14 | 11,90 | 83.947,04 |
| Mar-15 | 3,03 | 6,74 | 5,00 | 11,19 | 11,59 | 80.846,03 |
| Feb-15 | 3,90 | 6,88 | 5,39 | 11,05 | 11,42 | 84.147,51 |
| Jan-15 | 3,34 | 6,88 | 5,14 | 12,04 | 12,24 | 88.945,82 |
| Dec-14 | 2,67 | 7,09 | 3,83 | 11,71 | 12,42 | 85.721,13 |
| Nov-14 | 2,62 | 7,07 | 3,96 | 11,81 | 12,20 | 86.168,66 |
| Oct-14 | 2,44 | 6,89 | 3,70 | 10,72 | 11,20 | 80.579,66 |
| Sep-14 | 2,37 | 6,18 | 3,77 | 9,92 | 10,33 | 74.937,81 |
| Aug-14 | 2,63 | 6,34 | 3,37 | 10,44 | 10,98 | 80.312,94 |
| Jul-14 | 2,74 | 6,59 | 3,17 | 10,63 | 12,16 | 82.156,87 |
| Jun-14 | 2,63 | 6,33 | 3,16 | 9,82 | 11,51 | 78.489,01 |
| May-14 | 2,67 | 6,57 | 3,11 | 9,78 | 11,42 | 79.289,80 |
| Apr-14 | 2,72 | 6,48 | 3,14 | 8,91 | 10,68 | 73.871,54 |
| Mar-14 | 2,36 | 5,3 | 2,97 | 8,38 | 10,38 | 69.736,34 |
| Feb-14 | 2,51 | 5,2 | 3,00 | 7,60 | 10,00 | 62.553,32 |
| Jan-14 | 2,28 | 4,57 | 2,90 | 7,11 | 9,67 | 61.858,21 |
| Dec-13 | 2,36 | 4,48 | 3,07 | 8,17 | 9,86 | 67.801,73 |
| Nov-13 | 3,18 | 5,79 | 3,61 | 8,86 | 10,64 | 75.748,27 |
| Oct-13 | 3,45 | 6,22 | 3,79 | 9,10 | 10,77 | 77.620,37 |
| Sep-13 | 3,29 | 6,2 | 3,61 | 8,65 | 10,33 | 74.486,56 |
| Aug-13 | 3,01 | 4,94 | 3,41 | 7,65 | 9,29 | 66.394,41 |
| Jul-13 | 3,54 | 6,07 | 3,58 | 7,93 | 9,81 | 73.377,45 |
| Jun-13 | 3,58 | 5,41 | 3,48 | 8,60 | 9,73 | 76.294,51 |
| May-13 | 4,25 | 6,51 | 3,97 | 9,89 | 10,03 | 85.990,01 |
| Apr-13 | 5,14 | 6,24 | 4,04 | 10,07 | 9,64 | 86.046,04 |
| Mar-13 | 5,32 | 6,46 | 4,35 | 9,58 | 10,55 | 85.898,99 |
| Feb-13 | 5,14 | 6,66 | 3,94 | 8,63 | 10,38 | 79.333,67 |
| Jan-13 | 4,06 | 5,16 | 3,61 | 8,38 | 9,51 | 78.783,47 |
| Dec-12 | 3,73 | 5,03 | 3,65 | 8,45 | 10,03 | 78.208,44 |
| Nov-12 | 3,64 | 4,76 | 3,67 | 7,46 | 9,33 | 73.058,51 |
| Oct-12 | 3,88 | 4,92 | 3,39 | 7,68 | 9,51 | 72.528,97 |
| Sep-12 | 3,94 | 5,01 | 3,35 | 6,55 | 9,51 | 66.396,71 |
| Aug-12 | 4,00 | 5,29 | 3,59 | 6,75 | 9,38 | 67.367,95 |
| Jul-12 | 3,67 | 5,16 | 3,86 | 6,39 | 8,73 | 64.259,54 |
| Jun-12 | 3,88 | 5,12 | 3,94 | 6,29 | 7,95 | 62.543,49 |
| May-12 | 3,37 | 4,94 | 3,30 | 5,07 | 7,07 | 55.099,33 |
| Apr-12 | 3,88 | 5,46 | 3,97 | 5,67 | 7,62 | 60.010,42 |
| Mar-12 | 3,28 | 4,53 | 3,14 | 6,17 | 7,92 | 62.423,04 |
| Feb-12 | 3,13 | 4,5 | 2,68 | 6,21 | 8,34 | 60.721,23 |
| Jan-12 | 3,07 | 3,93 | 2,59 | 5,90 | 7,92 | 57.171,34 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Optimal Portfolio** | | | | |
| **Risk free rate** | 0,008 |  |  |  |
|  | **weights** |  |  | **weights** |
| Alcatel | 0,0000 |  | Alcatel | -0,0190 |
| Borusan | 0,1828 |  | Borusan | 0,2073 |
| Eczacibasi | 0,3786 |  | Eczacibasi | 0,3917 |
| Koc | 0,4386 |  | Koc | 0,4879 |
| Turkcell | 0,0000 |  | Turkcell | -0,0679 |
| sum | 1,0000 |  | sum | 1,0000 |
| E[r] | 0,021357117 |  | E[r] | 0,02199467 |
| port std dev | 0,004509166 |  | port std dev | 0,00470529 |
| sharpe | **2,962214584** |  | sharpe | **2,974241907** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variance-Covariance matrix** | | | | | |
|
|  | **Alcatel** | **Borusan** | **Eczacibasi** | **Koc** | **Turkcell** |
| **Alcatel** | 0,0324 | 0,006304228 | 0,009462543 | 0,003030158 | 0,002081575 |
| **Borusan** | 0,0063 | 0,009253926 | 0,003349146 | 0,002652897 | 0,002809758 |
| **Eczacibasi** | 0,0095 | 0,003349146 | 0,009653861 | 0,002223794 | 0,000777839 |
| **Koc** | 0,0030 | 0,002652897 | 0,002223794 | 0,006179223 | 0,00368783 |
| **Turkcell** | 0,0021 | 0,002809758 | 0,000777839 | 0,00368783 | 0,004161035 |

**Appendix-B**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Alcatel** | **Borusan** | **Eczacibasi** | **Koc** | **Turkcell** | **BIST-100** |
| **Mean** | 4,636229508 | 6,211147541 | 4,964098361 | 9,964754098 | 10,36262295 | 75399,8418 |
| **Standard Error** | 0,247476351 | 0,147808785 | 0,252922414 | 0,312854704 | 0,163624237 | 1031,062401 |
| **Standard Dev.** | 1,932852093 | 1,154423519 | 1,9753872 | 2,443473352 | 1,277946141 | 8052,854779 |
| **Sample Variance** | 3,735917213 | 1,332693661 | 3,90215459 | 5,970562022 | 1,633146339 | 64848470,1 |
| **Range** | 6,98 | 5,45 | 6,58 | 9,81 | 5,63 | 33846,49 |
| **Minimum** | 2,28 | 3,93 | 2,59 | 5,07 | 7,07 | 55099,33 |
| **Maximum** | 9,26 | 9,38 | 9,17 | 14,88 | 12,7 | 88945,82 |
| **Sum** | 282,81 | 378,88 | 302,81 | 607,85 | 632,12 | 4599390,35 |
| **Count** | 61 | 61 | 61 | 61 | 61 | 61 |

**Summary Statistics**