Problem Set 5

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**Part 1: Business Cycle Variation**

1. The table below displays the average returns on RMRF, SMB, HML, and UMD during recessions only. Here we ran regression of the portfolio returns on the indicator function. The average return during the recession is .

* The results tell me that, during the recessions, the market portfolio on average generated a negative return, but SML, HML and UMD portfolios on average generated positive returns.
* According to their ’s t-stats, only the market portfolio shows a significantly comove with the business cycle. However, the SML, HML and UMD portfolios show no significant sensitivity to the business cycle. I believe this insignificance can be the proof that SML, HML and UMD are the risk factors that unrelated to the market risk, but they may relate to other risks.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Portfolio | RMRF | SMB | HML | UMD |
| Intercept | 0.9045  (5.03) | 0.2484  (2.30) | 0.4436  (3.77) | 0.7589  (4.76) |
|  | -1.3806  **(-3.29)** | -0.1944  (-0.77) | -0.2444  (-0.89) | -0.5311  (-1.42) |
| Average return during recessions (%) | -0.0476 | 0.0540 | 0.1992 | 0.2278 |

1. The table below displays the average returns on the smallest growth stocks, smallest value stocks, largest growth stocks, and largest value stocks during the recessions only. On average, the large firms and the value stocks had better performance during recessions. The t-stats indicate that the smallest value stocks and the largest growth stocks have significant cyclical relationships.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Portfolio | Smallest Growth | Smallest Value | Largest Growth | Largest Value |
| Intercept | 0.8358  (2.03) | 1.7438  (5.59) | 0.8346  (4.65) | 1.1937  (4.15) |
|  | -1.4835  (-1.54) | -2.0686  **(-2.84)** | -1.2184  **(-2.91)** | -1.2727  (-1.89) |
| Average return during recessions (%) | -0.6477 | -0.3248 | -0.3838 | -0.0790 |

The table below displays the average returns on the smallest losers, smallest winners, largest losers, and largest winners during recessions only. On average, the small firms and the winners had better performance during recessions. The t-stats indicate that both the smallest and the largest winners have significant cyclical relationships.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Portfolio | Smallest Losers | Smallest Winners | Largest Losers | Largest Winners |
| Intercept | 0.8289  (2.28) | 1.9635  (6.63) | 0.5424  (1.90) | 1.2395  (6.38) |
|  | -1.1037  (-1.29) | -1.9742  **(-2.85)** | -1.2893  (-1.92) | -1.6632  **(-3.66)** |
| Average return during recessions (%) | -0.2748 | -0.0107 | -0.7469 | -0.4237 |

**Part 2: Characteristics vs. Covariances**

* **25 Size and BE/ME portfolios**

1. 1. The table below displays the 25 betas for the market portfolio, the SMB portfolio and the HML portfolio.

|  |  |  |  |
| --- | --- | --- | --- |
| Portfolio |  |  |  |
| 1 | 1.29 | 1.43 | 0.43 |
| 2 | 1.08 | 1.53 | 0.23 |
| 3 | 1.05 | 1.24 | 0.52 |
| 4 | 0.94 | 1.22 | 0.58 |
| 5 | 0.98 | 1.30 | 0.92 |
| 6 | 1.08 | 1.12 | -0.22 |
| 7 | 1.02 | 0.97 | 0.14 |
| 8 | 0.98 | 0.83 | 0.35 |
| 9 | 0.97 | 0.81 | 0.57 |
| 10 | 1.06 | 0.91 | 0.89 |
| 11 | 1.12 | 0.81 | -0.23 |
| 12 | 1.02 | 0.51 | 0.05 |
| 13 | 0.99 | 0.44 | 0.31 |
| 14 | 0.98 | 0.46 | 0.55 |
| 15 | 1.12 | 0.59 | 0.88 |
| 16 | 1.08 | 0.33 | -0.35 |
| 17 | 1.02 | 0.23 | 0.09 |
| 18 | 1.02 | 0.20 | 0.35 |
| 19 | 1.02 | 0.19 | 0.57 |
| 20 | 1.21 | 0.29 | 0.94 |
| 21 | 1.02 | -0.15 | -0.26 |
| 22 | 0.98 | -0.20 | 0.02 |
| 23 | 0.96 | -0.25 | 0.34 |
| 24 | 1.04 | -0.19 | 0.65 |
| 25 | 1.18 | -0.15 | 1.02 |

2. Applying the betas above to cross-sectional regressions, we obtained 1085 , , , , and .

3. The table below displays the average estimates of ,,,, and for 3 equations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Equation 1 |  |  |  |  |
| Estimates | 1.9633 | -0.6293 | -0.0460 | 0.2273 |
| Standard error | 0.41 | 0.45 | 0.03 | 0.06 |
| t-stat | 4.77 | -1.41 | -1.39 | **3.81** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Equation 2 |  |  |  |  |
| Estimates | 2.0548 | -1.0604 | 0.1222 | 0.4157 |
| Standard error | 0.40 | 0.42 | 0.10 | 0.11 |
| t-stat | 5.14 | -2.54 | 1.17 | **3.78** |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Equation 3 |  |  |  |  |  |  |
| Estimates | 1.8122 | 0.0407 | -0.0976 | 0.4671 | -0.1387 | -0.3941 |
| Standard error | 0.39 | 0.38 | 0.05 | 0.11 | 0.20 | 0.23 |
| t-stat | 4.70 | 0.11 | **-1.96** | **4.16** | -0.71 | -1.74 |

1. From the results of the equation 1 and 2, we can find the characteristic BE/ME and the covariance HML have a significant explanatory power on the 25 portfolios’ returns. However, based on the results of the equation (3), we can see that characteristics have a stronger explanatory power than the covariances. The argument is that the t-stat of and are significant while the t-stats of other variables are not.

Yet, one may argue that we cannot determine whether characteristics have better explanatory power than that of covariance, given true values. SMB and HML are proxies for size and book-to-market ratio respectively; however, they do not perfectly explain characteristics. First, our estimation of and in the time-series regression may contain noise. Second, this noise contained in , when fed into the cross-section regression, may result in the insignificant t-stats of and . Yet, since this proxy is all that we can observe and we cannot observe the true value of the beta’s, it is possible that we cannot say which better captures returns. Maybe both of them do capture the returns, but the noise embedded in the covariances weakens their explanatory power.

1. 1. The table below displays the 25 betas for the market portfolio, the SMB portfolio and the HML portfolio.

|  |  |  |  |
| --- | --- | --- | --- |
| Portfolio |  |  |  |
| 1 | 1.10 | 1.36 | -0.28 |
| 2 | 0.97 | 1.31 | 0.05 |
| 3 | 0.93 | 1.08 | 0.30 |
| 4 | 0.88 | 1.06 | 0.44 |
| 5 | 0.95 | 1.07 | 0.68 |
| 6 | 1.13 | 0.99 | -0.37 |
| 7 | 1.01 | 0.88 | 0.12 |
| 8 | 0.96 | 0.76 | 0.39 |
| 9 | 0.96 | 0.70 | 0.57 |
| 10 | 1.07 | 0.88 | 0.79 |
| 11 | 1.10 | 0.73 | -0.42 |
| 12 | 1.03 | 0.54 | 0.17 |
| 13 | 0.99 | 0.43 | 0.42 |
| 14 | 0.97 | 0.41 | 0.60 |
| 15 | 1.08 | 0.55 | 0.80 |
| 16 | 1.08 | 0.39 | -0.41 |
| 17 | 1.06 | 0.20 | 0.19 |
| 18 | 1.04 | 0.17 | 0.43 |
| 19 | 1.00 | 0.20 | 0.55 |
| 20 | 1.16 | 0.26 | 0.80 |
| 21 | 0.96 | -0.24 | -0.37 |
| 22 | 0.99 | -0.21 | 0.09 |
| 23 | 0.95 | -0.26 | 0.31 |
| 24 | 1.03 | -0.23 | 0.64 |
| 25 | 1.11 | -0.10 | 0.81 |

2. Applying the betas above to cross-sectional regressions, we obtained 1085 ,,,, and .

3. The table below displays the average estimates of ,,,, and for 3 equations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Equation 1 |  |  |  |  |
| Estimates | 1.9635 | -0.5551 | -0.0401 | 0.2340 |
| Standard error | 0.31 | 0.35 | 0.04 | 0.08 |
| t-stat | 6.42 | -1.61 | -1.07 | **3.08** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Equation 2 |  |  |  |  |
| Estimates | 1.6135 | -0.6741 | 0.1688 | 0.4078 |
| Standard error | 0.26 | .0.31 | 0.12 | 0.11 |
| t-stat | 6.23 | -2.16 | 1.36 | **3.59** |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Equation 3 |  |  |  |  |  |  |
| Estimates | 1.8593 | -0.6840 | 0.0242 | 0.4723 | 0.1818 | -0.3265 |
| Standard error | 0.41 | 0.35 | 0.06 | 0.13 | 0.23 | 0.23 |
| t-stat | 4.55 | -1.95 | 0.43 | **3.60** | 0.80 | -1.41 |

The results above further prove that the BE/ME is a characteristic that better capture the variation of returns than the covariances, because the t-stat of is significant at 95% confidence level while other variables are not.

* **25 Size and Momentum portfolios**

1. 1. The table below displays the 25 betas for the market portfolio, the SMB portfolio and the UMD portfolio.

|  |  |  |  |
| --- | --- | --- | --- |
| Portfolio |  |  |  |
| 1 | 1.06 | 1.48 | -0.76 |
| 2 | 1.01 | 1.31 | -0.46 |
| 3 | 0.96 | 1.24 | -0.31 |
| 4 | 1.04 | 1.26 | -0.05 |
| 5 | 1.09 | 1.32 | 0.23 |
| 6 | 1.16 | 1.00 | -0.71 |
| 7 | 1.02 | 0.90 | -0.40 |
| 8 | 0.99 | 0.76 | -0.17 |
| 9 | 1.01 | 0.89 | 0.04 |
| 10 | 1.15 | 1.01 | 0.33 |
| 11 | 1.18 | 0.61 | -0.78 |
| 12 | 1.06 | 0.52 | -0.40 |
| 13 | 1.01 | 0.49 | -0.20 |
| 14 | 0.99 | 0.48 | 0.08 |
| 15 | 1.12 | 0.68 | 0.43 |
| 16 | 1.22 | 0.26 | -0.83 |
| 17 | 1.09 | 0.15 | -0.41 |
| 18 | 1.01 | 0.21 | -0.17 |
| 19 | 1.05 | 0.19 | 0.08 |
| 20 | 1.11 | 0.41 | 0.46 |
| 21 | 1.13 | -0.08 | -0.75 |
| 22 | 0.98 | -0.19 | -0.45 |
| 23 | 0.99 | -0.17 | -0.18 |
| 24 | 1.00 | -0.20 | 0.13 |
| 25 | 1.10 | -0.04 | 0.46 |

2. Applying the betas above to the cross-sectional regressions, we obtained 1085 ,,,,, and.

3. The table below displays the average estimates of ,,,,, and for 3 equations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Equation 1 |  |  |  |  |
| Estimates | 2.4609 | -1.1704 | -0.1036 | 0.0090 |
| Standard error | 0.41 | 0.40 | 0.03 | 0.00 |
| t-stat | 5.99 | -2.94 | **-3.16** | **4.19** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Equation 2 |  |  |  |  |
| Estimates | 1.7784 | -0.6782 | 0.4133 | 0.6843 |
| Standard error | 0.36 | 0.37 | 0.11 | 0.15 |
| t-stat | 5.00 | -1.82 | **3.67** | **4.65** |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Equation 3 |  |  |  |  |  |  |
| Estimates | 2.9000 | -1.0298 | -0.0947 | 0.0096 | 0.0307 | 0.0150 |
| Standard error | 0.49 | 0.40 | 0.05 | 0.00 | 0.20 | 0.22 |
| t-stat | 5.96 | -2.61 | **-2.00** | **3.34** | 0.15 | 0.07 |

1. From the results of the equation 1 and 2, we can find the characteristics and the covariances have a significant explanatory power on the 25 portfolios’ returns. However, based on the results of the equation (3), we can see that characteristics have a stronger explanatory power than the covariances. The argument is that the t-stats of and are significant while the t-stats of and are not.

Yet, one may argue that we cannot determine whether characteristics have better explanatory power than that of covariance, given true values. SMB and HML are proxies for size and book-to-market ratio respectively; however, they do not perfectly explain characteristics. First, our estimation of and in the time-series regression may contain noise. Second, this noise contained in , when fed into the cross-section regression, may result in the insignificant t-stats of and . Yet, since this proxy is all that we can observe and we cannot observe the true value of the beta’s, it is possible that we cannot say which better captures returns. Maybe both of them do capture the returns, but the noise embedded in the covariances weakens their explanatory power.

1. 1. The table below displays the 25 betas for the market portfolio, the SMB portfolio and the UMD portfolio.

|  |  |  |  |
| --- | --- | --- | --- |
| Portfolio |  |  |  |
| 1 | 1.03 | 1.20 | -0.73 |
| 2 | 0.83 | 0.91 | -0.32 |
| 3 | 0.80 | 0.82 | -0.14 |
| 4 | 0.83 | 0.86 | 0.03 |
| 5 | 1.01 | 1.12 | 0.26 |
| 6 | 1.17 | 0.94 | -0.74 |
| 7 | 0.93 | 0.72 | -0.36 |
| 8 | 0.89 | 0.62 | -0.11 |
| 9 | 0.91 | 0.70 | 0.04 |
| 10 | 1.13 | 0.94 | 0.34 |
| 11 | 1.14 | 0.61 | -0.77 |
| 12 | 0.96 | 0.43 | -0.36 |
| 13 | 0.90 | 0.41 | -0.18 |
| 14 | 0.93 | 0.38 | 0.05 |
| 15 | 1.13 | 0.70 | 0.40 |
| 16 | 1.17 | 0.31 | -0.81 |
| 17 | 1.02 | 0.14 | -0.41 |
| 18 | 0.95 | 0.12 | -0.18 |
| 19 | 0.97 | 0.12 | 0.06 |
| 20 | 1.11 | 0.43 | 0.44 |
| 21 | 1.16 | -0.12 | -0.75 |
| 22 | 0.92 | -0.21 | -0.43 |
| 23 | 0.93 | -0.22 | -0.11 |
| 24 | 0.95 | -0.25 | 0.16 |
| 25 | 1.09 | -0.04 | 0.48 |

2. Applying the betas above to the dataset, we obtain 1085 .

3. The table below displays the average estimates of for 3 equations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Equation 1 |  |  |  |  |
| Estimates | 1.8647 | -0.8038 | -0.0425 | 0.0090 |
| Standard error | 0.29 | 0.35 | 0.03 | 0.00 |
| t-stat | 6.35 | -2.33 | -1.30 | **4.79** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Equation 2 |  |  |  |  |
| Estimates | 1.5037 | -0.4181 | 0.2532 | 0.7367 |
| Standard error | 0.26 | 0.30 | 0.13 | 0.17 |
| t-stat | 5.87 | -1.38 | 1.95 | **4.39** |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Equation 3 |  |  |  |  |  |  |
| Estimates | 1.9970 | -0.6907 | -0.0610 | 0.0103 | -0.0857 | -0.0935 |
| Standard error | 0.34 | 0.39 | 0.05 | 0.00 | 0.24 | 0.23 |
| t-stat | 5.95 | -1.76 | -1.14 | **4.73** | -0.35 | -0.41 |

The t-stats results after January, 1963 prove that the momentum characteristic still strongly capture the cross-section variation of returns while the size characteristic turns out not to work really well, but still the covariances do not significantly capture the variation of returns because their t-stats are between -1.96 and 1.96. This result makes me more strongly about my answer to the question in general.