**Final Exam**

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Question 1

Panel A

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | mean | alpha | beta(mkt) | beta(smb) | beta(hml) | beta(umd) | r2 |
| me | 0.2556 | 0.1673 | 0.1705 |  |  |  | 0.0619 |
|  | 1.9777 | 1.3266 | 6.0913 |  |  |  |  |
|  |  | 0.0356 | 0.0250 | 0.9758 | 0.1843 |  | 0.9324 |
|  |  | 1.0360 | 3.1189 | 84.9114 | 15.1562 |  |  |
|  |  | 0.0073 | 0.0314 | 0.9756 | 0.1960 | 0.0314 | 0.9342 |
|  |  | 0.2118 | 3.8884 | 85.9875 | 15.8479 | 3.9388 |  |
| IA | 0.3704 | 0.4473 | -0.1486 |  |  |  | 0.1293 |
|  | 4.7523 | 6.1047 | -9.1367 |  |  |  |  |
|  |  | 0.2829 | -0.0734 | -0.0290 | 0.3935 |  | 0.4915 |
|  |  | 4.9798 | -5.5431 | -1.5260 | 19.5697 |  |  |
|  |  | 0.2375 | -0.0631 | -0.0293 | 0.4122 | 0.0505 | 0.5045 |
|  |  | 4.1400 | -4.7237 | -1.5605 | 20.1466 | 3.8245 |  |
| ROE | 0.5415 | 0.6022 | -0.1173 |  |  |  | 0.0424 |
|  | 5.0401 | 5.6848 | -4.9870 |  |  |  |  |
|  |  | 0.7047 | -0.0890 | -0.3207 | -0.2022 |  | 0.2040 |
|  |  | 7.1917 | -3.8942 | -9.7866 | -5.8294 |  |  |
|  |  | 0.4637 | -0.0343 | -0.3223 | -0.1029 | 0.2682 | 0.3964 |
|  |  | 5.3118 | -1.6848 | -11.2838 | -3.3067 | 13.3465 |  |

Panel B

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | IA | ROE | MKT-RF | SMB | HML | mom |
| ME | -0.1079 | -0.3165 | 0.2489 | 0.9511 | -0.0221 | -0.0008 |
|  | 0.0103 | 0.0000 | 0.0000 | 0.0000 | 0.6006 | 0.9842 |
| IA |  | 0.0585 | -0.3596 | -0.2129 | 0.6756 | 0.0167 |
|  |  | 0.1652 | 0.0000 | 0.0000 | 0.0000 | 0.6914 |
| ROE |  |  | -0.2059 | -0.3822 | -0.1140 | 0.4889 |
|  |  |  | 0.0000 | 0.0000 | 0.0067 | 0.0000 |
| MKT-RF |  |  |  | 0.2674 | -0.2693 | -0.1471 |
|  |  |  |  | 0.0000 | 0.0000 | 0.0005 |
| SMB |  |  |  |  | -0.1915 | -0.0034 |
|  |  |  |  |  | 0.0000 | 0.9357 |
| HML |  |  |  |  |  | -0.1911 |
|  |  |  |  |  |  | 0.0000 |

Question 2

Connect to WRDS using Python package wrds to download all the data sets: Compustat annual data, Compustat quarterly data, CRSP, and linked table.

Create investment-to-assets, I/A, as the annual change in total assets (Compustat annual item AT) divided by 1-year-lagged total assets.

ROE, which is income before extraordinary items (Compustat quarterly item IBQ) divided by 1-quarter-lagged book equity.

Construct the q-factors from a triple 2-by-3-by-3 sort on size, I/A, and ROE.

2. (40 points) Replicate the 4 factors from Hou, Xue and Zhang (2015). Explain the replication procedure step-by-step.

(a) For each of the factors, report the following statistics for both original factor and replicated factors: annualized average returns, annualized volatility, annualized Sharpe ratio, monthly skewness, and monthly kurtosis. The outcome should be similar to Panel A of Table 3 of this exam (see last few pages of this exam).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | mkt-rf |  | ME |  | IA |  | ROE |  |
|  | original | replication | original | replication | original | replication | original | replication |
| Average | 6.71 | 6.89 | 3.17 | 2.57 | 4.14 | 4.41 | 6.4 | 6.56 |
| volatility | 15.72 | 15.95 | 10.43 | 10.6 | 6.01 | 6.75 | 8.64 | 8.79 |
| sharpe ratio | 0.5 | 0.52 | 0.59 | 0.16 | 0.59 | 0.24 | 0.24 | 1.03 |
| skewness | -0.19 | -0.07 | 0.43 | 0.89 | 0.26 | 0.19 | -0.93 | 0.37 |
| kurtosis | 2.28 | 1.63 | 5.77 | 6.54 | 2.19 | 1.48 | 4.99 | 4.8 |

(b) For each of the factors, compute the difference in basis points and report the following statistics: average, standard deviation, minimum and maximum difference, and quartiles. The outcome should be similar to Panel B of Table 3 of this exam (see last few pages of this exam).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| index | mkt-rf | me | ia | roe |
| mean | 15.780 | 32.140 | 40.650 | 42.230 |
| std | 17.820 | 27.710 | 33.120 | 36.530 |
| min | 0.011 | 0.058 | 0.073 | 0.181 |
| 25% | 5.252 | 10.687 | 15.140 | 16.319 |
| 50% | 10.340 | 21.817 | 31.064 | 34.400 |
| 75% | 22.375 | 49.471 | 56.326 | 50.542 |
| max | 182.840 | 236.251 | 205.961 | 210.804 |

(c) For each of the factors, compute the correlation between the original series and the replicated one (report 4 decimal digits). The outcome should be similar to Panel C of Table 3 of this exam (see last few pages of this exam).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Statistic | MKT-RF | ME | IA | ROE |
| Correlation | 0.9713 | 0.9017 | 0.8534 | 0.7108 |

(d) For each of the factors, plot three time series: the original factor, the replicated factor, and the difference. Report the factors in percent (i.e. multiplied by 100) and the difference in basis points. The outcome should be similar to Figures 1, 2, 3, 4, 5, 6, 7, and 8 of this exam (see last few pages of this exam).

Original mkt-rf factor





Question 3.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | mean | alpha | beta(mkt) | beta(smb) | beta(hml) | beta(umd) | r2 |
| me | 0.2359 | 0.1840 | 0.1472 |  |  |  | 0.0704 |
|  | 2.2526 | 1.5442 | 6.1156 |  |  |  |  |
|  |  | 0.0397 | 0.0257 | 1.0860 | 0.1970 |  | 1.0312 |
|  |  | 1.0090 | 2.5668 | 75.4013 | 13.1102 |  |  |
|  |  | 0.0072 | 0.0347 | 1.1131 | 0.2109 | 0.0332 | 1.0977 |
|  |  | 0.2256 | 4.0401 | 93.1245 | 18.6054 | 4.3957 |  |
| IA | 0.3782 | 0.4630 | -0.1780 |  |  |  | 0.1245 |
|  | 4.1583 | 5.0486 | -9.9042 |  |  |  |  |
|  |  | 0.3236 | -0.0831 | -0.0309 | 0.4714 |  | 0.3996 |
|  |  | 4.3673 | -6.2970 | -1.4223 | 23.1314 |  |  |
|  |  | 0.2073 | -0.0741 | -0.0299 | 0.4279 | 0.0466 | 0.5075 |
|  |  | 3.5479 | -4.6481 | -1.2889 | 20.7107 | 3.5682 |  |
| ROE | 0.4343 | 0.5799 | -0.1400 |  |  |  | 0.0366 |
|  | 5.0106 | 5.4404 | -4.9122 |  |  |  |  |
|  |  | 0.7033 | -0.0968 | -0.3031 | -0.2034 |  | 0.2191 |
|  |  | 6.2424 | -3.2556 | -11.5481 | -5.9635 |  |  |
|  |  | 0.4215 | -0.0327 | -0.3072 | -0.0946 | 0.2242 | 0.4261 |
|  |  | 5.4765 | -1.4254 | -10.7084 | -3.2273 | 10.9041 |  |

Panel B

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | IA | ROE | MKT-RF | SMB | HML | mom |
| ME | -0.0914 | -0.3703 | 0.2192 | 0.9644 | -0.0244 | -0.0008 |
|  | 0.0109 | 0.0000 | 0.0000 | 0.0000 | 0.6841 | 0.9025 |
| IA |  | 0.0529 | -0.4283 | -0.2188 | 0.7573 | 0.0186 |
|  |  | 0.1631 | 0.0000 | 0.0000 | 0.0000 | 0.5808 |
| ROE |  |  | -0.1904 | -0.3241 | -0.1020 | 0.5099 |
|  |  |  | 0.0000 | 0.0000 | 0.0060 | 0.0000 |
| MKT-RF |  |  |  | 0.2476 | -0.3189 | -0.1635 |
|  |  |  |  | 0.0000 | 0.0000 | 0.0004 |
| SMB |  |  |  |  | -0.1739 | -0.0040 |
|  |  |  |  |  | 0.0000 | 0.8384 |
| HML |  |  |  |  |  | -0.2089 |
|  |  |  |  |  |  | 0.0000 |
|  |  |  |  |  |  |  |

Question 4

Question 5

We can do robost test by using different market or different time period, such as international market, or other product market: FX futures and so on.

Pros: