**Appendix: A1-A8**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **BDO** | **MEG** | **SCC** | **SM** | **URC** |
| **N** | 2724 | 2724 | 2634 | 2725 | 2723 |
| **Mean** | 0.00044 | 0.00034 | 0.00131 | 0.00061 | 0.00076 |
| **Standard deviation** | 0.01906 | 0.02492 | 0.02320 | 0.01960 | 0.02107 |
| **Variance** | 0.00036 | 0.00062 | 0.00054 | 0.00038 | 0.00044 |
| **Skewness** | -1.17477 | 0.74534 | 0.25599 | 0.00697 | -0.40190 |
| **Kurtosis** | 19.35120 | 18.50253 | 11.27655 | 5.07377 | 5.05258 |
| **Coefficient of variation** | 4352.52523 | 7327.58745 | 1777.21092 | 3213.39467 | 2769.33863 |

**Table A1:** Descriptive statistics.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **BDO** | **MEG** | **SCC** | **SM** | **URC** |
| Kolmogorov-Smirnov statistic | 0.08338 | 0.13400 | 0.12389 | 0.09031 | 0.08599 |
| (<0.0100) | (<0.0100) | (<0.0100) | (<0.0100) | (<0.0100) |
| Cramer von Mises statistic | 9.06065 | 19.44639 | 19.33211 | 9.45629 | 7.83059 |
| (<0.0050) | (<0.0050) | (<0.0050) | (<0.0050) | (<0.0050) |
| Anderson-Darling statistic | 46.50919 | 100.1461 | 99.72343 | 49.80998 | 38.73516 |
| (<0.0050) | (<0.0050) | (<0.0050) | (<0.0050) | (<0.0050) |

**Table A2:** Test for normality.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Parameter** | **Estimate** | **Standard Error** |
| **BDO** | ϕ1 | -0.045100\*\* | 0.019300 |
| ϕ1 | 0.043300\*\* | 0.020400 |
|  | α0 | 0.000008\*\*\* | 0.000001 |
| α1 | 0.130600\*\*\* | 0.007345 |
| β1 | 0.856200\*\*\* | 0.007990 |
| **MEG** | ϕ1 | -0.075900\*\*\* | 0.017500 |
| ϕ2 | -0.020100 | 0.013500 |
| ϕ3 | 0.037300\*\*\* | 0.012100 |
| α0 | 0.000556\*\*\* | 0.000014 |
| α1 | 0.303500\*\*\* | 0.026300 |
| **SCC** | α0 | 0.000006\*\*\* | 0.000001 |
| α1 | 0.120400\*\*\* | 0.006125 |
| β1 | 0.882700\*\*\* | 0.004542 |
|  | | |
| **SM** | ϕ1 | 0.032300\*\* | 0.014900 |
| ϕ2 | -0.016000 | 0.009772 |
| α0 | 0.000267\*\*\* | 0.000005 |
| α1 | 0.350800\*\*\* | 0.023700 |
|  | | |
| **URC** | ϕ1 | 0.043600\*\* | 0.022000 |
| ϕ2 | 0.019200 | 0.020400 |
| ϕ3 | 0.051000\*\* | 0.020100 |
| α0 | 0.000064\*\*\* | 0.000006 |
| α1 | 0.223000\*\*\* | 0.018200 |
| β1 | 0.648300\*\*\* | 0.024000 |
|  |  |  |
| **\*\*\*Significant at α=0.01**  **\*\*Significant at α=0.05.** | | | |
|  | | | |

**Table A3:** ARMA-GARCH model parameters and statistics.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **BDO** | | **MEG** | | | | **SCC** | | |
| **Shape parameter** | **Left-tail**  **u=0.715** | **Right-tail**  **u=0.895** | **Left-tail**  **u=0.812** | | **Right-tail**  **u=1.11** | | **Left-tail**  **u=0.699** | | **Right-tail**  **u=0.829** |
| 0.2131 | 0.1782 | 0.0791 | | 0.2907 | | 0.0931 | | 0.0620 |
| **Standard Error** | 0.0572 | 0.0740 | 0.0840 | | 0.0704 | | 0.0711 | | 0.0630 |
| **Scale parameter** | 0.6290 | 0.5835 | 0.3562 | | 0.5511 | | 0.5730 | | 0.6684 |
| **Standard error** | 0.0661 | 0.0589 | 0.0529 | | 0.0701 | | 0.0690 | | 0.0607 |
|  | | | SM | | | URC | | | |
|  | | | **Left-tail**  **u=0.701** | **Right-tail**  **u=0.889** | | **Left-tail**  **u=0.521** | | **Right-tail**  **u=0.846** | |
| **Shape parameter** | | | 0.2420 | 0.1955 | | 0.1067 | | 0.1113 | |
| **Standard Error** | | | 0.0593 | 0.0642 | | 0.0525 | | 0.06770 | |
| **Scale parameter** | | | 0.3056 | 0.65210 | | 0.7353 | | 0.6510 | |
| **Standard error** | | | 0.0597 | 0.0560 | | 0.0576 | | 0.0639 | |

**Table A4:** GPD model parameters and statistics.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Probability** | | **VaR** | **CVaR** | **VaR** | **VaR** |
| **(EVT)** | **(EVT)** | **(Normal)** | **(Empirical)** |
|
| **BDO** | Left-tail distribution |  |  |  |  |
| 0.95 | 5.9477 | 8.1641 | 3.2243 | 2.9572 |
| 0.975 | 7.2505 | 9.8197 | 3.8499 | 3.9513 |
| 0.99 | 9.2962 | 12.4194 | 4.5771 | 5.0169 |
| 0.995 | 11.132 | 14.7523 | 5.0724 | 5.9024 |
| 0.999 | 16.6014 | 21.703 | 6.0937 | 15.3778 |
| Right-tail distribution |  |  |  |  |
| 0.95 | 4.7801 | 6.3326 | 3.3071 | 3.2635 |
| 0.975 | 5.7213 | 7.4779 | 3.9326 | 4.1566 |
| 0.99 | 7.1582 | 9.2263 | 4.6599 | 5.5031 |
| 0.995 | 8.4121 | 10.7521 | 5.1552 | 6.6554 |
| 0.999 | 11.9966 | 15.1139 | 6.1765 | 10.5396 |
| **MEG** | Left-tail distribution |  |  |  |  |
| 0.95 | 4.809 | 5.5392 | 4.6768 | 4.2328 |
| 0.975 | 5.2881 | 6.0594 | 5.5778 | 5.5556 |
| 0.99 | 5.9631 | 6.7923 | 6.6253 | 5.8947 |
| 0.995 | 6.5072 | 7.3831 | 7.3387 | 6.88 |
| 0.999 | 7.8917 | 8.8867 | 8.8096 | 9.51 |
| Right-tail distribution |  |  |  |  |
| 0.95 | 6.5189 | 9.5127 | 4.7301 | 4.6311 |
| 0.975 | 8.1496 | 11.8117 | 5.6311 | 6.1207 |
| 0.99 | 10.8768 | 15.6566 | 6.6785 | 9.9594 |
| 0.995 | 13.4803 | 19.3271 | 7.3919 | 12.6812 |
| 0.999 | 21.9911 | 31.326 | 8.8628 | 18.4978 |
| **SCC** | Left-tail distribution |  |  |  |  |
| 0.95 | 4.1304 | 5.1145 | 3.8349 | 3.0713 |
| 0.975 | 4.7694 | 5.8191 | 4.5948 | 3.9683 |
| 0.99 | 5.68 | 6.8232 | 5.4781 | 6.3416 |
| 0.995 | 6.4223 | 7.6417 | 6.0797 | 6.8498 |
| 0.999 | 8.3423 | 9.7588 | 7.3201 | 8.6813 |
| Right-tail distribution |  |  |  |  |
| 0.95 | 5.2131 | 6.2155 | 4.098 | 3.8111 |
| 0.975 | 5.879 | 6.9254 | 4.8579 | 5.3812 |
| 0.99 | 6.8044 | 7.9119 | 5.7412 | 6.8603 |
| 0.995 | 7.5402 | 8.6963 | 6.3428 | 8.1111 |
| 0.999 | 9.3756 | 10.6531 | 7.5832 | 10.9964 |
| **SM** | Left-tail distribution |  |  |  |  |
| 0.95 | 3.7631 | 5.1438 | 3.2547 | 3.1397 |
| 0.975 | 4.5529 | 6.1858 | 3.8889 | 4.1667 |
| 0.99 | 5.8226 | 7.8609 | 4.6262 | 5.504 |
| 0.995 | 6.9886 | 9.3992 | 5.1284 | 6.9523 |
| 0.999 | 10.5843 | 14.1428 | 6.1637 | 9.9208 |
| Right-tail distribution |  |  |  |  |
| 0.95 | 4.4558 | 6.1332 | 3.367 | 3.3557 |
| 0.975 | 5.4575 | 7.3783 | 4.0012 | 4.4226 |
| 0.99 | 7.0081 | 9.3057 | 4.7385 | 5.8843 |
| 0.995 | 8.3802 | 11.0112 | 5.2407 | 7.1452 |
| 0.999 | 12.3837 | 15.9875 | 6.276 | 11.5321 |
| **URC** | Left-tail distribution |  |  |  |  |
| 0.95 | 5.6601 | 7.0971 | 3.4069 | 3.1746 |
| 0.975 | 6.5836 | 8.1308 | 4.0749 | 4.0964 |
| 0.99 | 7.914 | 9.6202 | 4.8514 | 5.7143 |
| 0.995 | 9.0105 | 10.8477 | 5.3804 | 7.1543 |
| 0.999 | 11.8922 | 14.0735 | 6.4709 | 10.3048 |
| Right-tail distribution |  |  |  |  |
| 0.95 | 4.2739 | 5.4358 | 3.5675 | 3.5942 |
| 0.975 | 5.018 | 6.273 | 4.2355 | 4.5455 |
| 0.99 | 6.0939 | 7.4837 | 5.0121 | 5.8632 |
| 0.995 | 6.9839 | 8.4851 | 5.541 | 7.2727 |
| 0.999 | 9.3354 | 11.1312 | 6.6315 | 9.589 |

**Table A5:** VaR and CVaR under EVT and VaR under normal distribution assumption and empirical results.

|  |  |  |  |
| --- | --- | --- | --- |
| ***M*-year return level (%)** | **Left tail** |  | **Right tail** |
|  |  | **BDO** |  |
| 1-year | 8.54 |  | 8.27 |
| 5-year | 12.15 | 11.06 |
| 10–year | 14.13 | 12.56 |
| 20-year | 16.43 | 14.19 |
| 50-year | 20.03 | 16.72 |
|  |  | **MEG** |  |
| 1-year | 6.57 |  | 8.32 |
| 5-year | 7.48 | 13.22 |
| 10–year | 7.91 | 16.15 |
| 20-year | 8.37 | 19.73 |
| 50-year | 9.01 | 25.72 |
|  |  | **SCC** |  |
| 1-year | 9.83 |  | 14.86 |
| 5-year | 11.47 | 16.44 |
| 10–year | 12.26 | 17.17 |
| 20-year | 13.09 | 17.93 |
| 50-year | 14.29 | 19 |
|  |  | **SM** |  |
| 1-year | 3.95 |  | 9.44 |
| 5-year | 5.98 | 12.97 |
| 10-year | 7.12 | 14.87 |
| 20-year | 8.48 | 17.04 |
| 50-year | 10.66 | 20.41 |
|  |  | **URC** |  |
| 1-year | 11.63 |  | 10.51 |
| 5-year | 13.9 | 12.6 |
| 10-year | 15 | 13.62 |
| 20-year | 16.19 | 14.73 |
| 50-year | 17.9 | 16.32 |

**Table A6:** Computed return level estimates for various*M*levels.

|  |  |  |
| --- | --- | --- |
| **Zone** | **Number of exceptions** | **Cumulative probability (%)** |
| **Green** | 0 | 6.97 |
| 1 | 25.63 |
| 2 | 50.51 |
| 3 | 72.55 |
| 4 | 87.12 |
| 5 | 94.81 |
| **Yellow** | 6 | 98.18 |
| 7 | 99.43 |
| 8 | 99.84 |
| 9 | 99.96 |
| **Red** | ≥10 | 99.99 |

**Table A7:** Basel Committee three-zone approach for backtesting.

(coverage=99%, sample size=265)

|  |  |  |
| --- | --- | --- |
| **Zone** | **Number of exceptions** | **Cumulative probability (%)** |
| **Green** | 0 | < 0.01 |
| 1 | < 0.01 |
| 2 | 0.01 |
| 3 | 0.07 |
| 4 | 0.26 |
| 5 | 0.79 |
| 6 | 2 |
| 7 | 4.35 |
| 8 | 8.34 |
| 9 | 14.33 |
| 10 | 22.41 |
| 11 | 32.26 |
| 12 | 43.24 |
| 13 | 54.49 |
| 14 | 65.14 |
| 15 | 74.53 |
| 16 | 82.24 |
| 17 | 88.19 |
| 18 | 92.5 |
| **Yellow** | 19 | 95.46 |
| 20 | 97.37 |
| 21 | 98.54 |
| 22 | 99.22 |
| 23 | 99.6 |
| 24 | 99.81 |
| 25 | 99.91 |
| 26 | 99.96 |
| 27 | 99.98 |
| **Red** | 28 | 99.99 |

**Table A8:** Basel committee three-zone approach for back testing (coverage=95%, sample size=265).