1. **Summary Statistics of Each Security**

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| Arithmetic Mean Geometric Mean Median Variance Stdev  VEA 0.0048 0.0038 0.0041 0.0020 0.0448  EEM 0.0028 0.0014 -0.0004 0.0028 0.0532  VWO 0.0031 0.0018 0.0020 0.0027 0.0524  TIP 0.0030 0.0029 0.0032 0.0002 0.0129  SHV 0.0005 0.0005 0.0001 0.0000 0.0010  IGOV 0.0017 0.0015 0.0057 0.0004 0.0212  GSG -0.0062 -0.0077 0.0007 0.0030 0.0543  DJP -0.0052 -0.0061 -0.0047 0.0019 0.0431  VNQ 0.0089 0.0080 0.0112 0.0020 0.0450  EFA 0.0046 0.0036 0.0055 0.0020 0.0445   1. **Covariance**   VEA EEM VWO TIP SHV IGOV GSG DJP VNQ EFA  VEA 2.0e-03 2.0e-03 2.0e-03 6.4e-05 2.6e-06 4.5e-04 1.4e-03 1.1e-03 1.2e-03 2.0e-03  EEM 2.0e-03 2.8e-03 2.7e-03 1.5e-04 6.7e-06 5.9e-04 1.6e-03 1.4e-03 1.3e-03 2.0e-03  VWO 2.0e-03 2.7e-03 2.7e-03 1.5e-04 5.3e-06 5.6e-04 1.5e-03 1.4e-03 1.3e-03 1.9e-03  TIP 6.4e-05 1.5e-04 1.5e-04 1.7e-04 3.0e-06 1.2e-04 -2.1e-05 4.5e-05 2.5e-04 6.4e-05  SHV 2.6e-06 6.7e-06 5.3e-06 3.0e-06 9.8e-07 4.3e-06 1.4e-06 2.2e-06 7.8e-06 2.2e-06  IGOV 4.5e-04 5.9e-04 5.6e-04 1.2e-04 4.3e-06 4.5e-04 3.6e-04 4.1e-04 3.6e-04 4.5e-04  GSG 1.4e-03 1.6e-03 1.5e-03 -2.1e-05 1.4e-06 3.6e-04 3.0e-03 2.0e-03 4.8e-04 1.4e-03  DJP 1.1e-03 1.4e-03 1.4e-03 4.5e-05 2.2e-06 4.1e-04 2.0e-03 1.9e-03 6.1e-04 1.1e-03  VNQ 1.2e-03 1.3e-03 1.3e-03 2.5e-04 7.8e-06 3.6e-04 4.8e-04 6.1e-04 2.0e-03 1.2e-03  EFA 2.0e-03 2.0e-03 1.9e-03 6.4e-05 2.2e-06 4.5e-04 1.4e-03 1.1e-03 1.2e-03 2.0e-03   1. **Correlation**   VEA EEM VWO TIP SHV IGOV GSG DJP VNQ EFA  VEA 1.000 0.85 0.85 0.111 0.058 0.48 0.574 0.571 0.60 0.98  EEM 0.848 1.00 0.99 0.222 0.127 0.52 0.554 0.622 0.53 0.84  VWO 0.845 0.99 1.00 0.227 0.102 0.51 0.539 0.616 0.54 0.83  TIP 0.111 0.22 0.23 1.000 0.239 0.43 -0.030 0.081 0.43 0.11  SHV 0.058 0.13 0.10 0.239 1.000 0.21 0.027 0.053 0.18 0.05  IGOV 0.476 0.52 0.51 0.427 0.207 1.00 0.312 0.450 0.38 0.47  GSG 0.574 0.55 0.54 -0.030 0.027 0.31 1.000 0.875 0.20 0.56  DJP 0.571 0.62 0.62 0.081 0.053 0.45 0.875 1.000 0.32 0.57  VNQ 0.596 0.53 0.54 0.433 0.176 0.38 0.195 0.317 1.00 0.59  EFA 0.984 0.84 0.83 0.112 0.050 0.47 0.564 0.566 0.59 1.00   1. **Correlation Chart**      1. **Beta**   VEA EEM VWO TIP SHV IGOV GSG DJP VNQ EFA  Beta: GSPC.Adjusted 0.95 0.98 0.96 -0.023 -0.00012 0.13 0.78 0.57 0.65 0.94  VEA EEM VWO TIP SHV IGOV GSG DJP VNQ EFA  Beta: DJI.Adjusted 0.89 0.92 0.9 -0.039 -0.001 0.1 0.76 0.56 0.59 0.89   1. **Asset vs Benchmark Returns**      1. **Calculations for Portfolio Optimization**   R Program  #Initialize Portfolio Objects  portf<-portfolio.spec(colnames(sec\_returns))  #Add portfolio Constraints. Sum of Weights should not exceed 1  portf<-add.constraint(portf,type="weight\_sum",min\_sum=1 , max\_sum=1)  #Add allocation Constraints. Min Weight of Security 0, Maximum =1  portf<-add.constraint(portf,type="box",min=0 , max=1)  #Add Objectives - Maximize return.  portf<-add.objective(portf,type="return",name="mean")  #Add Objectives - Minimize Risk  portf<-add.objective(portf,type="risk",name="StdDev")  #Optimize using ROI method (Max Return of Investment)  optPort <- optimize.portfolio(sec\_returns, portf, optimize\_method = "ROI",trace=TRUE)  \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  Output of Portfolio Optimization  \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  Efficient Frontier Points: 25  **Weights along the efficient frontier:**  VEA EEM VWO TIP SHV IGOV GSG DJP VNQ EFA  1 0.00 0 0 0.00 1.00 0 0 0 0.00 0  2 0.00 0 0 0.08 0.90 0 0 0 0.02 0  3 0.00 0 0 0.15 0.81 0 0 0 0.04 0  4 0.01 0 0 0.23 0.71 0 0 0 0.05 0  5 0.01 0 0 0.31 0.61 0 0 0 0.07 0  6 0.01 0 0 0.38 0.52 0 0 0 0.09 0  7 0.01 0 0 0.46 0.42 0 0 0 0.11 0  8 0.01 0 0 0.54 0.32 0 0 0 0.13 0  9 0.01 0 0 0.61 0.23 0 0 0 0.15 0  10 0.01 0 0 0.69 0.13 0 0 0 0.17 0  11 0.01 0 0 0.77 0.03 0 0 0 0.18 0  12 0.00 0 0 0.77 0.00 0 0 0 0.23 0  13 0.00 0 0 0.71 0.00 0 0 0 0.29 0  14 0.00 0 0 0.65 0.00 0 0 0 0.35 0  15 0.00 0 0 0.59 0.00 0 0 0 0.41 0  16 0.00 0 0 0.53 0.00 0 0 0 0.47 0  17 0.00 0 0 0.47 0.00 0 0 0 0.53 0  18 0.00 0 0 0.41 0.00 0 0 0 0.59 0  19 0.00 0 0 0.35 0.00 0 0 0 0.65 0  20 0.00 0 0 0.30 0.00 0 0 0 0.70 0  21 0.00 0 0 0.24 0.00 0 0 0 0.76 0  22 0.00 0 0 0.18 0.00 0 0 0 0.82 0  23 0.00 0 0 0.12 0.00 0 0 0 0.88 0  24 0.00 0 0 0.06 0.00 0 0 0 0.94 0  25 0.00 0 0 0.00 0.00 0 0 0 1.00 0  **Risk and return metrics along the efficient frontier:**  mean StdDev out  1 0.00 0.00 0  2 0.00 0.00 0  3 0.00 0.00 0  4 0.00 0.00 0  5 0.00 0.01 0  6 0.00 0.01 0  7 0.00 0.01 0  8 0.00 0.01 0  9 0.00 0.01 0  10 0.00 0.01 0  11 0.00 0.02 0  12 0.00 0.02 0  13 0.00 0.02 0  14 0.01 0.02 0  15 0.01 0.02 0  16 0.01 0.02 0  17 0.01 0.03 0  18 0.01 0.03 0  19 0.01 0.03 0  20 0.01 0.03 0  21 0.01 0.04 0  22 0.01 0.04 0  23 0.01 0.04 0  24 0.01 0.04 0  25 0.01 0.05 0 |
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| 1. **Plot Efficient Frontier based on Portfolio Optimization**  |  | | --- | |  | |

