

M.S. Thesis - First Draft

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Background and Introduction

Value-at-risk modeling, or VaR, is a commonly used tool to measure riskiness in a financial institution. CAViaR was a new take on risk modeling originally proposed by Robert Engle and Simone Manganello in 2004 which builds upon the literature of modeling regression quantiles in settings which are essential.

and agree with the basic premise of the CAViaR paper that many of the nonparametric historical simulation methods don't have attractive statistical properties and are chosen more for experimental qualities (an example of this in the 1998 paper by Boudoukh, Richardson, and Whitelaw cited by Engle which uses a semiparametric "hybrid" approach) I think trying to think too narrowly about VaR isn't a very interesting statistical problem - in a sense, VaR is just a useful summarization of quantile risk put into dollar figures for easy consumption. In my opinion, the most interesting question in the CAViaR paper isn't VaR per se, it's testing their theorems under relaxations of their assumptions to better understand their approach to extreme value theory. In particular, the following analyses catch my eye: How important is the assumption C2 on page 374 of the CAVIAR paper (which underlies Theorem 1 about the consistency of the estimator $\hat{\beta}$)? It states that "conditional on all of the past information... the error terms form a stationary process". It may be an interesting test to see how much nonstationarity affects the consistency of the estimator $\hat{\beta}$. I could do this via simulation and see if there's a lot of value here, which may lead us to a more fundamental result. In my opinion, theorems 4 and 5 (p. 371) are the most important in the paper because they state that the DQ_IS and DQ_OOS quantities are pivotal asymptotically. But it begs the question of how much does that matter, especially in the context of VaR, which in all likelihood is working with limited data? Therefore, it seems to me that the $DQ8$ and $DQ9$ assumptions are the shakiest assumptions required for theorem 5. It might be interesting to see how far off from a chi-squared distribution real-world data actually is. This may allow us to develop "rules of thumb" about the accuracy of these asymptotic distributions.

Methods Used

Fill in.

Data Used

Results

CODE

Libraries

Univariate CAViaR Section

MV Caviar - Pulling the data

MV Caviar - Modified DI code

The code that is used in a diffusion index model is as follows. The key is figuring out where to make the extension. I'll go through and comment everything and see what's what.

Now that we have the function, let's see if we can get it to work. First, we'll need to compile all of our data. Let's add a code which incorporates the previous values of the return.

MV Caviar - Calculating losses

MV Caviar - Choosing the optimal number of predictors

MV Caviar - Running the univariate model multiple times

MV Caviar - Plotting function

MV Caviar - Old Loss Test Function

MV Caviar - A generalized loss calculation function

MV Caviar - Tables function

Export function

Big Simulation Function

Sector ETFs as Explanatory Variables

Here's what I'm thinking.

Lowest level: 1%, 5%, 10% VaR Next, 2008, 2010, 2014, or 2016 Highest - ETF choices $3 \times 4 \times 5 = 60$ runs

Table 1: Fake Data				
	One	Two	Three	Four
Numbers	1	2	3	4

Note:

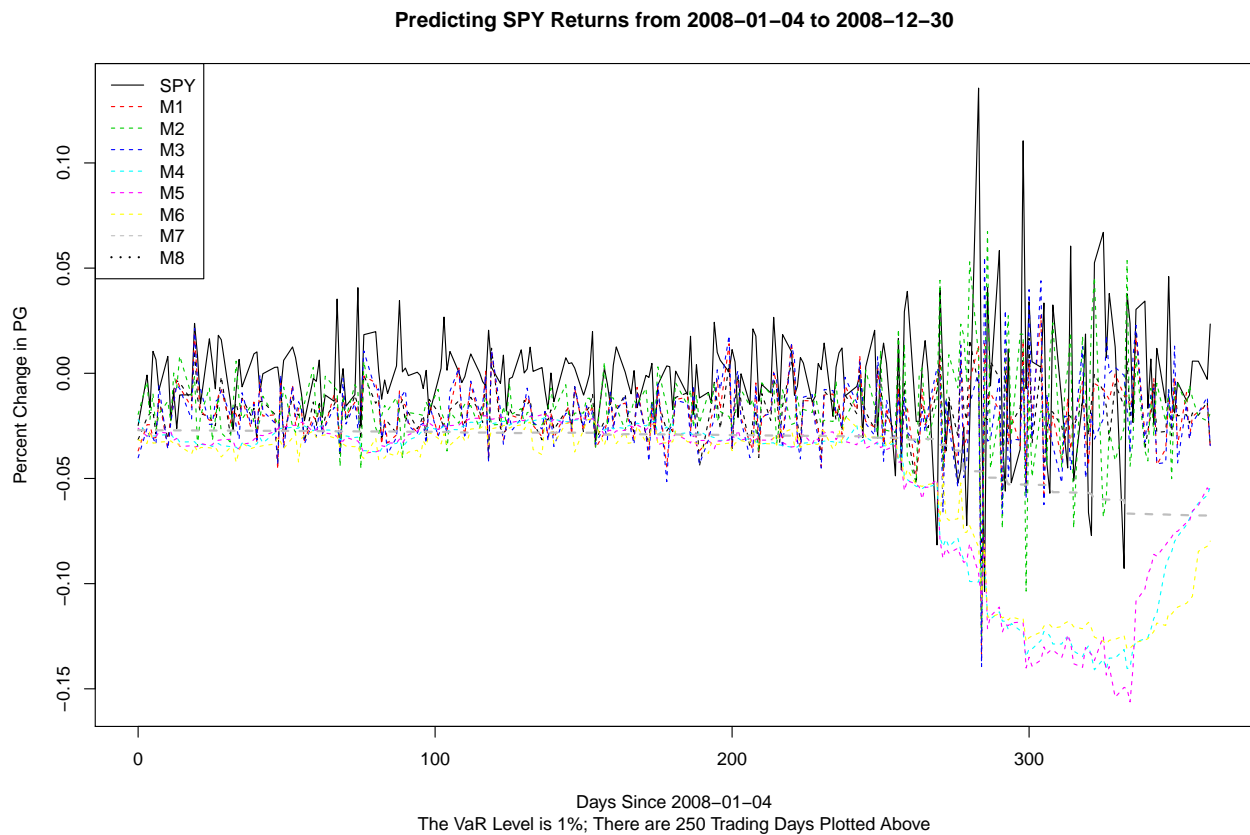
Calculated using 4 fake data points

Importing and Running Datasets

Problem Solving on 4.29.2020

2008 Ending

U.S. ETFs



```
## $rect
## $rect$w
## [1] 36.54219
##
## $rect$h
## [1] 0.1023135
##
## $rect$left
## [1] -14.44
##
## $rect$top
```

```

## [1] 0.1472487
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.13701735 0.12678600 0.11655465 0.10632330 0.09609195 0.08586060
## [7] 0.07562925 0.06539790 0.05516654
##
##
## \begin{table}[t]
##
## \caption{\label{tab:unnamed-chunk-28}Comparison of VaR Methods for a 1% VaR}
## \centering
## \begin{tabular}{l|r|r|r|r|r|r|r|r}
## \hline
## & M1 & M2 & M3 & M4 & M5 & M6 & M7 & M8\\
## \hline
## Losses & 1.046 & 1.1 & 1.371 & 1.265 & 0.208 & 0.213 & 0.219 & 0.355\\
## \hline
## VaR Breaks (%) & 0.200 & 0.2 & 0.212 & 0.208 & 0.028 & 0.028 & 0.028 & 0.060\\
## \hline
## \multicolumn{9}{l}{\textit{Note: }}\\
## \multicolumn{9}{l}{Calculated using 250 trading days from 2008-01-04 to 2008-12-30}\\
## \end{tabular}
## \end{table}

```

\begin{table}[t]

\caption{Comparison of VaR Methods for a 1% VaR}

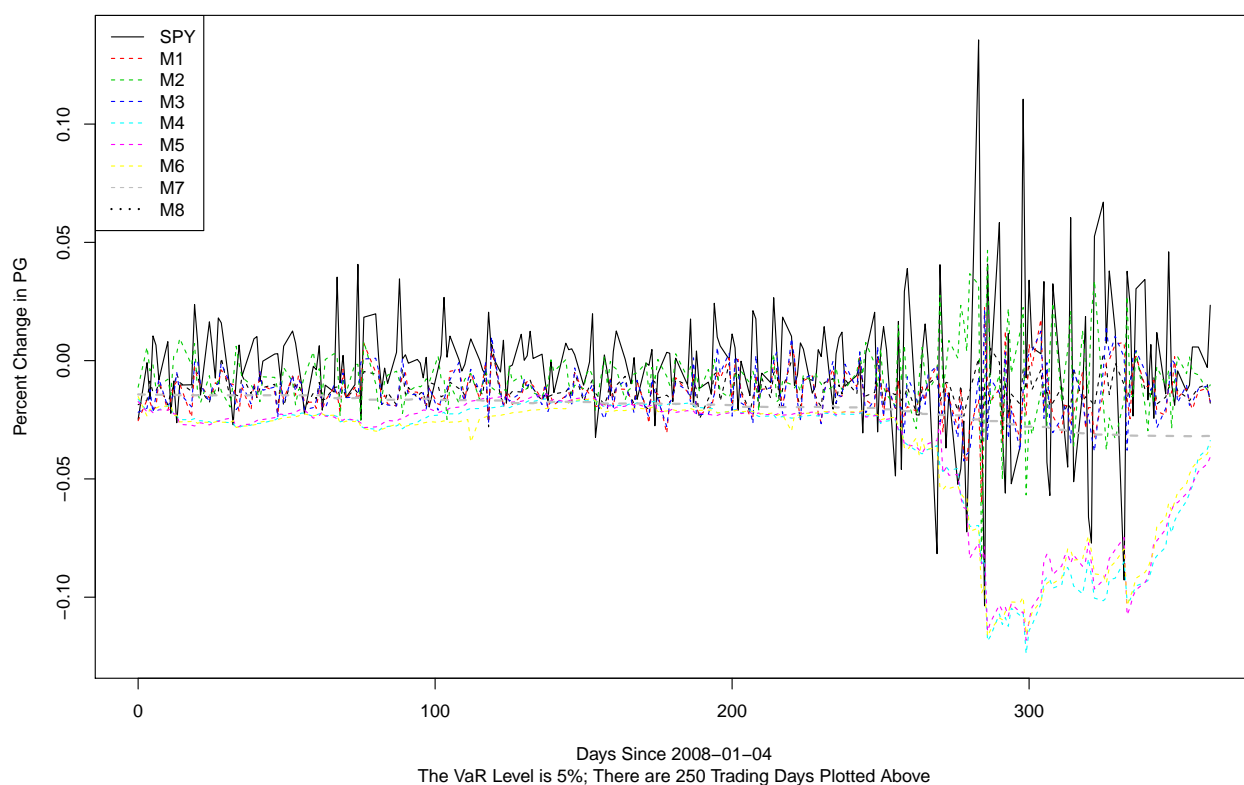
	M1	M2	M3	M4	M5	M6	M7	M8
Losses	1.046	1.1	1.371	1.265	0.208	0.213	0.219	0.355
VaR Breaks (%)	0.200	0.2	0.212	0.208	0.028	0.028	0.028	0.060

Note:

Calculated using 250 trading days from 2008-01-04 to 2008-12-30

\end{table}

Predicting SPY Returns from 2008-01-04 to 2008-12-30



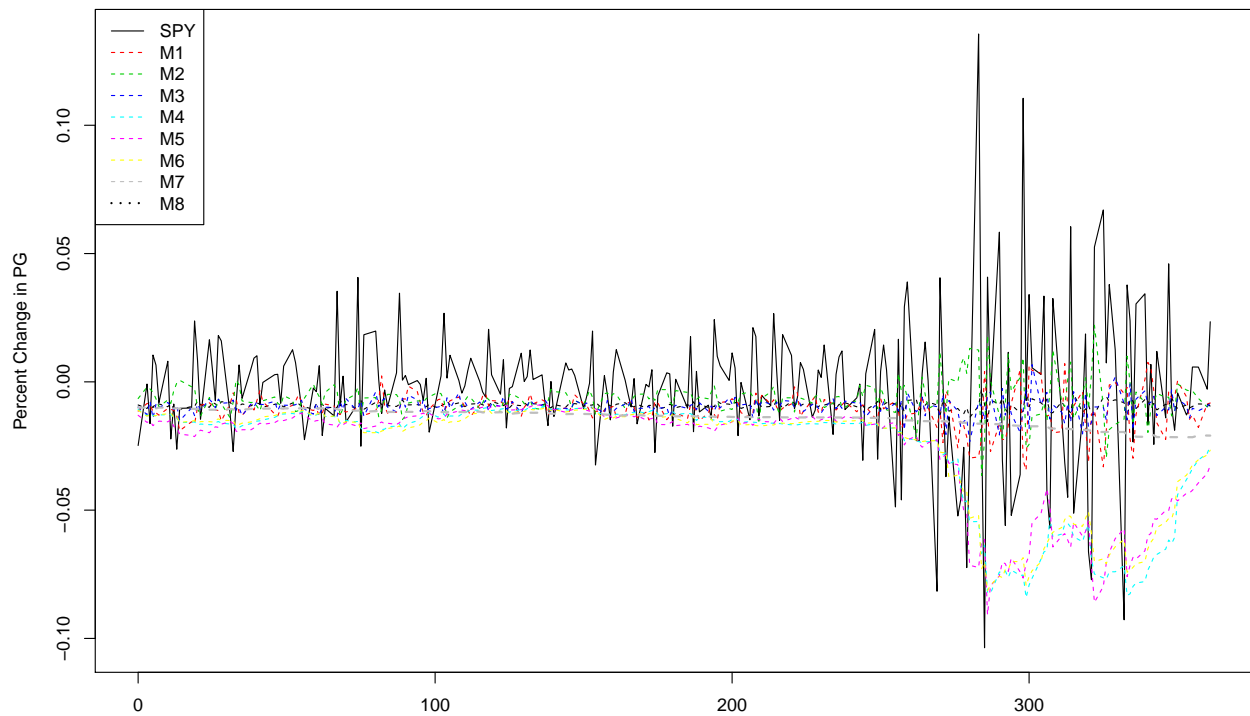
```
## $rect
## $rect$w
## [1] 36.54219
##
## $rect$h
## [1] 0.09098009
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.1459559
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.13685785 0.12775984 0.11866183 0.10956382 0.10046581 0.09136780
## [7] 0.08226979 0.07317178 0.06407377
##
##
## \begin{table}[t]
##
## \caption{\label{tab:unnamed-chunk-28}Comparison of VaR Methods for a 5% VaR}
## \centering
```

```

## \begin{tabular}{l|r|r|r|r|r|r|r|r}
## \hline
##   & M1 & M2 & M3 & M4 & M5 & M6 & M7 & M8\\
## \hline
## Losses & 1.319 & 1.344 & 1.768 & 1.385 & 0.651 & 0.654 & 0.640 & 0.956\\
## \hline
## VaR Breaks (\%) & 0.260 & 0.236 & 0.340 & 0.260 & 0.076 & 0.076 & 0.064 & 0.160\\
## \hline
## \multicolumn{9}{l}{\textit{Note: }}\\
## \multicolumn{9}{l}{Calculated using 250 trading days from 2008-01-04 to 2008-12-30}\\
## \end{tabular}
## \end{table}

```

Predicting SPY Returns from 2008-01-04 to 2008-12-30



Days Since 2008-01-04
The VaR Level is 10%; There are 250 Trading Days Plotted Above

```

## $rect
## $rect$w
## [1] 36.54219
##
## $rect$h
## [1] 0.08388041
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.145146
##
##
## $text

```

```

## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.13675792 0.12836988 0.11998184 0.11159380 0.10320576 0.09481772
## [7] 0.08642968 0.07804164 0.06965360
##
##
## \begin{table}[t]
##
## \caption{\label{tab:unnamed-chunk-28}Comparison of VaR Methods for a 10% VaR}
## \centering
## \begin{tabular}{l|r|r|r|r|r|r|r|r}
## \hline
## & M1 & M2 & M3 & M4 & M5 & M6 & M7 & M8\\
## \hline
## Losses & 1.623 & 1.564 & 1.738 & 1.534 & 1.077 & 1.066 & 1.068 & 1.366\\
## \hline
## VaR Breaks (\%) & 0.328 & 0.312 & 0.348 & 0.332 & 0.144 & 0.156 & 0.140 & 0.224\\
## \hline
## \multicolumn{9}{l}{\textit{Note: }}\\
## \multicolumn{9}{l}{Calculated using 250 trading days from 2008-01-04 to 2008-12-30}\\
## \end{tabular}
## \end{table}

## [[1]]
##
##          SPY          M1          M2          M3
## 2008-01-04 -0.0248118342 -0.009008995 -0.0114038250 -6.506809e-03
## 2008-01-07 -0.0008496457 -0.010368632 -0.0084263336 -2.036757e-03
## 2008-01-08 -0.0162801552 -0.008802236 -0.0086991683 -2.789016e-03
## 2008-01-09 0.0104552682 -0.010007454 -0.0116292656 -3.989046e-03
## 2008-01-10 0.0065326791 -0.008237012 -0.0120536801 -6.577309e-03
## 2008-01-11 -0.0081012617 -0.008609990 -0.0129927437 -9.762320e-03
## 2008-01-14 0.0080307055 -0.009693916 -0.0103604940 -7.036558e-03
## 2008-01-15 -0.0222590643 -0.008431257 -0.0107313252 -8.410308e-03
## 2008-01-16 -0.0086497429 -0.010423230 -0.0110791278 -3.437999e-03
## 2008-01-17 -0.0262580047 -0.009571017 -0.0132299493 -4.863722e-04
## 2008-01-18 -0.0103207892 -0.010797726 -0.0190338918 5.987178e-04
## 2008-01-22 -0.0101983469 -0.009605623 -0.0155451810 -1.908073e-03
## 2008-01-23 0.0237370019 -0.009639679 -0.0163684113 -2.596526e-03
## 2008-01-24 0.0084061146 -0.007409178 -0.0100474056 -1.010362e-02
## 2008-01-25 -0.0145510127 -0.008840543 -0.0091431102 -1.341522e-02
## 2008-01-28 0.0164012399 -0.009938185 -0.0081656547 -6.081848e-03
## 2008-01-29 0.0049417741 -0.007968071 -0.0092892564 -8.738580e-03
## 2008-01-30 -0.0073848272 -0.008596855 -0.0110532525 -1.079707e-02
## 2008-01-31 0.0180699420 -0.009524466 -0.0111233920 -6.712125e-03
## 2008-02-01 0.0159598414 -0.007756630 -0.0152328258 -8.498832e-03
## 2008-02-04 -0.0126893053 -0.007936975 -0.0085145294 -1.405719e-02
## 2008-02-05 -0.0271387661 -0.009637700 -0.0042830575 -7.857168e-03
## 2008-02-06 -0.0080845276 -0.010811106 -0.0068349665 7.617532e-04
## 2008-02-07 0.0065919871 -0.009410725 -0.0120956639 -1.257335e-03
## 2008-02-08 -0.0064417940 -0.008615910 -0.0130952735 -7.442815e-03
## 2008-02-11 0.0050966925 -0.009368441 -0.0088169211 -8.079318e-03
## 2008-02-12 0.0092287560 -0.008610177 -0.0109754180 -7.887713e-03

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```

## 2008-02-13 0.0101709979 -0.008206896 -0.0072899663 -9.499480e-03
## 2008-02-14 -0.0088387495 -0.008662643 -0.0034199380 -1.133014e-02
## 2008-02-15 -0.0002217737 -0.009865055 -0.0076506907 -7.386325e-03
## 2008-02-19 0.0028078397 -0.008752311 -0.0125648537 -5.889297e-03
## 2008-02-20 0.0029473150 -0.008657089 -0.0133507941 -8.341232e-03
## 2008-02-21 -0.0083486448 -0.008957609 -0.0103648493 -9.189042e-03
## 2008-02-22 0.0061388665 -0.009812979 -0.0104726336 -5.365208e-03
## 2008-02-25 0.0125298205 -0.008249017 -0.0091615346 -7.087356e-03
## 2008-02-26 0.0074727484 -0.008427043 -0.0075540555 -1.159413e-02
## 2008-02-27 -0.0010126331 -0.008564273 -0.0050563357 -1.122542e-02
## 2008-02-28 -0.0098152362 -0.009300350 -0.0077330765 -7.676311e-03
## 2008-02-29 -0.0225356856 -0.009715207 -0.0102540059 -6.336050e-03
## 2008-03-03 -0.0023943356 -0.010715271 -0.0111511634 -9.231015e-04
## 2008-03-04 -0.0038274278 -0.008661862 -0.0104759316 -3.681841e-03
## 2008-03-05 0.0062962527 -0.009268762 -0.0131507287 -5.814803e-03
## 2008-03-06 -0.0209151448 -0.008661525 -0.0123276509 -8.934318e-03
## 2008-03-07 -0.0103537085 -0.010299790 -0.0086824929 -4.105654e-03
## 2008-03-10 -0.0132709532 -0.009772380 -0.0094145094 -1.133176e-03
## 2008-03-11 0.0353069013 -0.010005542 -0.0120210470 -3.596715e-03
## 2008-03-12 -0.0093956541 -0.006829697 -0.0127647007 -1.320668e-02
## 2008-03-13 0.0022053488 -0.009469711 -0.0110452077 -1.015872e-02
## 2008-03-14 -0.0156173232 -0.008764945 -0.0117671308 -6.925152e-03
## 2008-03-17 -0.0101584795 -0.010165074 -0.0106106051 -4.986029e-03
## 2008-03-18 0.0407036536 -0.009689853 -0.0100672542 -2.156171e-03
## 2008-03-19 -0.0250818491 -0.006388991 -0.0115073692 -1.344860e-02
## 2008-03-20 0.0183532925 -0.010703682 -0.0130045908 -6.288316e-03
## 2008-03-24 0.0197907260 -0.007990610 -0.0115022698 -6.146751e-03
## 2008-03-25 0.0009646820 -0.007668727 -0.0071201631 -1.364887e-02
## 2008-03-26 -0.0123112882 -0.008810584 0.0023141238 -1.092103e-02
## 2008-03-27 -0.0031585591 -0.009770029 -0.0096555770 -6.661349e-03
## 2008-03-28 -0.0096105193 -0.009253123 -0.0122075248 -4.873192e-03
## 2008-03-31 0.0034917825 -0.009585075 -0.0118099038 -4.965288e-03
## 2008-04-01 0.0345554764 -0.008756104 -0.0103472125 -6.900763e-03
## 2008-04-02 0.0006585635 -0.007054069 -0.0065405357 -1.469148e-02
## 2008-04-03 0.0024843280 -0.008789507 -0.0067383411 -1.330204e-02
## 2008-04-04 -0.0010953896 -0.008983872 -0.0016709888 -8.258529e-03
## 2008-04-07 0.0005112351 -0.008900336 -0.0037977186 -7.449499e-03
## 2008-04-08 -0.0010226662 -0.009014350 -0.0081290029 -7.418208e-03
## 2008-04-09 -0.0072621323 -0.009069519 -0.0119318420 -8.003548e-03
## 2008-04-10 0.0013979696 -0.009679355 -0.0131530340 -6.495937e-03
## 2008-04-11 -0.0195997100 -0.008818423 -0.0106663172 -5.822471e-03
## 2008-04-14 -0.0033793720 -0.010182540 -0.0069344720 -4.095752e-03
## 2008-04-15 0.0023291752 -0.009286144 -0.0066675930 -4.648167e-03
## 2008-04-16 0.0267334733 -0.008735598 -0.0112287777 -7.427651e-03
## 2008-04-17 0.0014600779 -0.007466123 -0.0094122855 -1.407224e-02
## 2008-04-18 0.0103804298 -0.009032809 -0.0073928352 -1.171313e-02
## 2008-04-21 0.0005051632 -0.008196470 -0.0059049694 -9.395215e-03
## 2008-04-22 -0.0044122300 -0.009124997 -0.0075596071 -9.329673e-03
## 2008-04-23 -0.0015963935 -0.009654872 -0.0097764786 -7.384091e-03
## 2008-04-24 0.0043473397 -0.009034157 -0.0108286996 -5.648843e-03
## 2008-04-25 0.0092113415 -0.008645427 -0.0134112793 -6.253240e-03
## 2008-04-28 0.0002150994 -0.008467068 -0.0089681018 -1.039274e-02
## 2008-04-29 -0.0039467796 -0.008933061 -0.0056142597 -8.173139e-03
## 2008-04-30 -0.0059136301 -0.009396057 -0.0045445344 -5.854553e-03

```



```

## 2008-05-01 0.0204743354 -0.009647983 -0.0093389533 -6.869330e-03
## 2008-05-02 0.0027600366 -0.007635783 -0.0073064619 -8.041400e-03
## 2008-05-05 -0.0048171655 -0.008737952 -0.0076116895 -1.193308e-02
## 2008-05-06 0.0086260700 -0.009273423 -0.0086225189 -7.468741e-03
## 2008-05-07 -0.0179713227 -0.008601222 -0.0093840212 -8.949787e-03
## 2008-05-08 -0.0025837062 -0.010129929 -0.0065284720 -4.985588e-03
## 2008-05-09 -0.0018699025 -0.008931359 -0.0082239227 -4.761851e-03
## 2008-05-12 0.0111686003 -0.009284553 -0.0134015989 -6.824563e-03
## 2008-05-13 0.0001424174 -0.008144653 -0.0099090503 -8.522933e-03
## 2008-05-14 0.0020618202 -0.009043985 -0.0084488040 -9.835671e-03
## 2008-05-15 0.0124255030 -0.008714788 -0.0046449225 -6.969332e-03
## 2008-05-16 0.0009117828 -0.008468629 -0.0085913564 -1.027173e-02
## 2008-05-19 0.0027300754 -0.008876867 -0.0069908722 -1.075360e-02
## 2008-05-20 -0.0081422442 -0.008751969 -0.0076908499 -8.065270e-03
## 2008-05-21 -0.0170593399 -0.009664896 -0.0129163904 -7.651344e-03
## 2008-05-22 0.0001434719 -0.010191092 -0.0108505800 -2.939370e-03
## 2008-05-23 -0.0134949236 -0.008834264 -0.0109120649 -3.780096e-03
## 2008-05-27 0.0073832283 -0.009829299 -0.0101715399 -4.262240e-03
## 2008-05-28 0.0046050538 -0.008655302 -0.0119377833 -6.275858e-03
## 2008-05-29 0.0050126405 -0.008729524 -0.0093534639 -1.022954e-02
## 2008-05-30 0.0024965093 -0.008469196 -0.0050385378 -7.269173e-03
## 2008-06-02 -0.0103845953 -0.009028096 -0.0085846550 -8.877645e-03
## 2008-06-03 -0.0058486286 -0.009674288 -0.0090114624 -6.303002e-03
## 2008-06-04 -0.0005071990 -0.009108791 -0.0113517204 -3.282676e-03
## 2008-06-05 0.0197999656 -0.009038541 -0.0140747752 -6.088543e-03
## 2008-06-06 -0.0324135219 -0.007921051 -0.0114746838 -1.266514e-02
## 2008-06-09 0.0024184013 -0.011258927 -0.0114033270 -4.660554e-03
## 2008-06-10 -0.0049897990 -0.008768479 -0.0097804247 -4.280059e-03
## 2008-06-11 -0.0148216573 -0.009287020 -0.0100541328 -5.866447e-03
## 2008-06-12 0.0038006245 -0.010017039 -0.0095581533 -4.632764e-03
## 2008-06-13 0.0125646686 -0.008730929 -0.0137035480 -4.837934e-03
## 2008-06-16 0.0005874783 -0.008139567 -0.0126652284 -1.040212e-02
## 2008-06-17 -0.0048563358 -0.009089069 -0.0081276691 -9.703975e-03
## 2008-06-18 -0.0097843640 -0.009305167 -0.0079610277 -7.562118e-03
## 2008-06-19 0.0012653750 -0.009819992 -0.0098020101 -5.687118e-03
## 2008-06-20 -0.0163647288 -0.008707371 -0.0139613551 -4.798442e-03
## 2008-06-23 -0.0009887771 -0.010158193 -0.0118418895 -4.778801e-03
## 2008-06-24 -0.0019798898 -0.009176511 -0.0148801871 -6.659369e-03
## 2008-06-25 0.0047149920 -0.009186771 -0.0137983406 -5.619032e-03
## 2008-06-26 -0.0275358331 -0.008550182 -0.0075372065 -7.195321e-03
## 2008-06-27 -0.0054738974 -0.010675156 -0.0082139259 -2.971130e-03
## 2008-06-30 0.0035221919 -0.009728980 -0.0147488944 -3.055801e-03
## 2008-07-01 0.0031205832 -0.008736678 -0.0133791624 -7.854543e-03
## 2008-07-02 -0.0172852620 -0.009240903 -0.0136079676 -9.128634e-03
## 2008-07-03 0.0010299015 -0.010062039 -0.0119384932 -3.408260e-03
## 2008-07-07 -0.0102655093 -0.008928848 -0.0142611808 -4.113105e-03
## 2008-07-08 0.0176013870 -0.009358703 -0.0089678539 -4.319657e-03
## 2008-07-09 -0.0194427981 -0.007778975 -0.0101004944 -7.038855e-03
## 2008-07-10 0.0040785720 -0.010134194 -0.0112295230 -6.853763e-03
## 2008-07-11 -0.0117208313 -0.008725634 -0.0151027112 -5.937145e-03
## 2008-07-14 -0.0090848395 -0.010005993 -0.0121056951 -6.604875e-03
## 2008-07-15 -0.0141975488 -0.009344450 -0.0089886319 -3.949404e-03
## 2008-07-16 0.0242512465 -0.009670440 -0.0126691641 -1.544330e-03
## 2008-07-17 0.0099534022 -0.007486000 -0.0150223060 -6.943702e-03

```

```

## 2008-07-18 0.0062110876 -0.008368813 -0.0080485990 -1.142292e-02
## 2008-07-21 0.0005553612 -0.008697845 -0.0075731813 -1.041290e-02
## 2008-07-22 0.0112808321 -0.009128305 -0.0065476800 -1.076400e-02
## 2008-07-23 0.0053979008 -0.007954793 -0.0079157754 -6.813814e-03
## 2008-07-24 -0.0209721275 -0.008916176 -0.0080325669 -7.895643e-03
## 2008-07-25 -0.0002388821 -0.010368616 -0.0120137737 -4.737324e-03
## 2008-07-28 -0.0147724364 -0.009065992 -0.0138906291 -3.942548e-03
## 2008-07-29 0.0211274210 -0.010077932 -0.0120657817 -5.793040e-03
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## 2008-12-30 -0.008281552 -0.025045511 -0.032522506 -0.02662770 -0.02094917
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## [[2]]$rect
## [[2]]$rect$w
## [1] 36.54219
##
## [[2]]$rect$h
## [1] 0.08388041
##
## [[2]]$rect$left
## [1] -14.44
##

```



```

## [[2]]$rect$top
## [1] 0.145146
##
##
## [[2]]$text
## [[2]]$text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## [[2]]$text$y
## [1] 0.13675792 0.12836988 0.11998184 0.11159380 0.10320576 0.09481772
## [7] 0.08642968 0.07804164 0.06965360
##
##
##
## [[3]]
## [[3]][[1]]
## [1] 1.622597 1.564253 1.737877 1.534359 1.076953 1.066265 1.068465 1.366382
##
## [[3]][[2]]
## [1] 0.328 0.312 0.348 0.332 0.144 0.156 0.140 0.224
##
## [[3]][[3]]
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## [214,] 7.756158e-03 3.428947e-04 3.496454e-02
## [215,] 9.683473e-03 9.111272e-03 5.069847e-03
## [216,] 4.687765e-03 4.355712e-03 5.013118e-04
## [217,] 2.780654e-03 2.231534e-03 1.184842e-02
## [218,] 1.662283e-03 7.150059e-04 2.406596e-02
## [219,] 1.249082e-02 1.129110e-02 7.892227e-03
## [220,] 3.553351e-04 4.254999e-04 2.946567e-02
## [221,] 4.680906e-03 4.293484e-03 5.321025e-04
## [222,] 7.705760e-03 7.186880e-03 3.737436e-03
## [223,] 1.114822e-02 1.404710e-02 4.272356e-02
## [224,] 4.878294e-03 1.621857e-02 5.190050e-02
## [225,] 1.384930e-02 1.225760e-02 7.204445e-03
## [226,] 1.467292e-02 1.359653e-02 8.653503e-03
## [227,] 7.797323e-03 7.828970e-03 2.688615e-03
## [228,] 1.043329e-02 1.054189e-02 5.745017e-03
## [229,] 7.360138e-03 7.680489e-03 3.206163e-03
## [230,] 3.198360e-02 2.817525e-02 6.588842e-02
## [231,] 1.136624e-02 1.119510e-02 5.843987e-03
## [232,] 9.528377e-03 9.733651e-03 4.441175e-03
## [233,] 4.500261e-03 4.887238e-03 2.475326e-03
## [234,] 9.942932e-03 1.012574e-02 5.174739e-03
## [235,] 1.001614e-02 1.043617e-02 5.575142e-03
## [236,] 4.332844e-03 4.837843e-03 4.138791e-04
## [237,] 6.588317e-03 6.928247e-03 2.759603e-03
## [238,] 2.900184e-03 3.656516e-03 3.211340e-03
## [239,] 6.541132e-03 6.864519e-03 3.338855e-03
## [240,] 3.606896e-03 4.072565e-03 7.505712e-04
## [241,] 9.615261e-03 9.924323e-03 6.752115e-03
## [242,] 3.588229e-03 4.361363e-03 1.180814e-03
## [243,] 2.621559e-03 3.077345e-03 2.698030e-04
## [244,] 4.208115e-03 3.457766e-03 1.725260e-03
## [245,] 3.052703e-03 2.347406e-03 8.670555e-04
## [246,] 3.287538e-03 2.402693e-03 1.117487e-03
## [247,] 4.806347e-03 3.822148e-03 2.736832e-03
## [248,] 4.515099e-03 3.614100e-03 2.667054e-03
## [249,] 3.283388e-03 2.560578e-03 1.805427e-03
## [250,] 5.594872e-03 5.005391e-03 4.437539e-03
##
## [[3]][[4]]
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8]
## [1,]    1    1    1    1    1    1    1    1
## [2,]    0    0    0    0    0    0    0    0
## [3,]    1    1    1    1    1    1    1    1
## [4,]    0    0    0    0    0    0    0    0
## [5,]    0    0    0    0    0    0    0    0
## [6,]    0    0    0    0    0    0    0    0
## [7,]    0    0    0    0    0    0    0    0
## [8,]    1    1    1    1    1    1    1    1
## [9,]    0    0    1    0    0    0    0    0
## [10,]   1    1    1    1    1    1    1    1
## [11,]   0    0    1    0    0    0    0    0
## [12,]   1    0    1    1    0    0    0    0
## [13,]   0    0    0    0    0    0    0    0

```

##	[14,]	0	0	0	0	0	0	0
##	[15,]	1	1	1	1	0	0	1
##	[16,]	0	0	0	0	0	0	0
##	[17,]	0	0	0	0	0	0	0
##	[18,]	0	0	0	0	0	0	0
##	[19,]	0	0	0	0	0	0	0
##	[20,]	0	0	0	0	0	0	0
##	[21,]	1	1	0	1	0	0	1
##	[22,]	1	1	1	1	1	1	1
##	[23,]	0	1	1	0	0	0	0
##	[24,]	0	0	0	0	0	0	0
##	[25,]	0	0	0	0	0	0	0
##	[26,]	0	0	0	0	0	0	0
##	[27,]	0	0	0	0	0	0	0
##	[28,]	0	0	0	0	0	0	0
##	[29,]	1	1	0	1	0	0	0
##	[30,]	0	0	0	0	0	0	0
##	[31,]	0	0	0	0	0	0	0
##	[32,]	0	0	0	0	0	0	0
##	[33,]	0	0	0	0	0	0	0
##	[34,]	0	0	0	0	0	0	0
##	[35,]	0	0	0	0	0	0	0
##	[36,]	0	0	0	0	0	0	0
##	[37,]	0	0	0	0	0	0	0
##	[38,]	1	1	1	1	0	0	0
##	[39,]	1	1	1	1	1	1	1
##	[40,]	0	0	1	0	0	0	0
##	[41,]	0	0	1	0	0	0	0
##	[42,]	0	0	0	0	0	0	0
##	[43,]	1	1	1	1	1	1	1
##	[44,]	1	1	1	1	0	0	0
##	[45,]	1	1	1	1	0	0	1
##	[46,]	0	0	0	0	0	0	0
##	[47,]	1	0	0	1	0	0	0
##	[48,]	0	0	0	0	0	0	0
##	[49,]	1	1	1	1	1	0	1
##	[50,]	0	0	1	0	0	0	0
##	[51,]	0	0	0	0	0	0	0
##	[52,]	1	1	1	1	1	1	1
##	[53,]	0	0	0	0	0	0	0
##	[54,]	0	0	0	0	0	0	0
##	[55,]	0	0	0	0	0	0	0
##	[56,]	1	1	1	1	0	0	1
##	[57,]	0	0	0	0	0	0	0
##	[58,]	1	0	1	0	0	0	0
##	[59,]	0	0	0	0	0	0	0
##	[60,]	0	0	0	0	0	0	0
##	[61,]	0	0	0	0	0	0	0
##	[62,]	0	0	0	0	0	0	0
##	[63,]	0	0	0	0	0	0	0
##	[64,]	0	0	0	0	0	0	0
##	[65,]	0	0	0	0	0	0	0
##	[66,]	0	0	0	1	0	0	0
##	[67,]	0	0	0	0	0	0	0

## [68,]	1	1	1	1	1	1	1	1
## [69,]	0	0	0	0	0	0	0	0
## [70,]	0	0	0	0	0	0	0	0
## [71,]	0	0	0	0	0	0	0	0
## [72,]	0	0	0	0	0	0	0	0
## [73,]	0	0	0	0	0	0	0	0
## [74,]	0	0	0	0	0	0	0	0
## [75,]	0	0	0	0	0	0	0	0
## [76,]	0	0	0	0	0	0	0	0
## [77,]	0	0	0	0	0	0	0	0
## [78,]	0	0	0	0	0	0	0	0
## [79,]	0	0	0	0	0	0	0	0
## [80,]	0	0	0	0	0	0	0	0
## [81,]	0	1	1	0	0	0	0	0
## [82,]	0	0	0	0	0	0	0	0
## [83,]	0	0	0	0	0	0	0	0
## [84,]	0	0	0	0	0	0	0	0
## [85,]	0	0	0	0	0	0	0	0
## [86,]	1	1	1	1	1	1	1	1
## [87,]	0	0	0	0	0	0	0	0
## [88,]	0	0	0	0	0	0	0	0
## [89,]	0	0	0	0	0	0	0	0
## [90,]	0	0	0	0	0	0	0	0
## [91,]	0	0	0	0	0	0	0	0
## [92,]	0	0	0	0	0	0	0	0
## [93,]	0	0	0	0	0	0	0	0
## [94,]	0	0	0	0	0	0	0	0
## [95,]	0	1	1	1	0	0	0	0
## [96,]	1	1	1	1	1	1	1	1
## [97,]	0	0	0	0	0	0	0	0
## [98,]	1	1	1	1	1	1	1	1
## [99,]	0	0	0	0	0	0	0	0
## [100,]	0	0	0	0	0	0	0	0
## [101,]	0	0	0	0	0	0	0	0
## [102,]	0	0	0	0	0	0	0	0
## [103,]	1	1	1	1	1	1	0	0
## [104,]	0	0	0	0	0	0	0	0
## [105,]	0	0	0	0	0	0	0	0
## [106,]	0	0	0	0	0	0	0	0
## [107,]	1	1	1	1	1	1	1	1
## [108,]	0	0	0	0	0	0	0	0
## [109,]	0	0	1	0	0	0	0	0
## [110,]	1	1	1	1	1	1	1	1
## [111,]	0	0	0	0	0	0	0	0
## [112,]	0	0	0	0	0	0	0	0
## [113,]	0	0	0	0	0	0	0	0
## [114,]	0	0	0	0	0	0	0	0
## [115,]	1	1	1	1	0	0	0	0
## [116,]	0	0	0	0	0	0	0	0
## [117,]	1	1	1	1	1	1	1	1
## [118,]	0	0	0	0	0	0	0	0
## [119,]	0	0	0	0	0	0	0	0
## [120,]	0	0	0	0	0	0	0	0
## [121,]	1	1	1	1	1	1	1	1

## [122,]	0	0	1	0	0	0	0	0
## [123,]	0	0	0	0	0	0	0	0
## [124,]	0	0	0	0	0	0	0	0
## [125,]	1	1	1	1	1	1	1	1
## [126,]	0	0	0	0	0	0	0	0
## [127,]	1	0	1	0	0	0	0	0
## [128,]	0	0	0	0	0	0	0	0
## [129,]	1	1	1	1	1	1	1	1
## [130,]	0	0	0	0	0	0	0	0
## [131,]	1	0	1	1	0	0	0	0
## [132,]	0	0	1	0	0	0	0	0
## [133,]	1	1	1	1	0	0	0	1
## [134,]	0	0	0	0	0	0	0	0
## [135,]	0	0	0	0	0	0	0	0
## [136,]	0	0	0	0	0	0	0	0
## [137,]	0	0	0	0	0	0	0	0
## [138,]	0	0	0	0	0	0	0	0
## [139,]	0	0	0	0	0	0	0	0
## [140,]	1	1	1	1	1	1	1	1
## [141,]	0	0	0	0	0	0	0	0
## [142,]	1	1	1	1	0	0	0	1
## [143,]	0	0	0	0	0	0	0	0
## [144,]	0	0	0	0	0	0	0	0
## [145,]	1	1	0	1	0	0	0	0
## [146,]	0	1	0	0	0	0	0	0
## [147,]	0	1	1	1	0	0	0	0
## [148,]	0	0	0	0	0	0	0	0
## [149,]	0	0	0	0	0	0	0	0
## [150,]	1	1	1	1	0	1	0	1
## [151,]	0	0	0	0	0	0	0	0
## [152,]	0	0	0	0	0	0	0	0
## [153,]	1	1	0	1	0	0	0	0
## [154,]	0	1	0	0	0	0	0	0
## [155,]	0	0	0	0	0	0	0	0
## [156,]	0	0	0	0	0	0	0	0
## [157,]	1	1	1	1	0	1	0	0
## [158,]	1	1	1	1	0	0	0	0
## [159,]	0	0	0	0	0	0	0	0
## [160,]	0	0	0	0	0	0	0	0
## [161,]	0	0	0	0	0	0	0	0
## [162,]	1	1	1	1	1	1	1	1
## [163,]	0	0	0	0	0	0	0	0
## [164,]	0	0	0	0	0	0	0	0
## [165,]	0	0	0	0	0	0	0	0
## [166,]	1	1	1	1	0	0	0	0
## [167,]	0	0	0	0	0	0	0	0
## [168,]	0	0	0	0	0	0	0	0
## [169,]	1	1	1	1	1	1	1	1
## [170,]	0	0	0	0	0	0	0	0
## [171,]	0	0	0	0	0	0	0	0
## [172,]	1	1	1	1	1	1	1	1
## [173,]	0	0	0	0	0	0	0	0
## [174,]	0	0	0	0	0	0	0	0
## [175,]	0	0	0	0	0	0	0	0

## [176,]	1	1	1	1	1	1	1	1
## [177,]	0	0	0	0	0	0	0	0
## [178,]	1	1	1	1	1	1	1	1
## [179,]	0	0	0	0	0	0	0	0
## [180,]	0	0	0	0	0	0	0	0
## [181,]	1	1	1	1	0	1	1	1
## [182,]	1	1	1	1	0	0	0	1
## [183,]	0	0	0	0	0	0	0	0
## [184,]	0	0	0	0	0	0	0	0
## [185,]	0	0	0	0	0	0	0	0
## [186,]	1	1	1	1	1	1	1	1
## [187,]	0	0	0	0	0	0	0	0
## [188,]	0	0	0	0	0	0	0	0
## [189,]	1	1	1	1	1	1	1	1
## [190,]	1	1	1	1	0	0	0	0
## [191,]	1	1	1	1	1	1	1	1
## [192,]	1	1	1	1	1	1	1	1
## [193,]	1	1	1	1	0	0	0	1
## [194,]	1	1	1	1	1	1	1	1
## [195,]	1	0	1	1	0	0	0	1
## [196,]	0	0	0	0	0	0	0	0
## [197,]	1	0	0	1	0	0	0	0
## [198,]	1	1	1	1	1	1	1	1
## [199,]	0	0	0	0	0	0	0	0
## [200,]	0	0	1	1	0	0	0	0
## [201,]	0	0	0	0	0	0	0	0
## [202,]	1	1	1	1	0	0	0	1
## [203,]	1	1	1	1	0	0	0	1
## [204,]	0	0	0	0	0	0	0	0
## [205,]	1	1	1	1	0	0	0	1
## [206,]	1	1	1	1	0	0	0	1
## [207,]	0	0	0	0	0	0	0	0
## [208,]	1	0	0	1	0	0	0	0
## [209,]	0	0	0	0	0	0	0	0
## [210,]	0	0	0	1	0	0	0	0
## [211,]	0	1	0	0	0	0	0	0
## [212,]	0	0	0	0	0	0	0	0
## [213,]	1	1	1	1	0	1	0	1
## [214,]	1	1	1	1	1	1	0	1
## [215,]	0	0	0	0	0	0	0	0
## [216,]	1	0	1	1	0	0	0	0
## [217,]	1	1	1	1	0	0	0	1
## [218,]	1	1	1	1	0	0	0	1
## [219,]	0	0	0	0	0	0	0	0
## [220,]	1	1	1	1	0	0	0	1
## [221,]	1	1	1	0	0	0	0	0
## [222,]	0	0	0	0	0	0	0	0
## [223,]	1	1	1	1	1	1	1	1
## [224,]	1	1	1	1	1	1	1	1
## [225,]	0	0	0	0	0	0	0	0
## [226,]	0	0	0	0	0	0	0	0
## [227,]	0	0	0	0	0	0	0	0
## [228,]	0	0	0	0	0	0	0	0
## [229,]	0	0	0	0	0	0	0	0

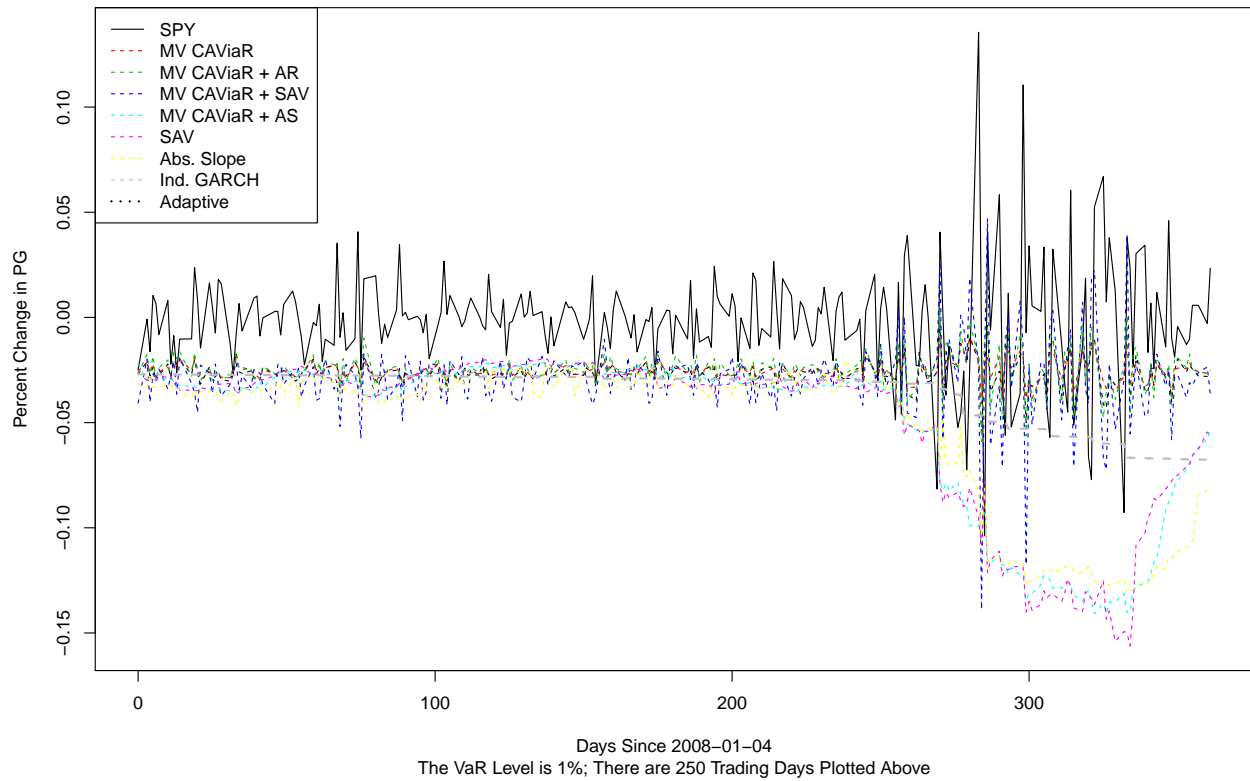
```

## [230,] 1 1 1 1 1 1 1 1
## [231,] 0 0 0 0 0 0 0 0
## [232,] 0 0 0 0 0 0 0 0
## [233,] 1 0 1 1 0 0 0 1
## [234,] 0 0 0 0 0 0 0 0
## [235,] 0 0 0 0 0 0 0 0
## [236,] 1 1 0 1 0 0 0 0
## [237,] 0 0 0 0 0 0 0 0
## [238,] 1 1 1 1 0 0 0 1
## [239,] 0 0 0 0 0 0 0 0
## [240,] 1 0 1 1 0 0 0 0
## [241,] 0 0 0 0 0 0 0 0
## [242,] 1 1 0 1 0 0 0 0
## [243,] 1 1 1 1 0 0 0 0
## [244,] 0 1 1 0 0 0 0 0
## [245,] 1 1 1 1 0 0 0 0
## [246,] 1 0 1 0 0 0 0 0
## [247,] 0 0 0 0 0 0 0 0
## [248,] 0 0 0 0 0 0 0 0
## [249,] 0 0 0 0 0 0 0 0
## [250,] 0 0 0 0 0 0 0 0
##
##
## [[4]]
## \begin{table}[t]
##
## \caption{\label{tab:unnamed-chunk-28}Comparison of VaR Methods for a 10% VaR}
## \centering
## \begin{tabular}{l|r|r|r|r|r|r|r}
## \hline
## & M1 & M2 & M3 & M4 & M5 & M6 & M7 & M8\\
## \hline
## Losses & 1.623 & 1.564 & 1.738 & 1.534 & 1.077 & 1.066 & 1.068 & 1.366\\
## \hline
## VaR Breaks (%) & 0.328 & 0.312 & 0.348 & 0.332 & 0.144 & 0.156 & 0.140 & 0.224\\
## \hline
## \multicolumn{9}{l}{\textit{Note: }}\\
## \multicolumn{9}{l}{Calculated using 250 trading days from 2008-01-04 to 2008-12-30}\\
## \end{tabular}
## \end{table}

```

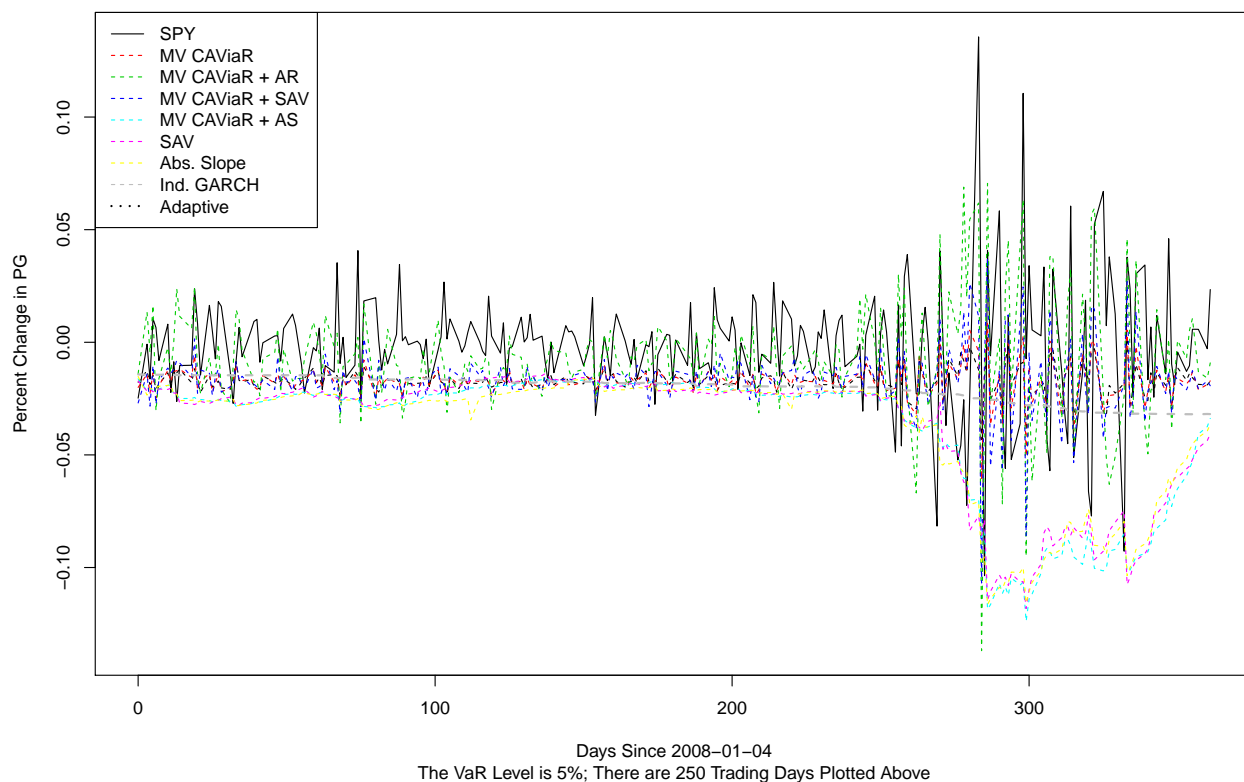
Global ETFs

Predicting SPY Returns from 2008-01-04 to 2008-12-30



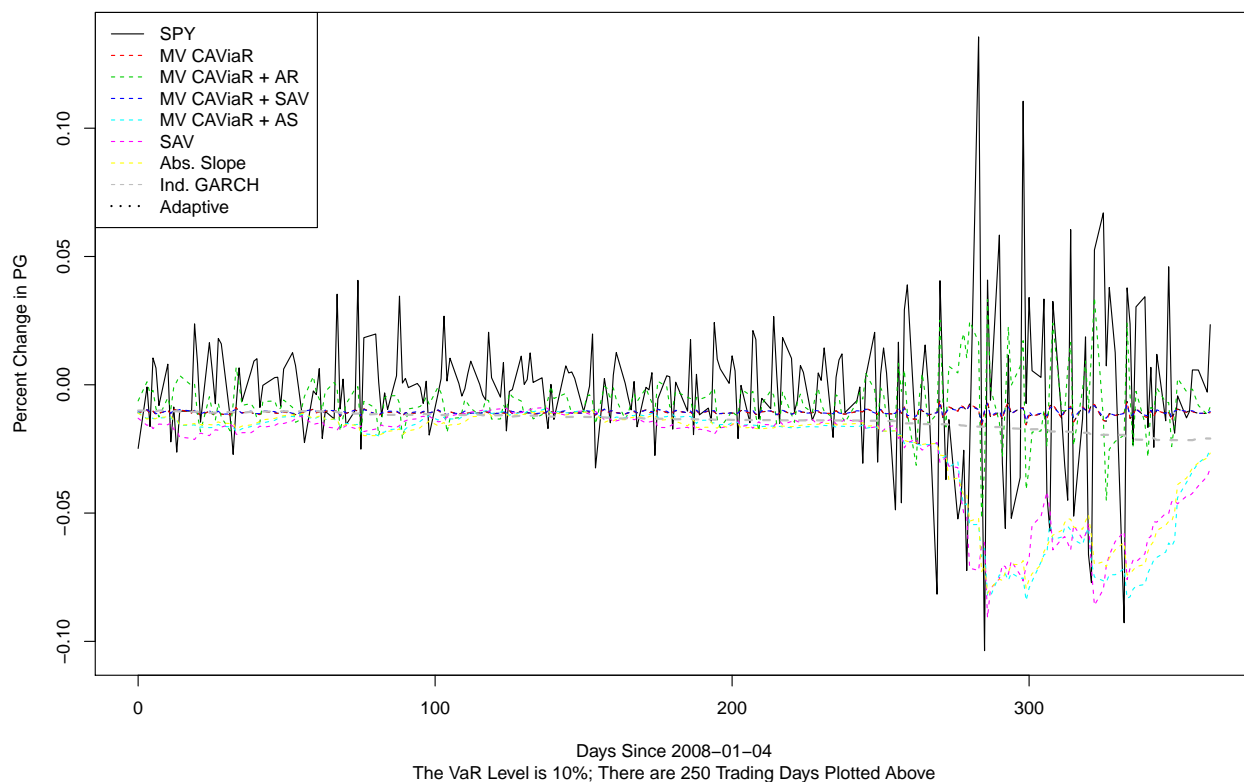
```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.1023135
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.1472487
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.13701735 0.12678600 0.11655465 0.10632330 0.09609195 0.08586060
## [7] 0.07562925 0.06539790 0.05516654
```


Predicting SPY Returns from 2008-01-04 to 2008-12-30



```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.09555369
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.1464776
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.13692221 0.12736685 0.11781148 0.10825611 0.09870074 0.08914537
## [7] 0.07959000 0.07003463 0.06047926
```

Predicting SPY Returns from 2008-01-04 to 2008-12-30

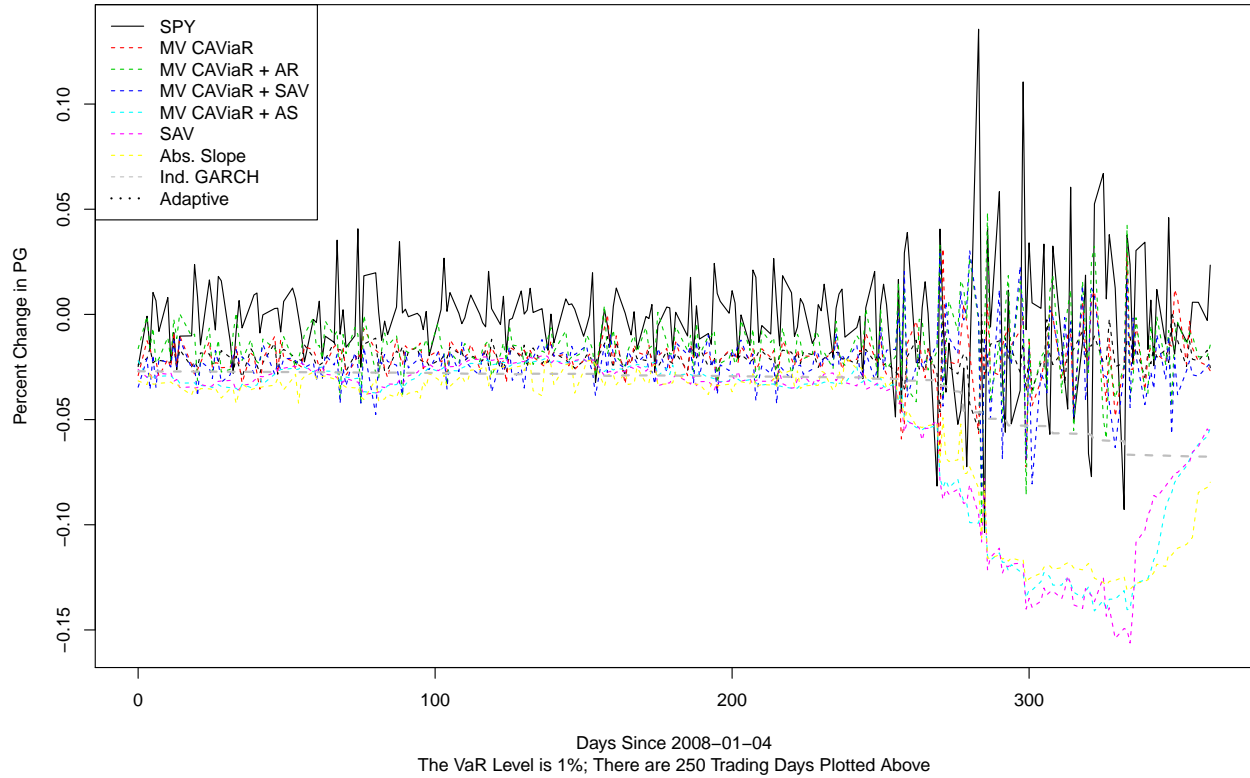


```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.08388041
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.145146
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.13675792 0.12836988 0.11998184 0.11159380 0.10320576 0.09481772
## [7] 0.08642968 0.07804164 0.06965360
```

Commodity ETFs

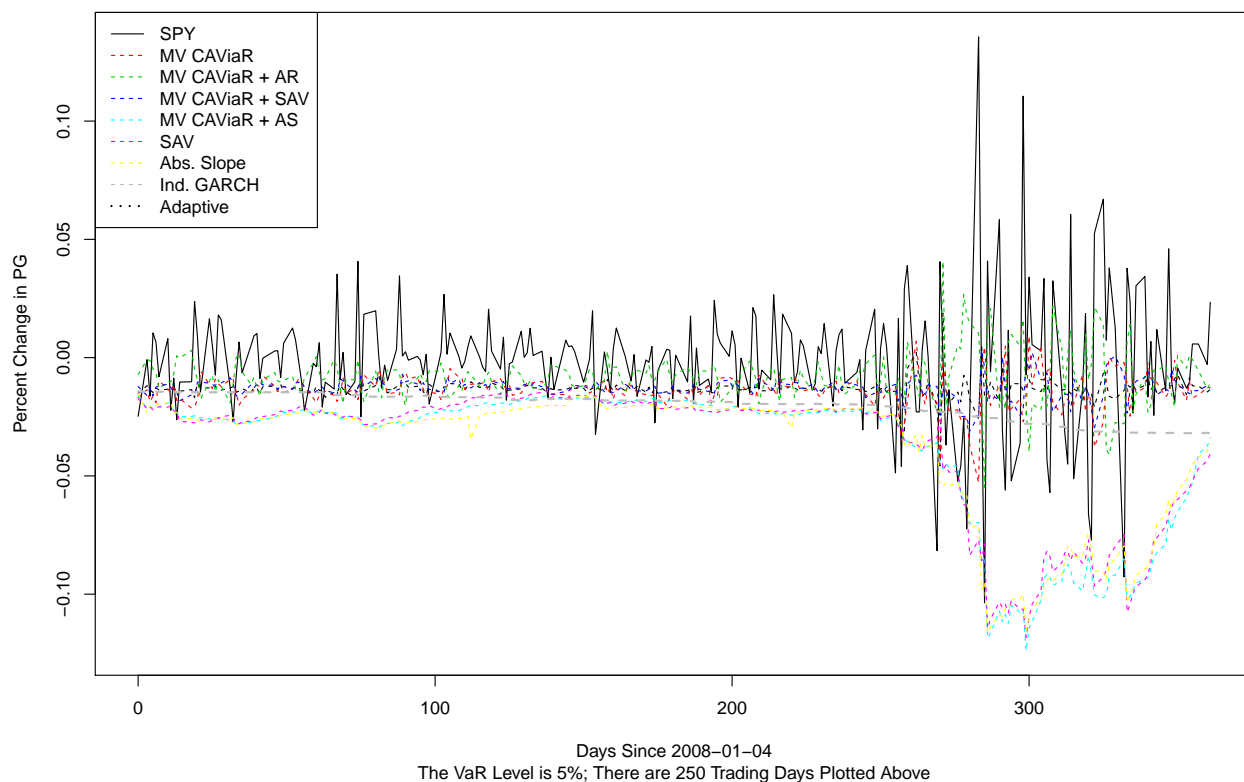
Bond ETFs

Predicting SPY Returns from 2008-01-04 to 2008-12-30



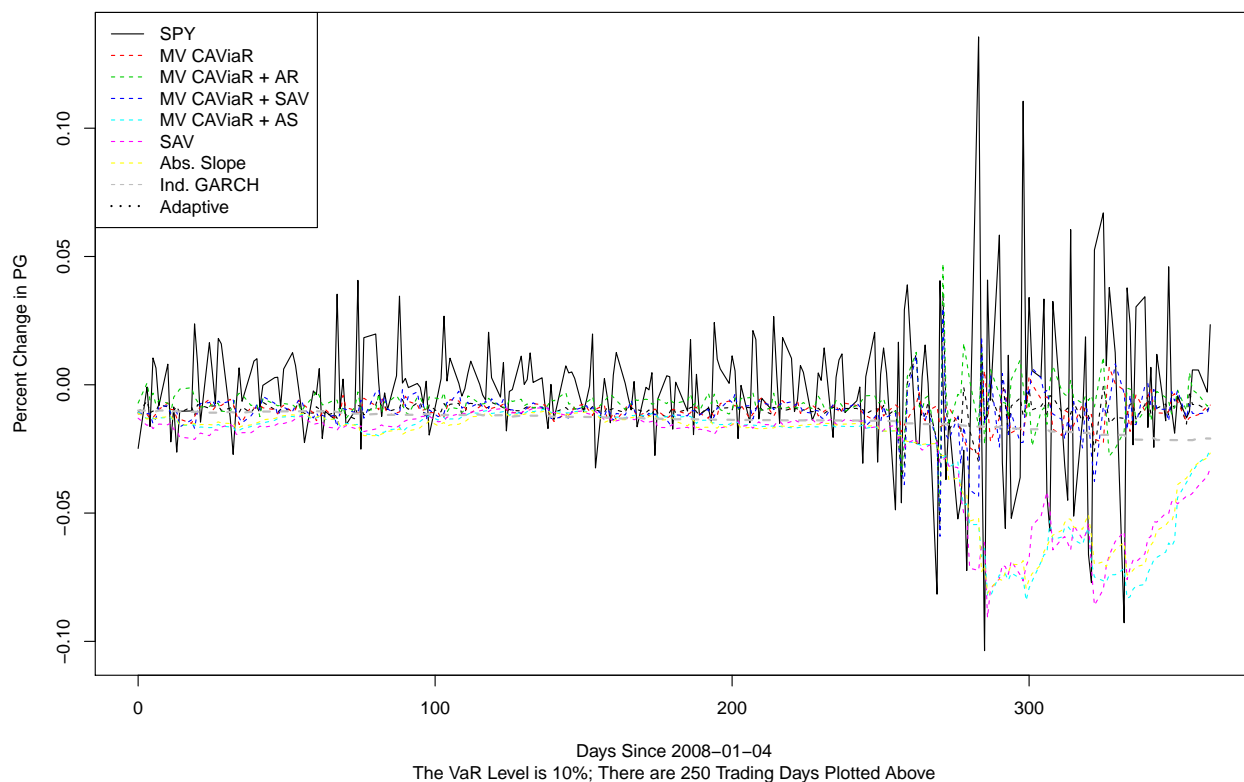
```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.1023135
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.1472487
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.13701735 0.12678600 0.11655465 0.10632330 0.09609195 0.08586060
## [7] 0.07562925 0.06539790 0.05516654
```

Predicting SPY Returns from 2008-01-04 to 2008-12-30



```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.09098009
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.1459559
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.13685785 0.12775984 0.11866183 0.10956382 0.10046581 0.09136780
## [7] 0.08226979 0.07317178 0.06407377
```

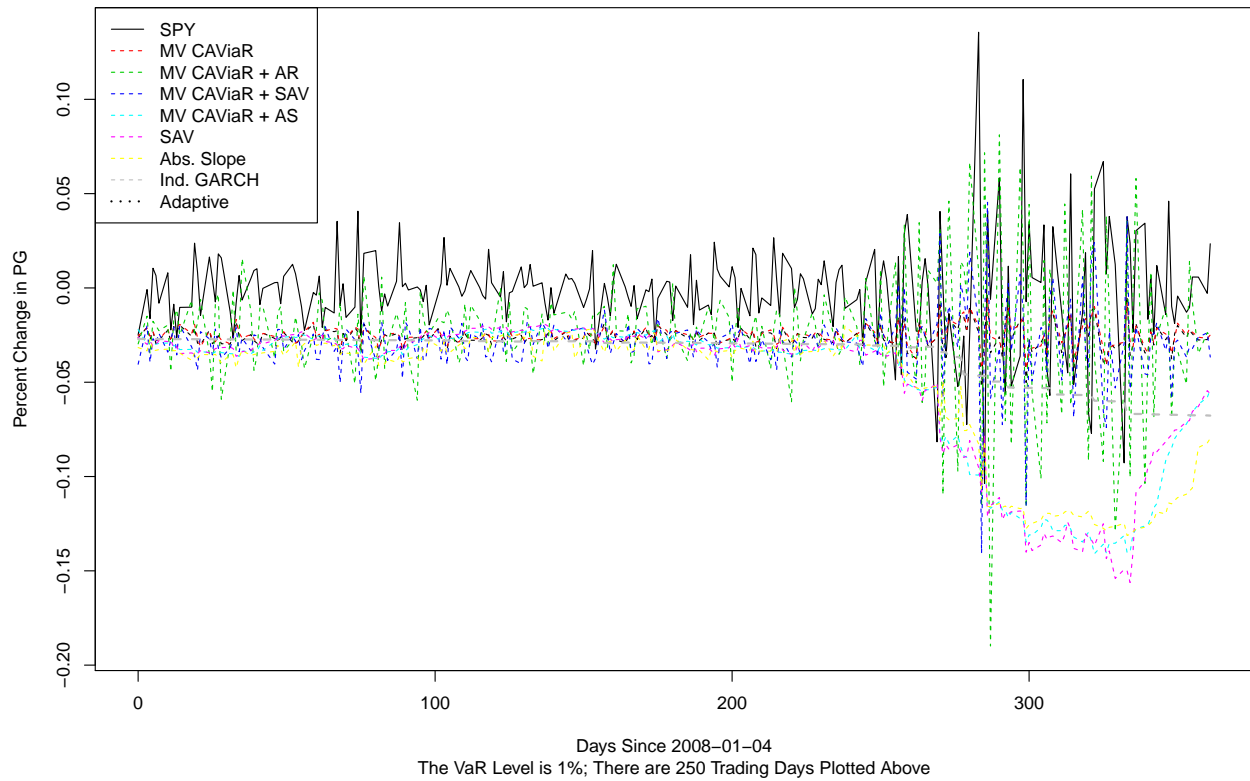
Predicting SPY Returns from 2008-01-04 to 2008-12-30



```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.08388041
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.145146
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.13675792 0.12836988 0.11998184 0.11159380 0.10320576 0.09481772
## [7] 0.08642968 0.07804164 0.06965360
```

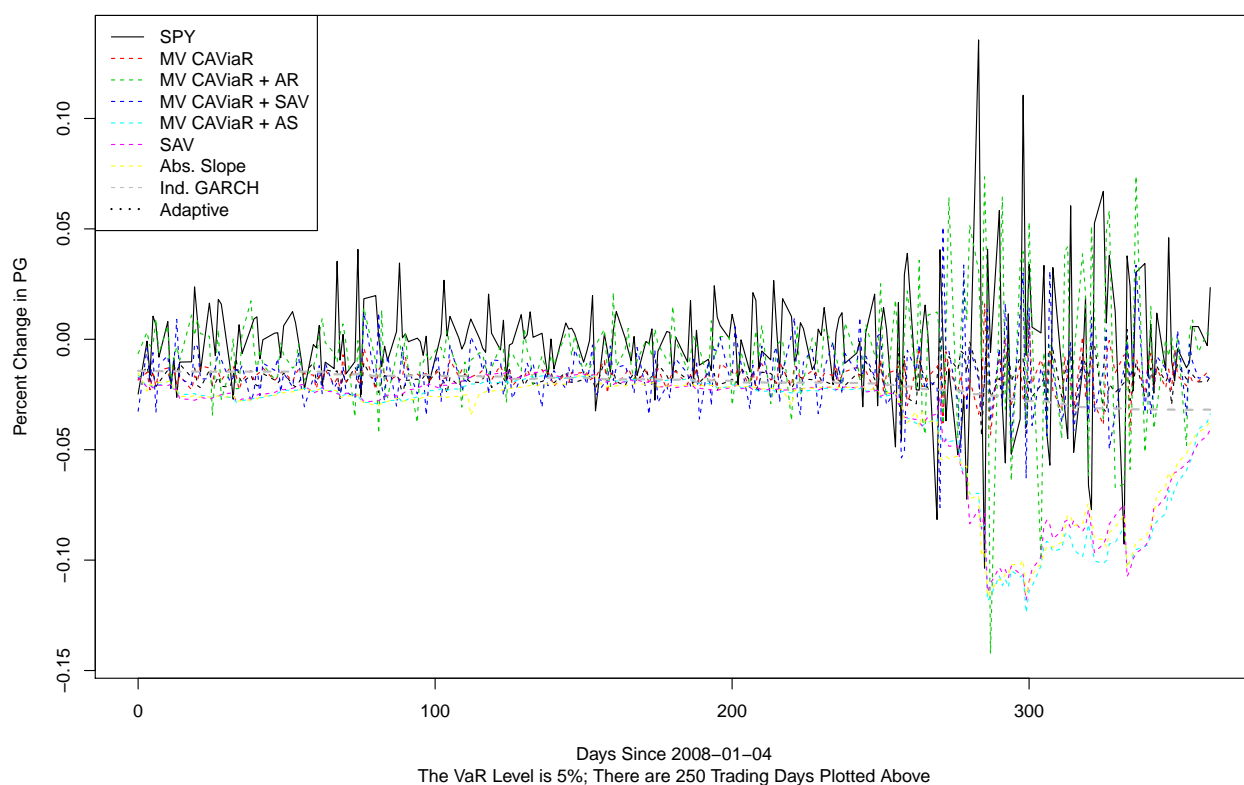
All ETFs

Predicting SPY Returns from 2008-01-04 to 2008-12-30



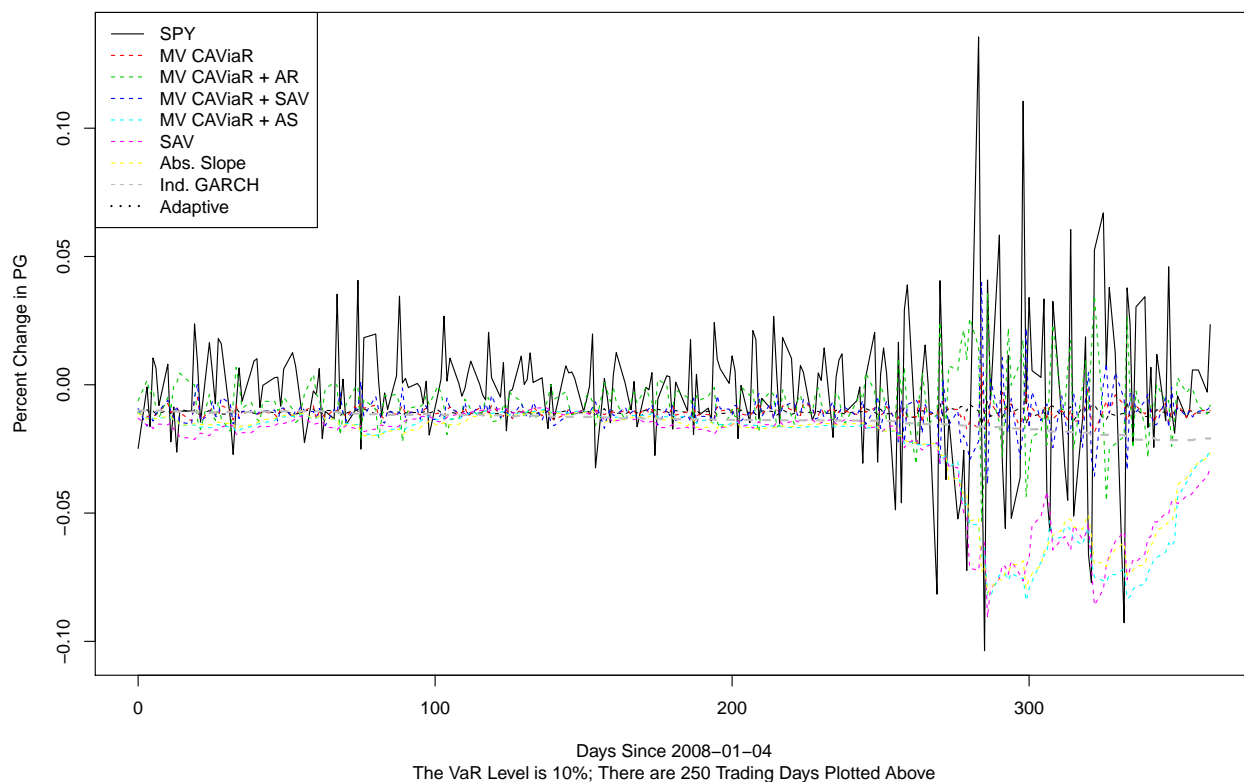
```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.1141163
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.1485951
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.13718347 0.12577184 0.11436021 0.10294859 0.09153696 0.08012533
## [7] 0.06871371 0.05730208 0.04589045
```

Predicting SPY Returns from 2008-01-04 to 2008-12-30



```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.09746432
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.1466955
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.13694910 0.12720267 0.11745624 0.10770981 0.09796338 0.08821694
## [7] 0.07847051 0.06872408 0.05897765
```

Predicting SPY Returns from 2008-01-04 to 2008-12-30

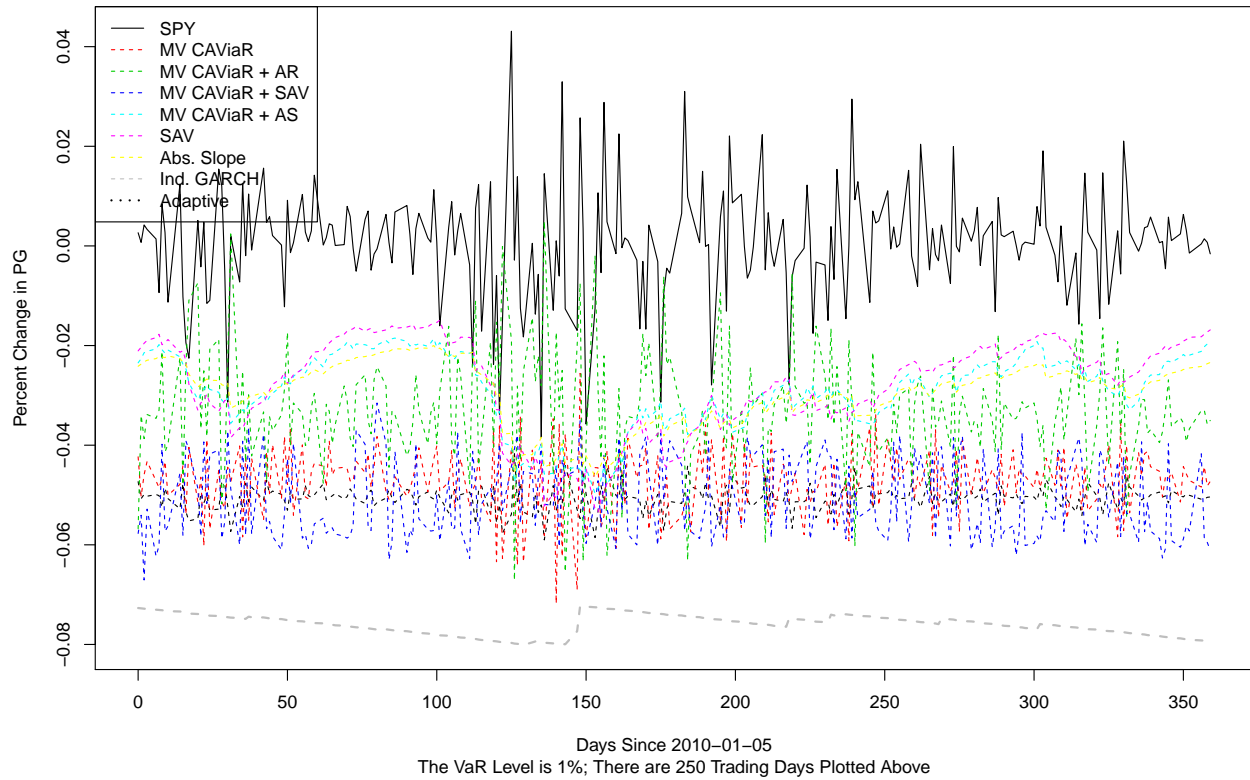


```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.08388041
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.145146
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.13675792 0.12836988 0.11998184 0.11159380 0.10320576 0.09481772
## [7] 0.08642968 0.07804164 0.06965360
```


2010 Ending

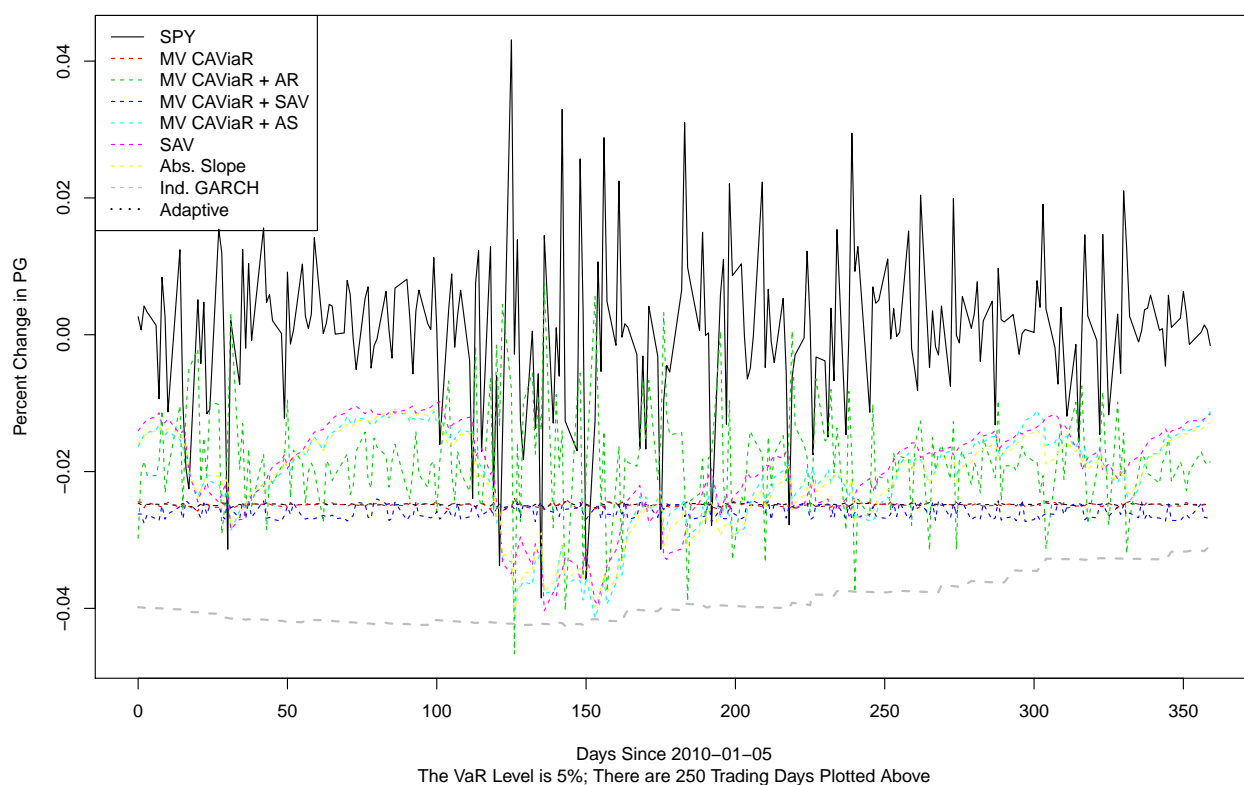
U.S. ETFs

Predicting SPY Returns from 2010-01-05 to 2010-12-30



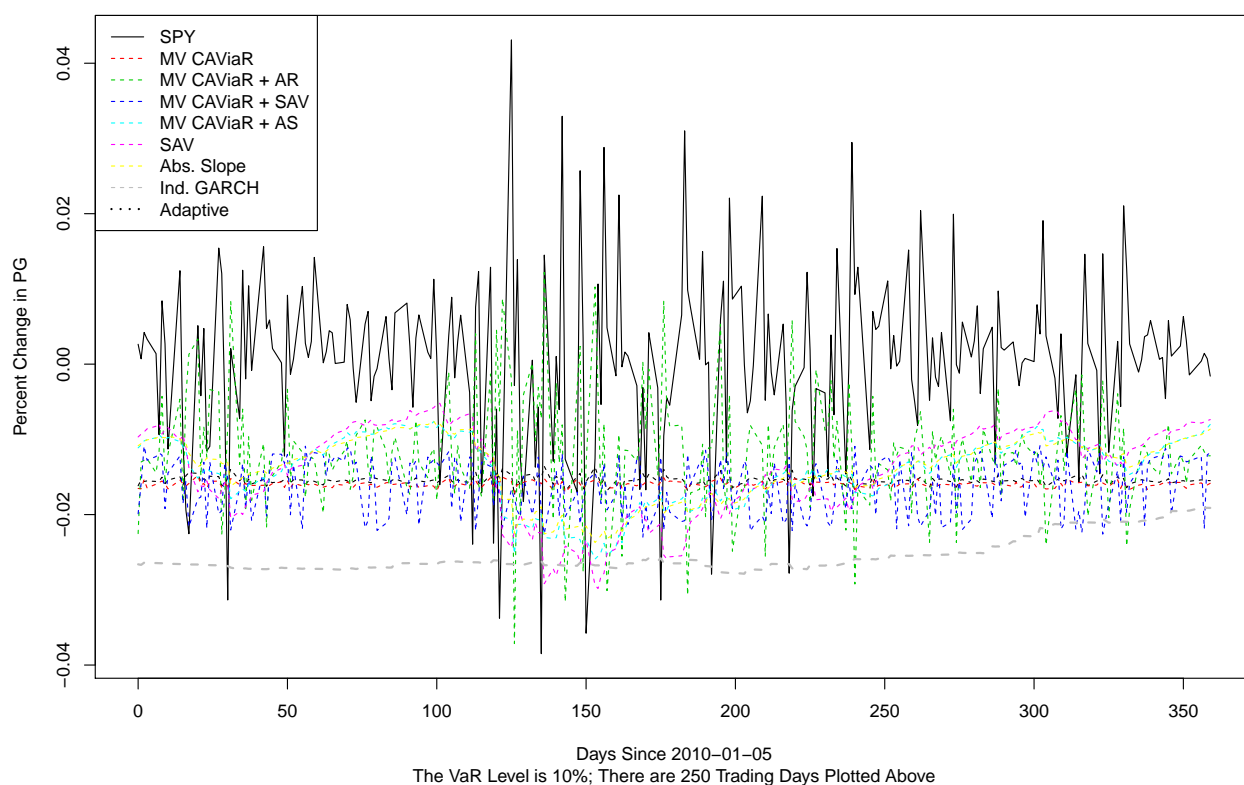
```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.04320275
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.04802718
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.043706906 0.039386631 0.035066356 0.030746080 0.026425805 0.022105530
## [7] 0.017785255 0.013464980 0.009144705
```

Predicting SPY Returns from 2010-01-05 to 2010-12-30



```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.03146179
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.04668784
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.04354166 0.04039548 0.03724931 0.03410313 0.03095695 0.02781077
## [7] 0.02466459 0.02151841 0.01837223
```

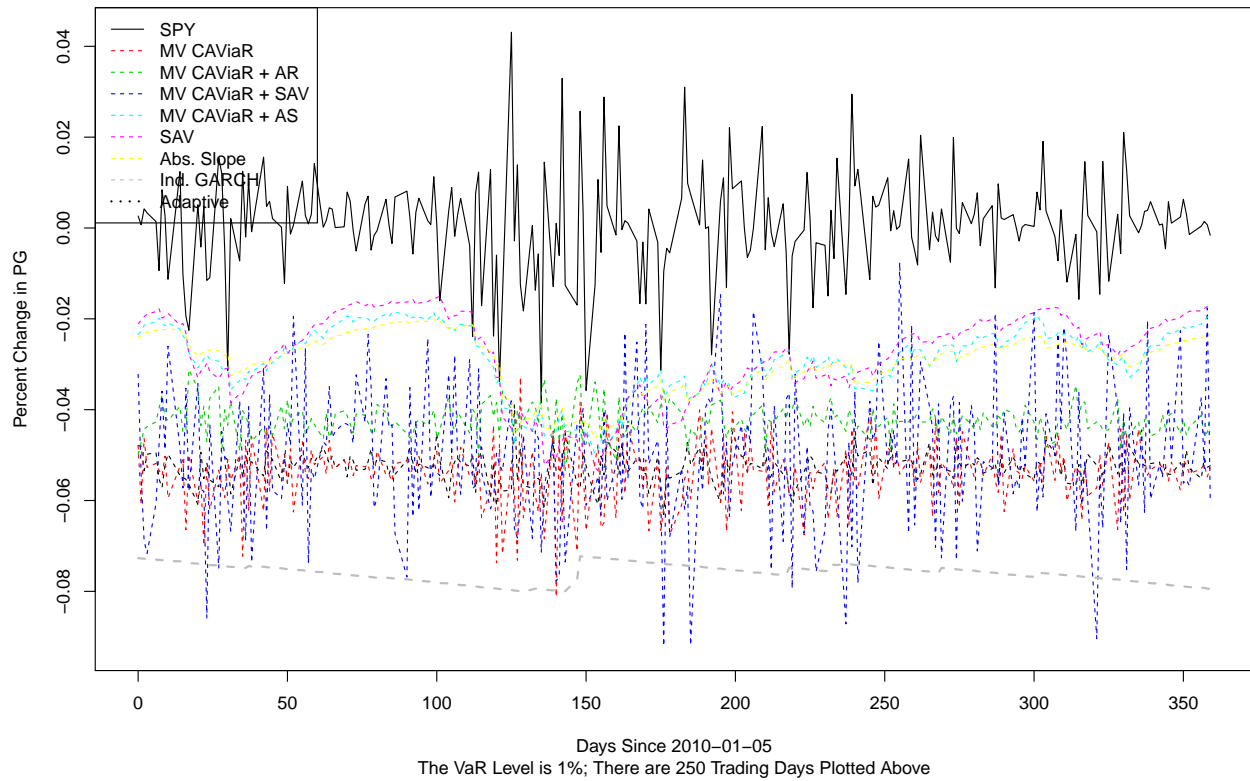
Predicting SPY Returns from 2010-01-05 to 2010-12-30



```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02860942
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.04636246
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.04350152 0.04064058 0.03777963 0.03491869 0.03205775 0.02919681
## [7] 0.02633586 0.02347492 0.02061398
```

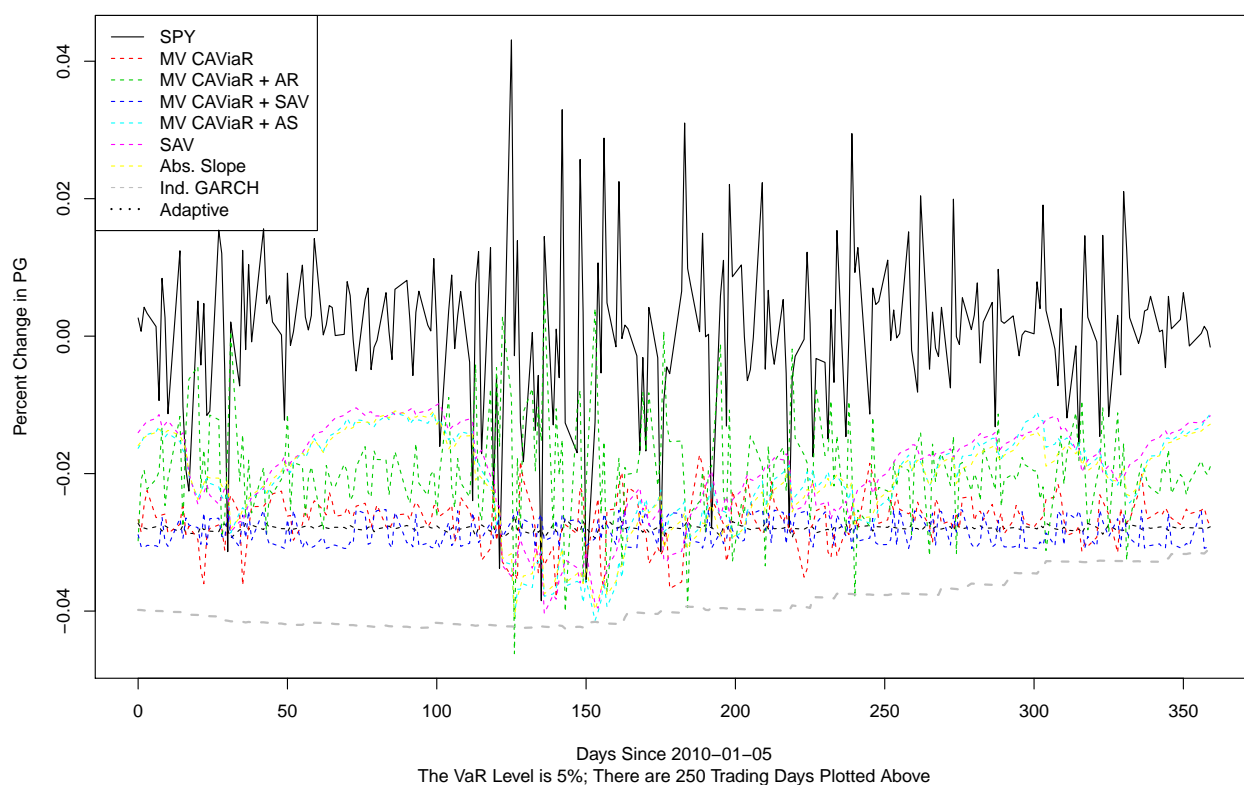
Global ETFs

Predicting SPY Returns from 2010-01-05 to 2010-12-30



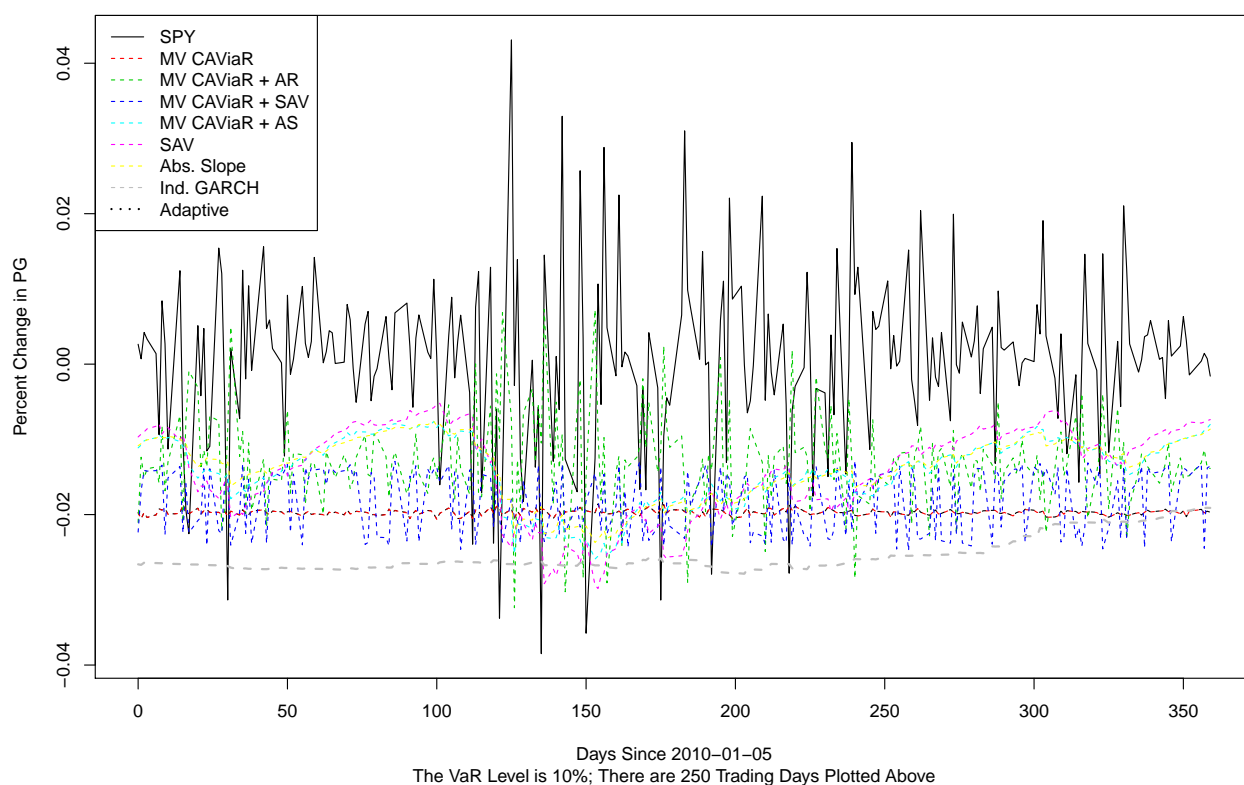
```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.04738496
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.04850426
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.043765767 0.039027271 0.034288774 0.029550278 0.024811782 0.020073286
## [7] 0.015334790 0.010596294 0.005857798
```

Predicting SPY Returns from 2010-01-05 to 2010-12-30



```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.03131297
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.04667087
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.04353957 0.04040827 0.03727697 0.03414568 0.03101438 0.02788308
## [7] 0.02475178 0.02162049 0.01848919
```

Predicting SPY Returns from 2010-01-05 to 2010-12-30

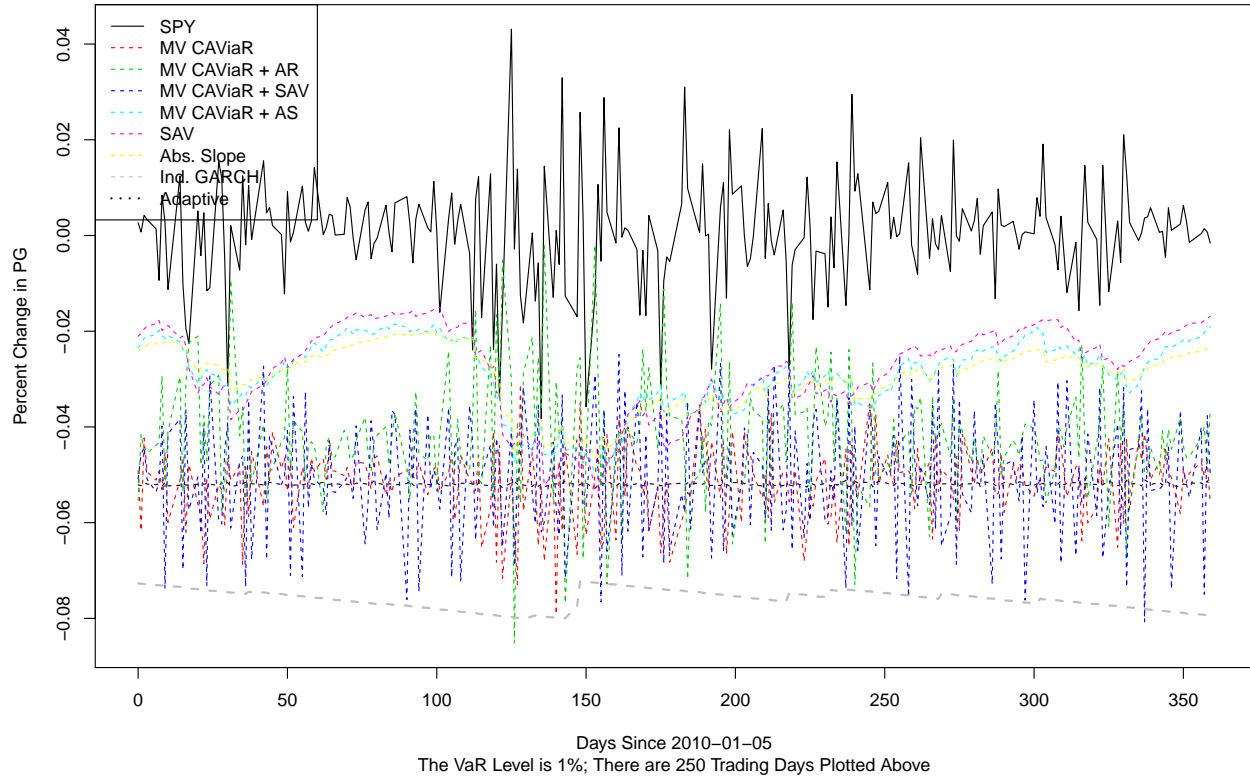


```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02860942
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.04636246
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.04350152 0.04064058 0.03777963 0.03491869 0.03205775 0.02919681
## [7] 0.02633586 0.02347492 0.02061398
```

Commodity ETFs

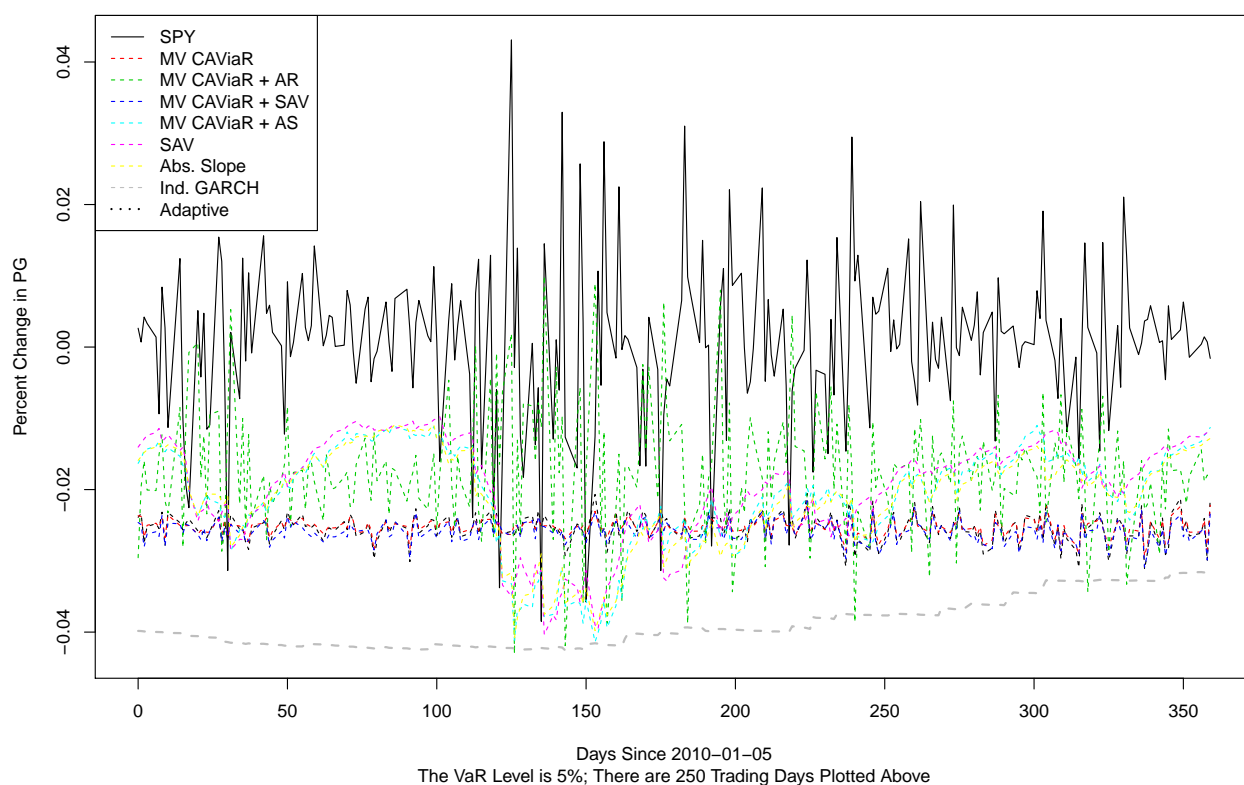
Bond ETFs

Predicting SPY Returns from 2010-01-05 to 2010-12-30



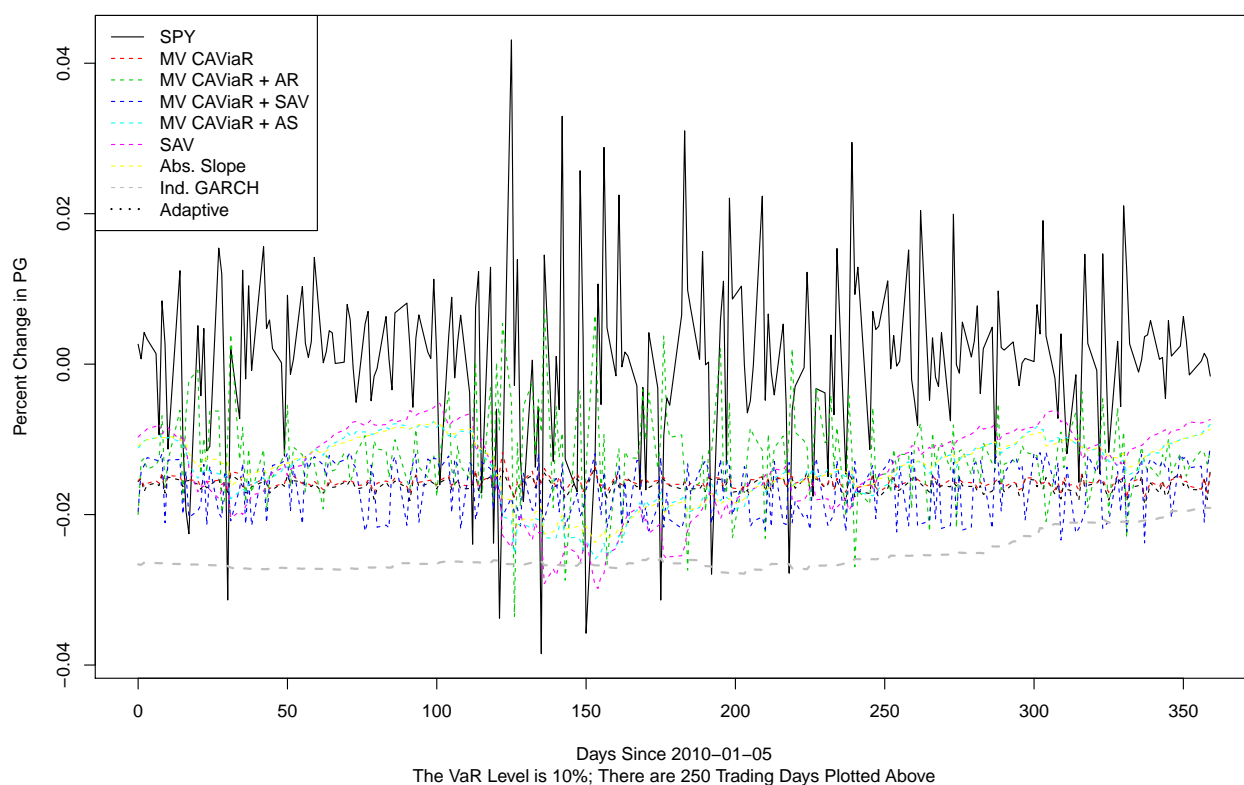
```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.04496796
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.04822855
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.043731750 0.039234954 0.034738158 0.030241363 0.025744567 0.021247772
## [7] 0.016750976 0.012254180 0.007757385
```

Predicting SPY Returns from 2010-01-05 to 2010-12-30



```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.03020047
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.04654396
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.04352391 0.04050386 0.03748382 0.03446377 0.03144372 0.02842368
## [7] 0.02540363 0.02238358 0.01936354
```

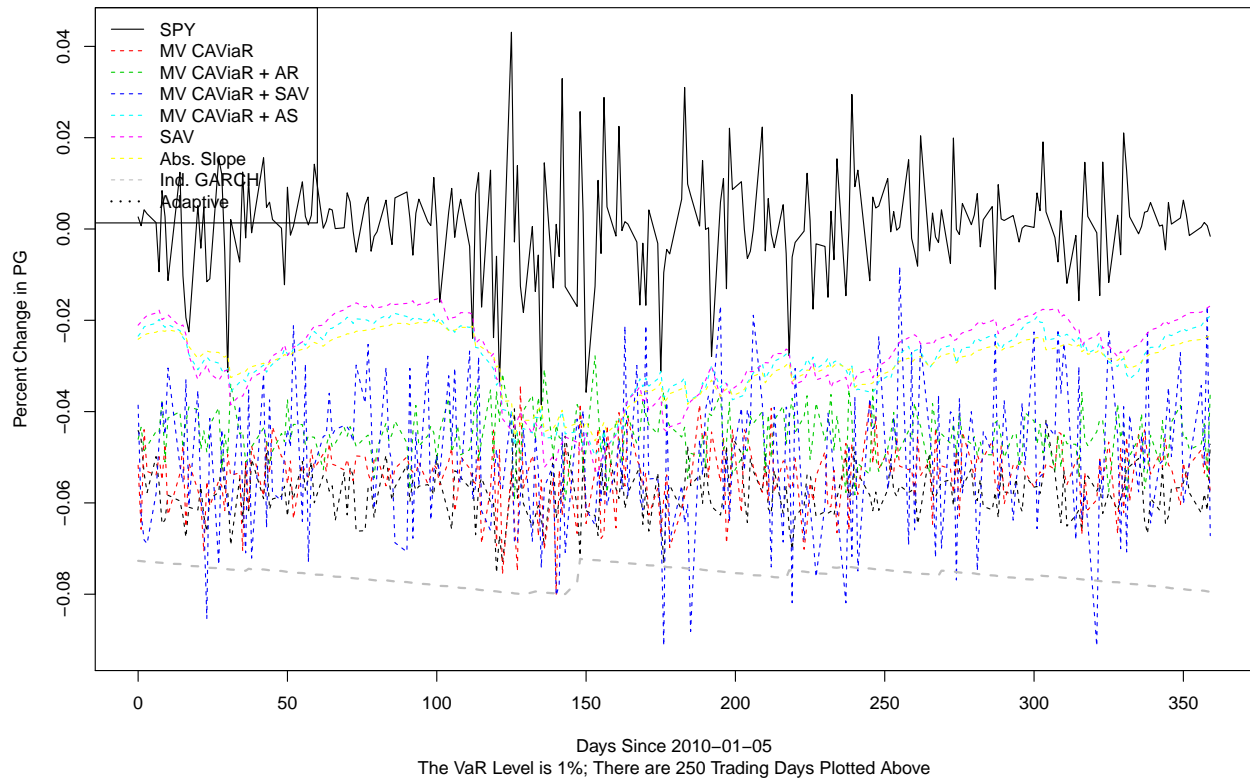

Predicting SPY Returns from 2010-01-05 to 2010-12-30



```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02860942
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.04636246
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.04350152 0.04064058 0.03777963 0.03491869 0.03205775 0.02919681
## [7] 0.02633586 0.02347492 0.02061398
```

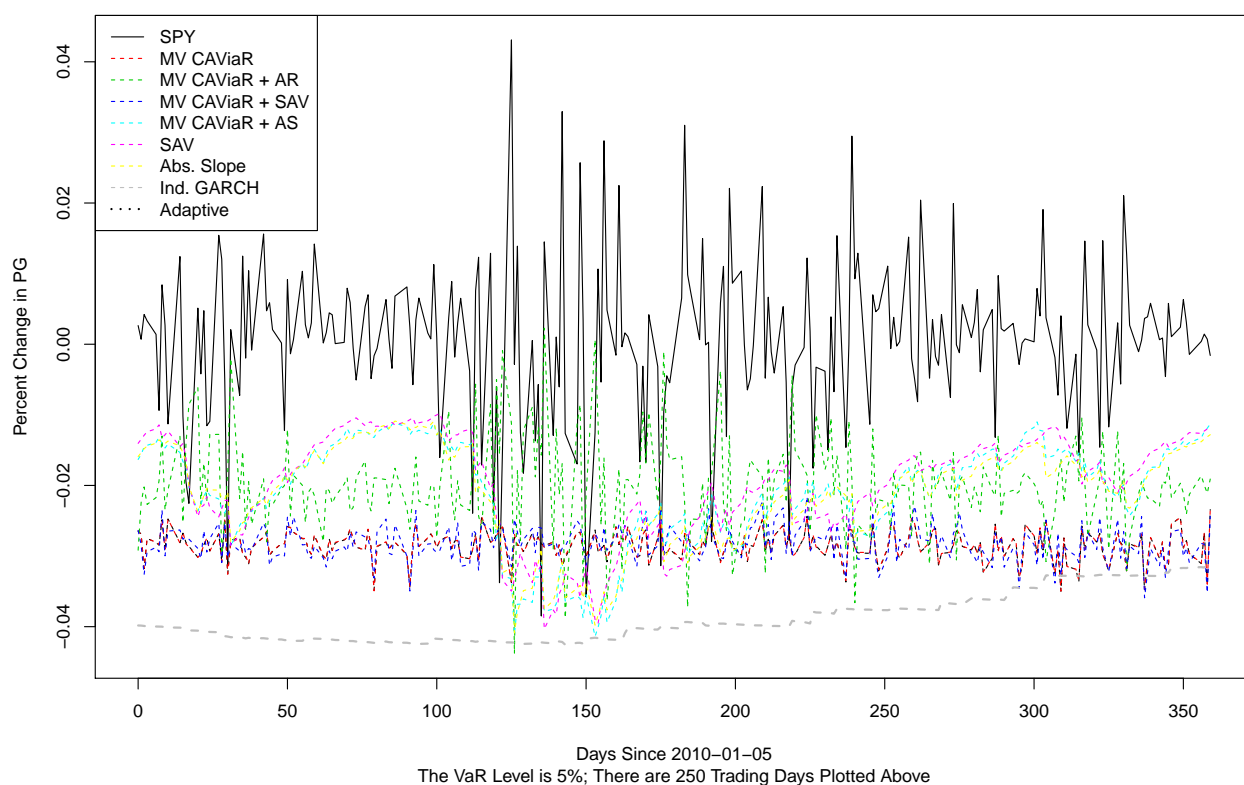
All ETFs

Predicting SPY Returns from 2010-01-05 to 2010-12-30



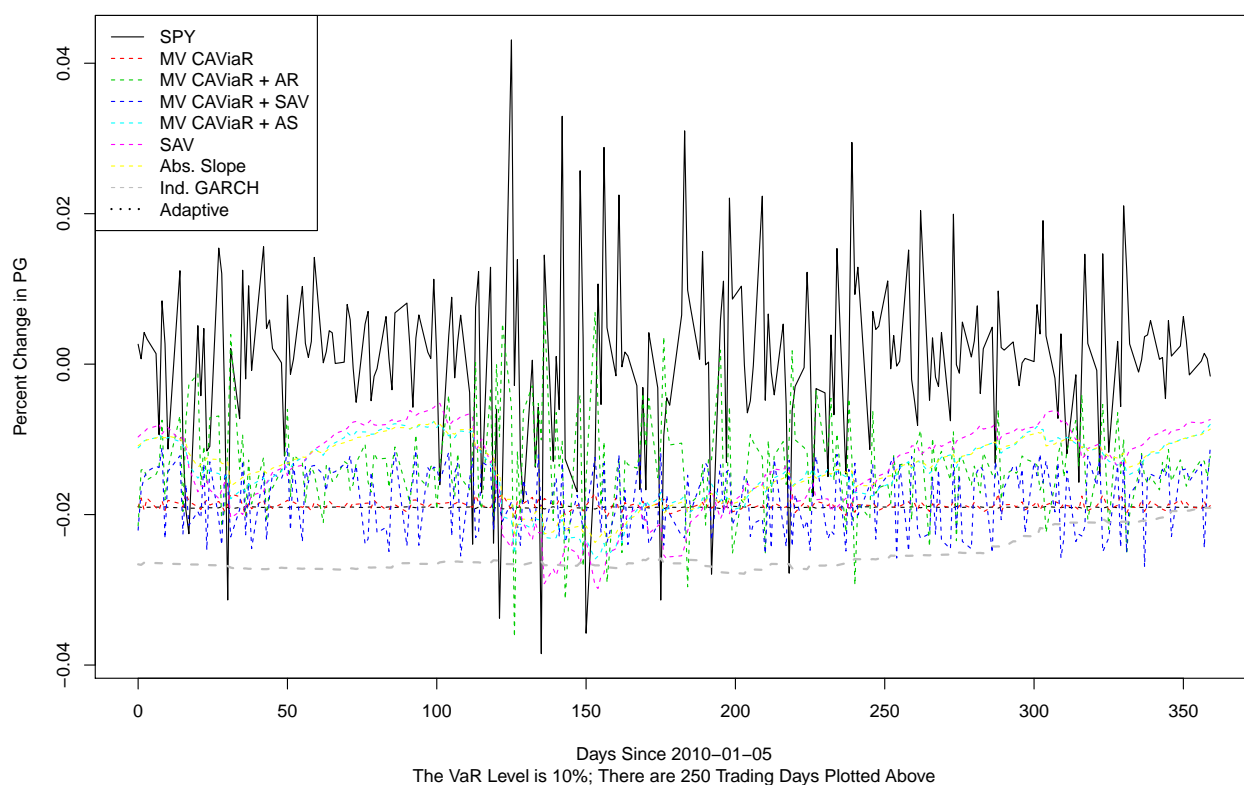
```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.04714375
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.04847675
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.043762372 0.039047996 0.034333621 0.029619245 0.024904870 0.020190495
## [7] 0.015476119 0.010761744 0.006047368
```

Predicting SPY Returns from 2010-01-05 to 2010-12-30



```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.03048103
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.04657596
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.04352786 0.04047976 0.03743165 0.03438355 0.03133545 0.02828735
## [7] 0.02523924 0.02219114 0.01914304
```

Predicting SPY Returns from 2010-01-05 to 2010-12-30

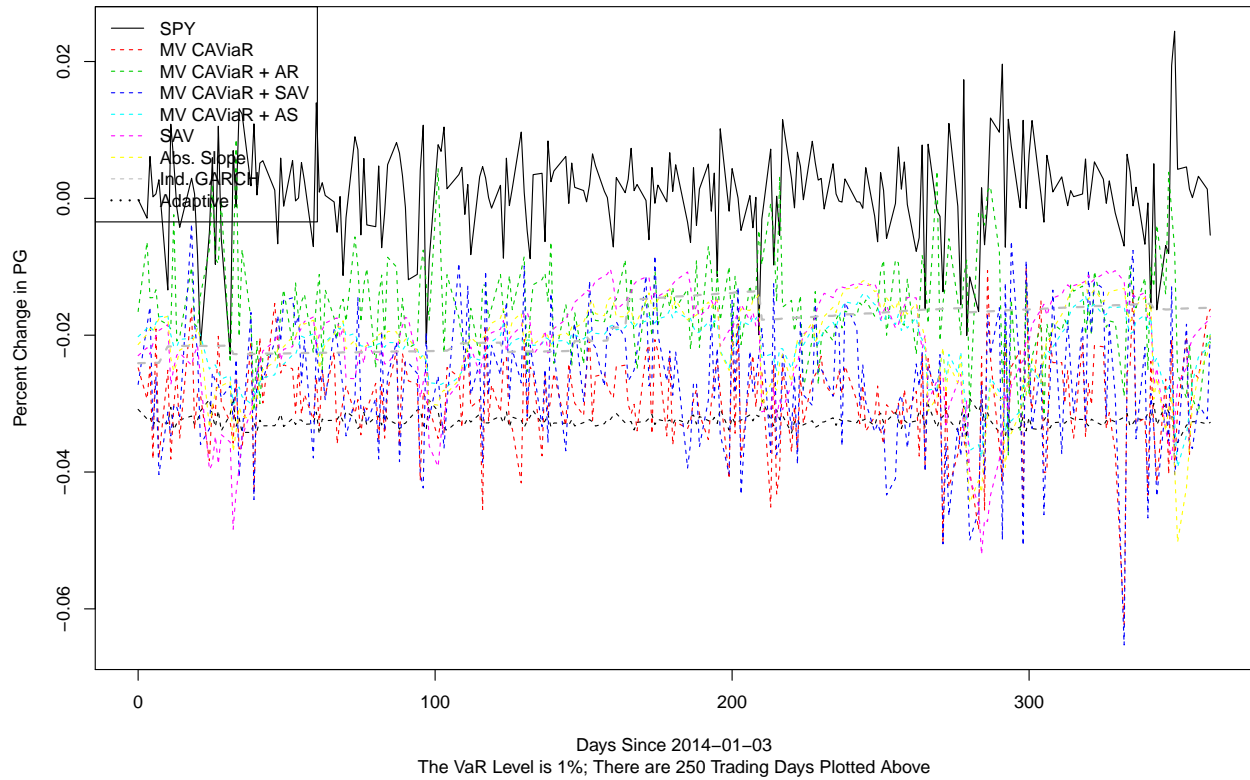


```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02860942
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.04636246
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.04350152 0.04064058 0.03777963 0.03491869 0.03205775 0.02919681
## [7] 0.02633586 0.02347492 0.02061398
```

2014 Ending

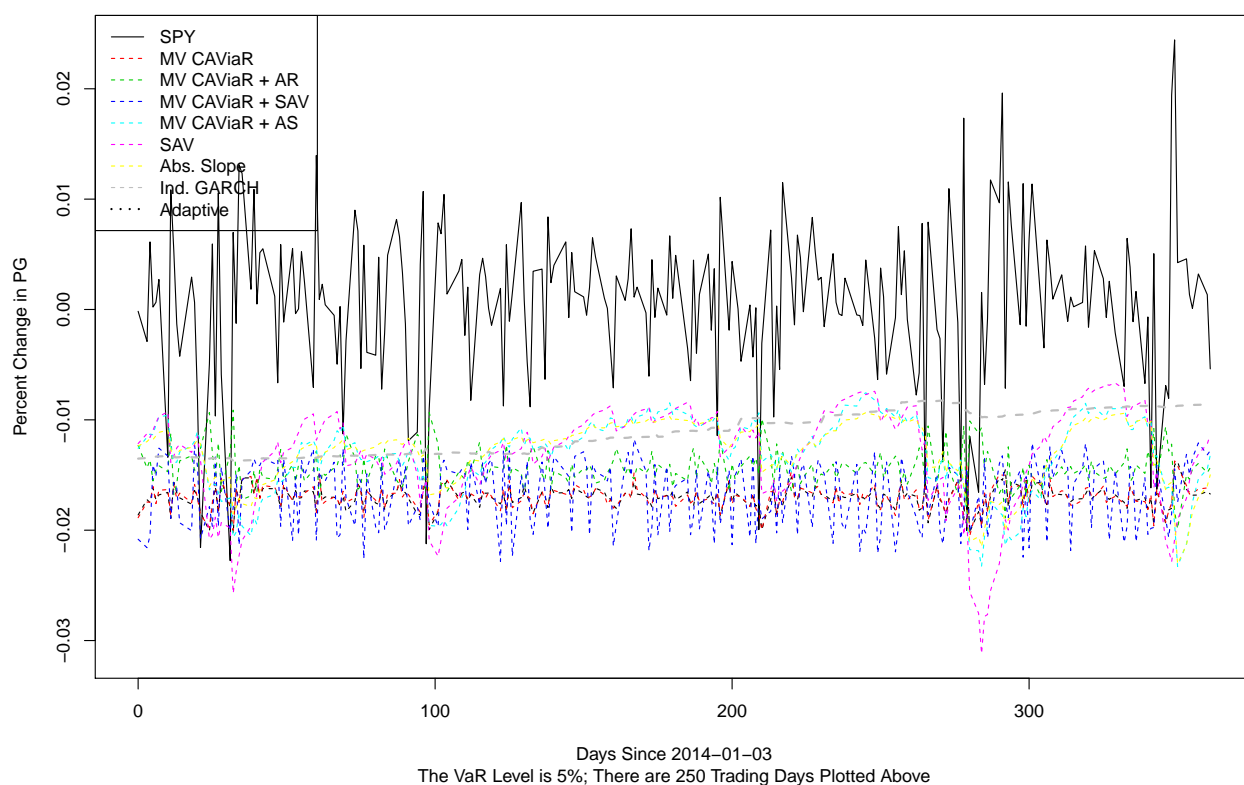
U.S. ETFs

Predicting SPY Returns from 2014-01-03 to 2014-12-30



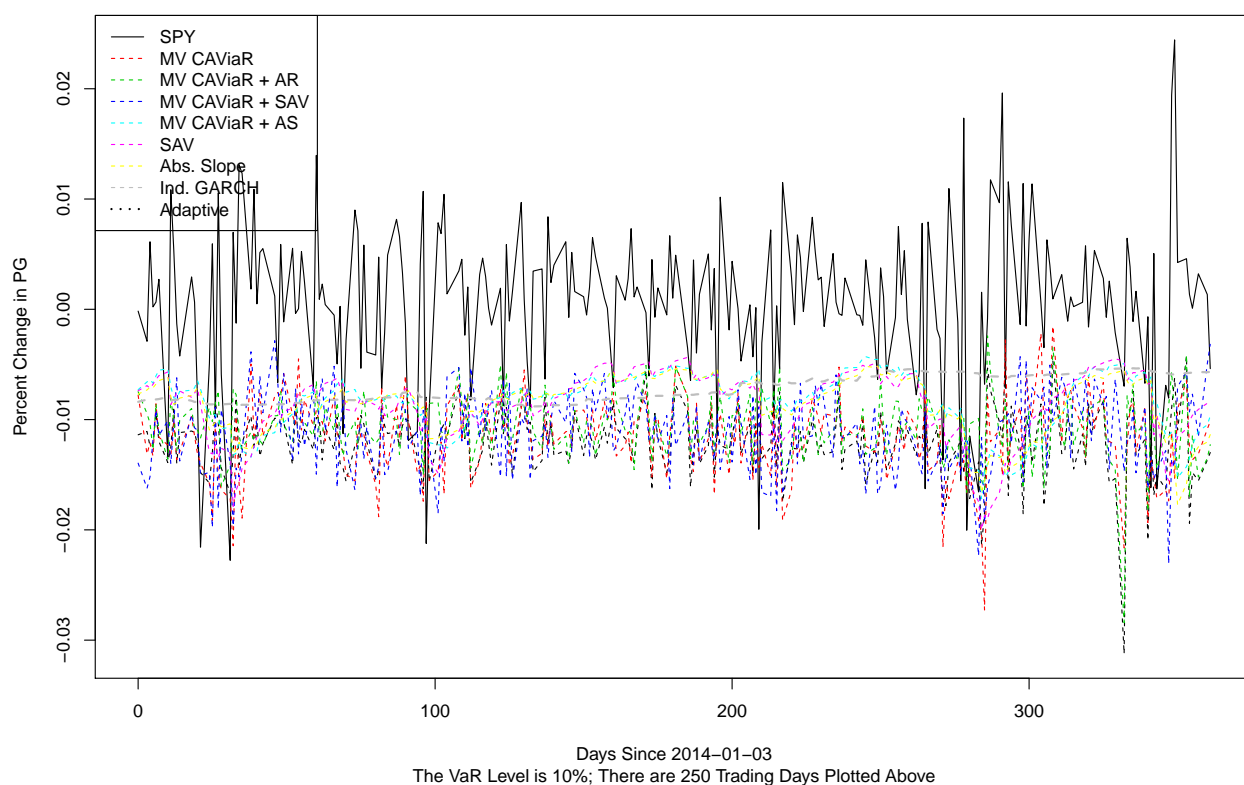
```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.03145657
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.02801616
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.024870507 0.021724850 0.018579192 0.015433535 0.012287878
## [6] 0.009142221 0.005996563 0.002850906 -0.000294751
```

Predicting SPY Returns from 2014-01-03 to 2014-12-30



```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.01950283
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.02665255
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.024702269 0.022751986 0.020801703 0.018851420 0.016901137 0.014950854
## [7] 0.013000571 0.011050288 0.009100005
```

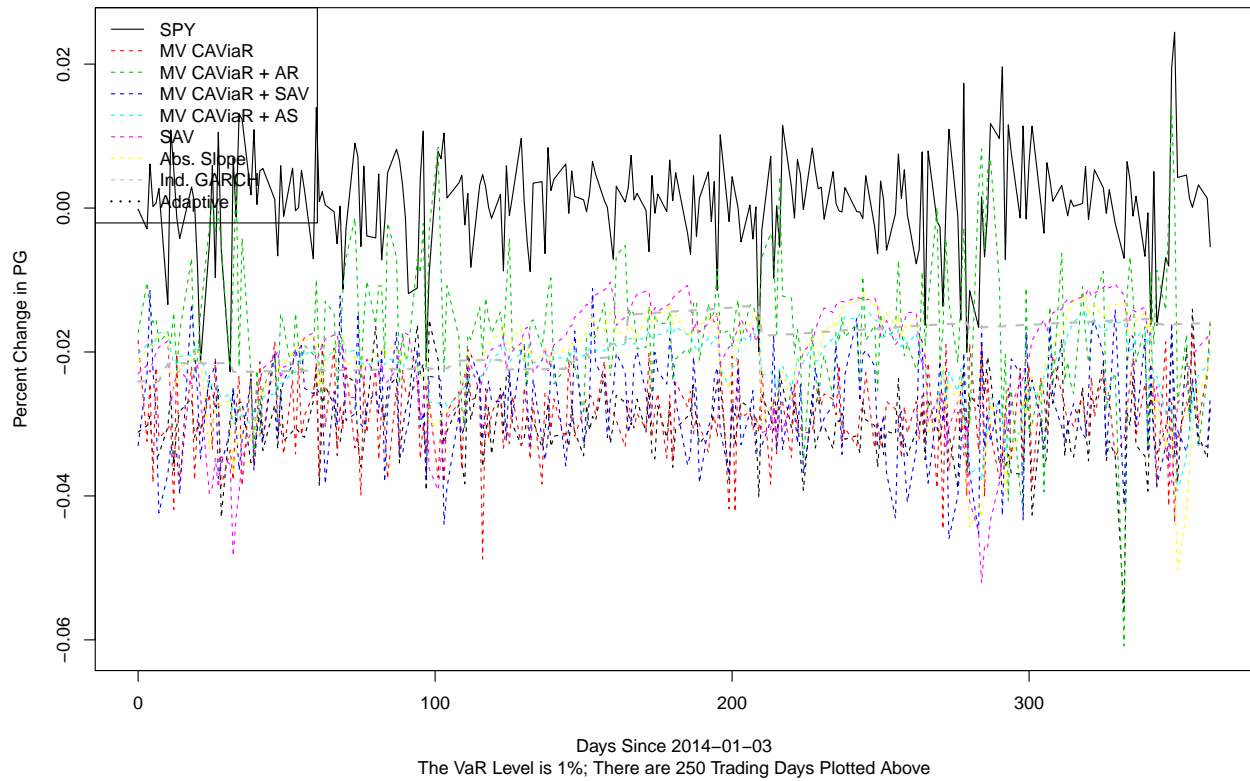
Predicting SPY Returns from 2014-01-03 to 2014-12-30



```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.01951584
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.02665404
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.024702452 0.022750868 0.020799284 0.018847701 0.016896117 0.014944533
## [7] 0.012992949 0.011041365 0.009089781
```

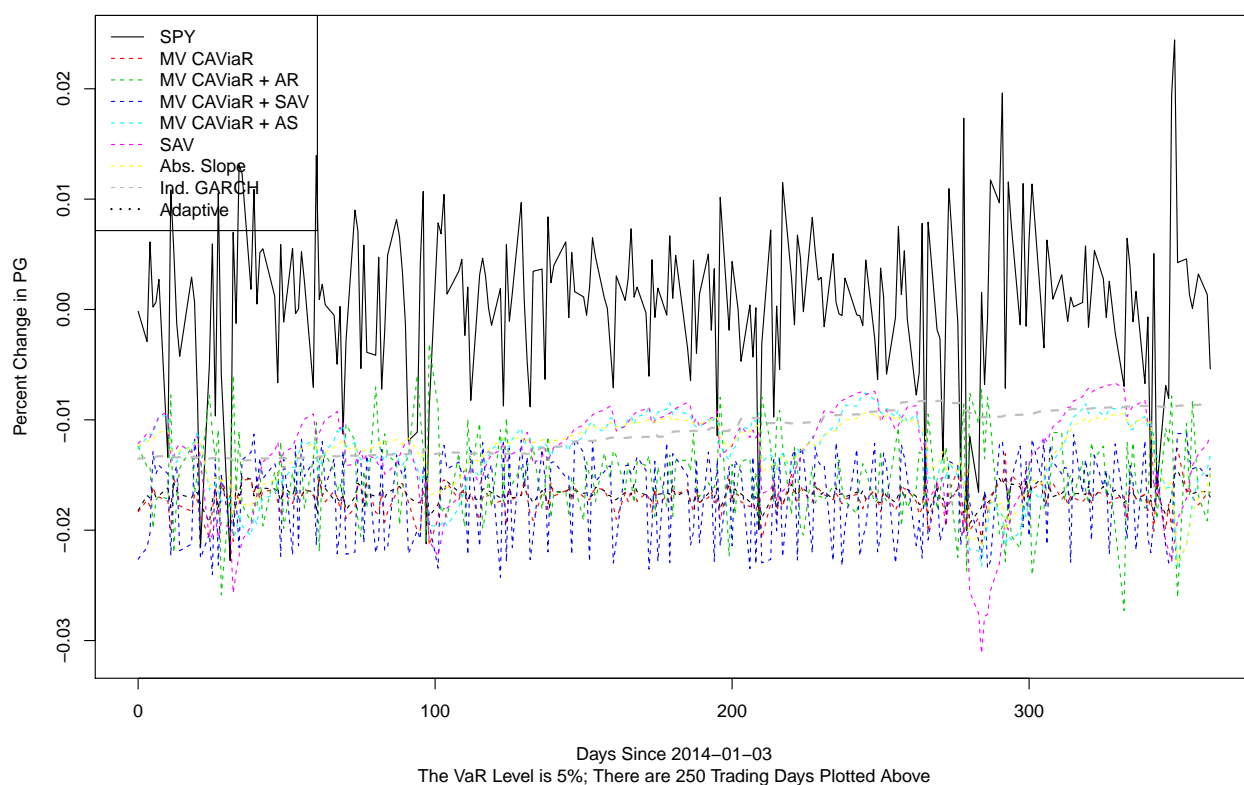
Global ETFs

Predicting SPY Returns from 2014-01-03 to 2014-12-30



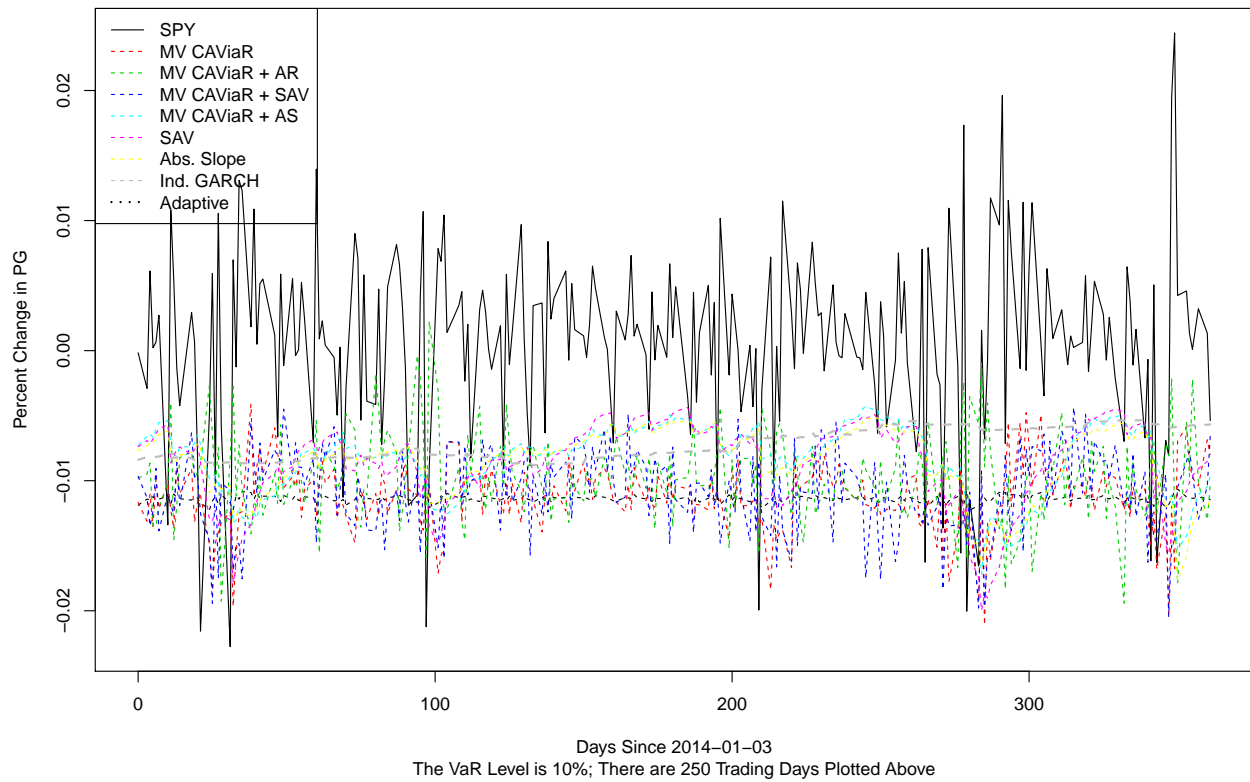
```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.02990429
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.02783909
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.0248486600 0.0218582305 0.0188678011 0.0158773717 0.0128869423
## [6] 0.0098965129 0.0069060835 0.0039156541 0.0009252247
```


Predicting SPY Returns from 2014-01-03 to 2014-12-30



```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.01950283
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.02665255
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.024702269 0.022751986 0.020801703 0.018851420 0.016901137 0.014950854
## [7] 0.013000571 0.011050288 0.009100005
```

Predicting SPY Returns from 2014-01-03 to 2014-12-30

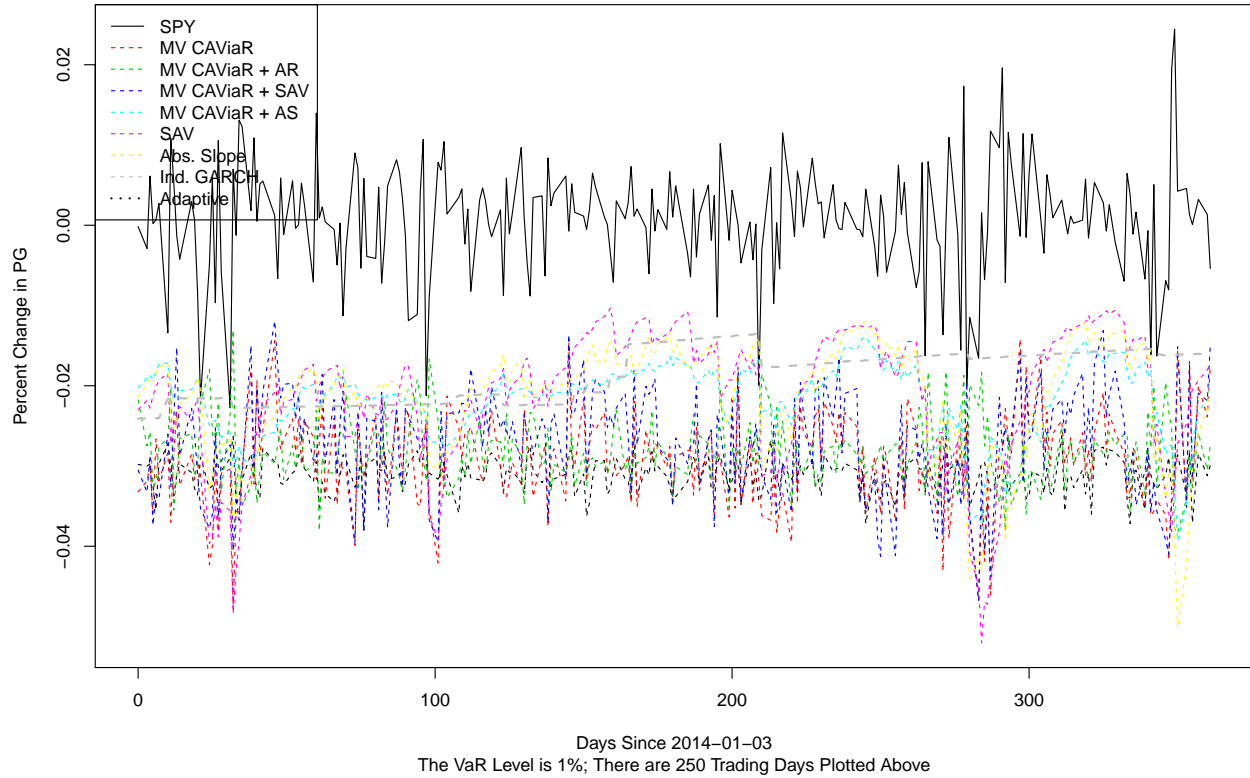


```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.01654714
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.02631538
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.02466067 0.02300596 0.02135124 0.01969653 0.01804181 0.01638710
## [7] 0.01473239 0.01307767 0.01142296
```

Commodity ETFs

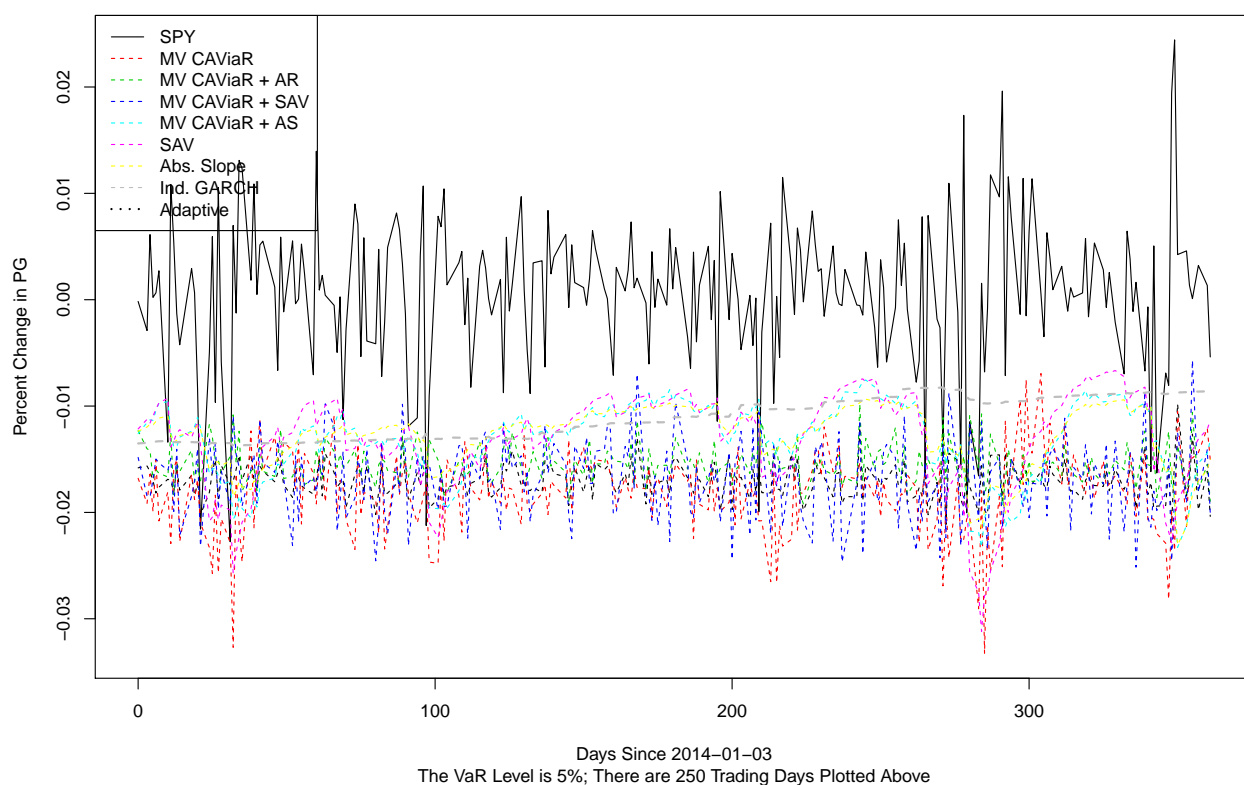
Bond ETFs

Predicting SPY Returns from 2014-01-03 to 2014-12-30



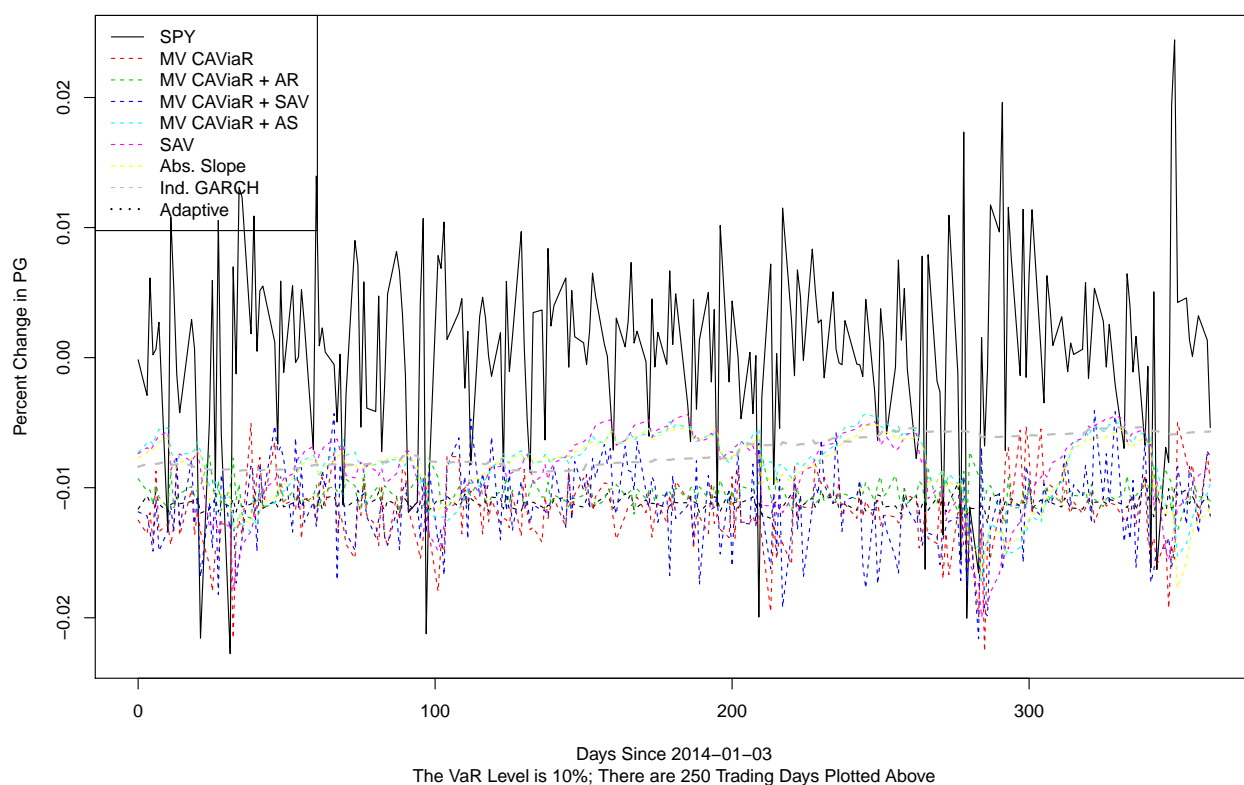
```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.0268189
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.02748713
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.024805236 0.022123346 0.019441455 0.016759565 0.014077674 0.011395784
## [7] 0.008713893 0.006032003 0.003350113
```

Predicting SPY Returns from 2014-01-03 to 2014-12-30



```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.02023662
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.02673626
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.024712596 0.022688935 0.020665273 0.018641611 0.016617949 0.014594287
## [7] 0.012570626 0.010546964 0.008523302
```

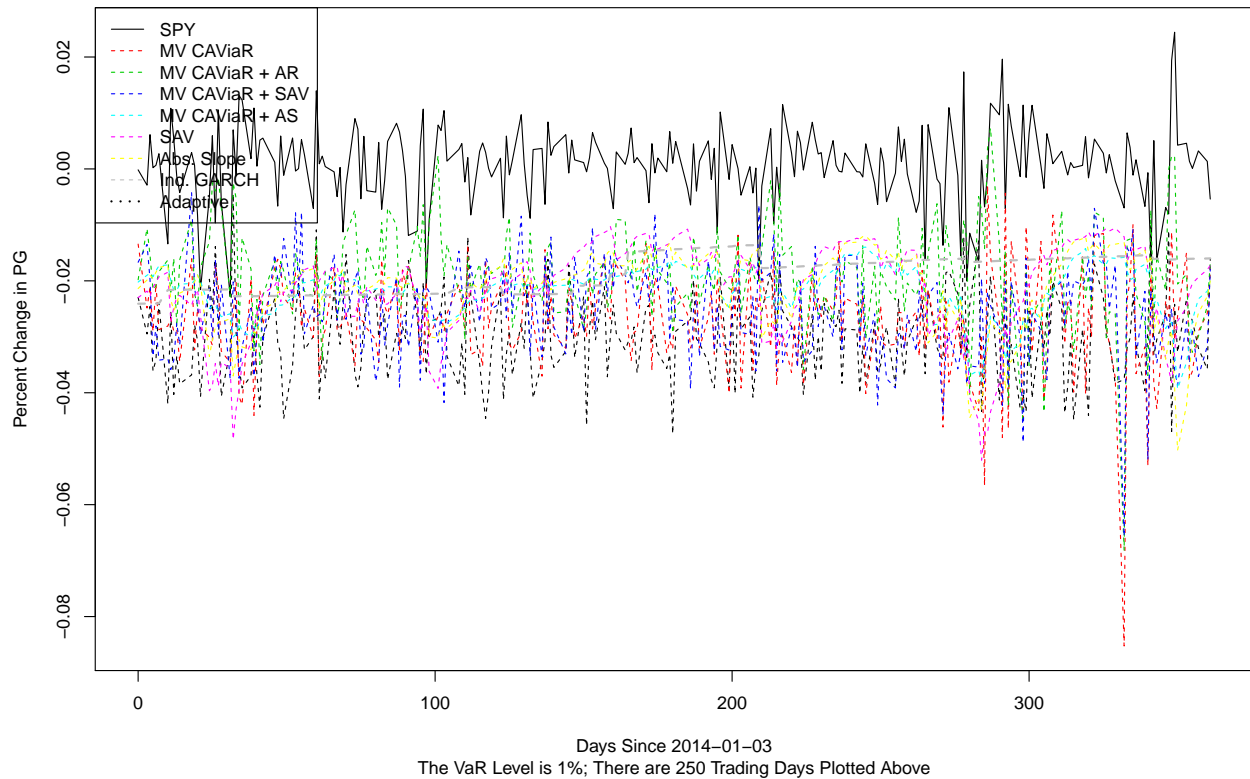
Predicting SPY Returns from 2014-01-03 to 2014-12-30



```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.01654714
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.02631538
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.02466067 0.02300596 0.02135124 0.01969653 0.01804181 0.01638710
## [7] 0.01473239 0.01307767 0.01142296
```

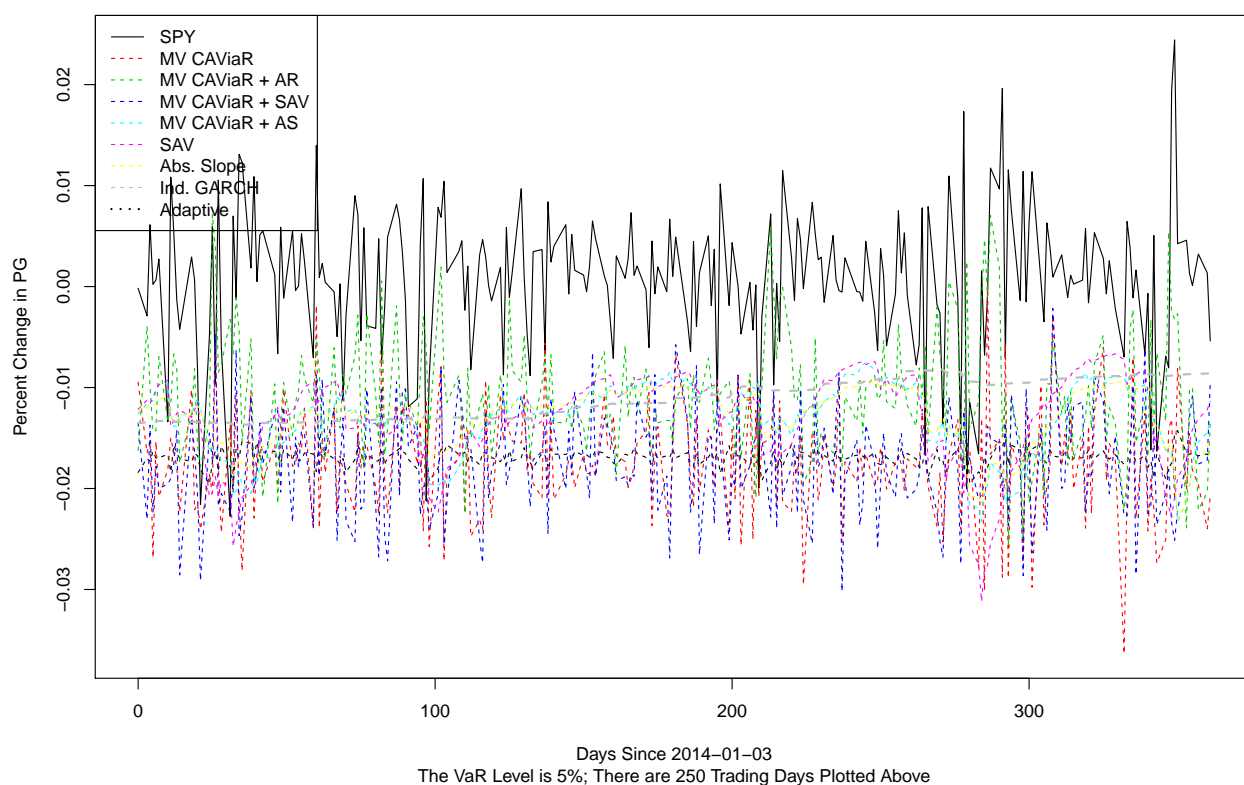
All ETFs

Predicting SPY Returns from 2014-01-03 to 2014-12-30



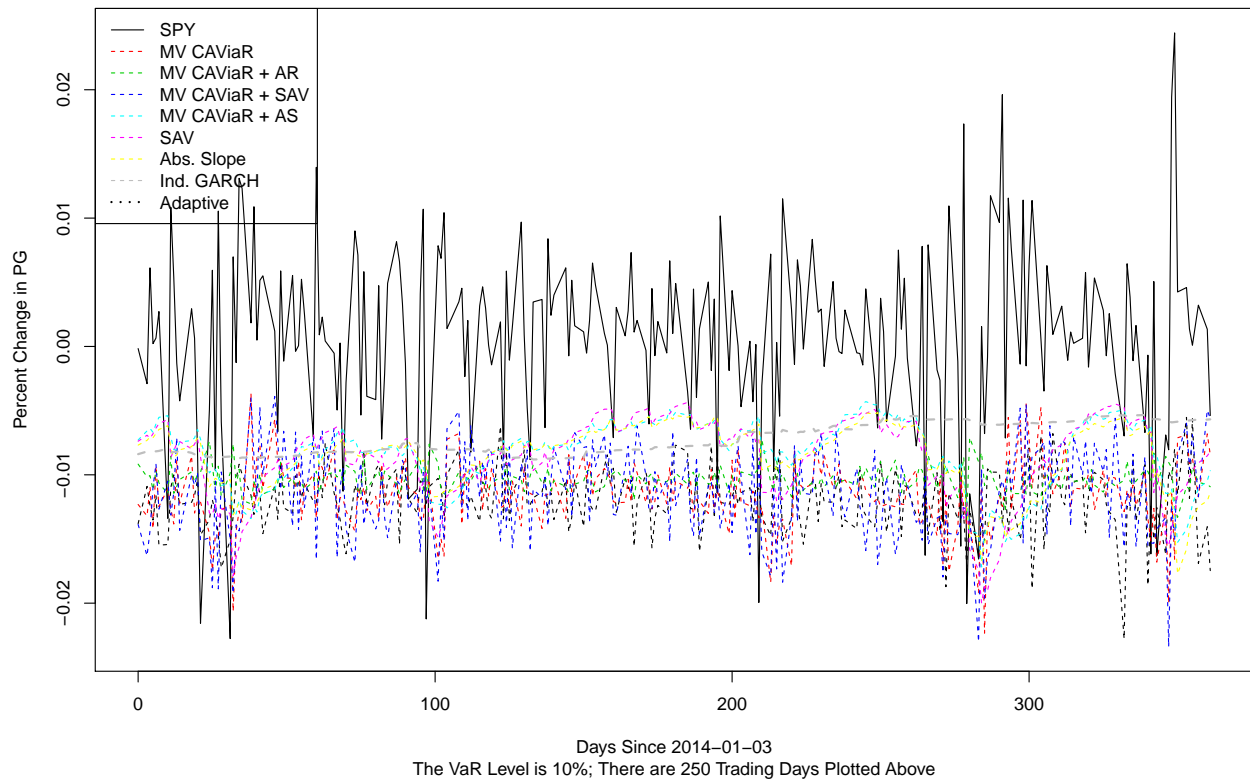
```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.03846295
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.02881541
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.024969115 0.021122820 0.017276524 0.013430229 0.009583933
## [6] 0.005737638 0.001891343 -0.001954953 -0.005801248
```

Predicting SPY Returns from 2014-01-03 to 2014-12-30



```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.02131482
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.02685925
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.024727771 0.022596289 0.020464806 0.018333324 0.016201841 0.014070359
## [7] 0.011938876 0.009807394 0.007675911
```

Predicting SPY Returns from 2014-01-03 to 2014-12-30

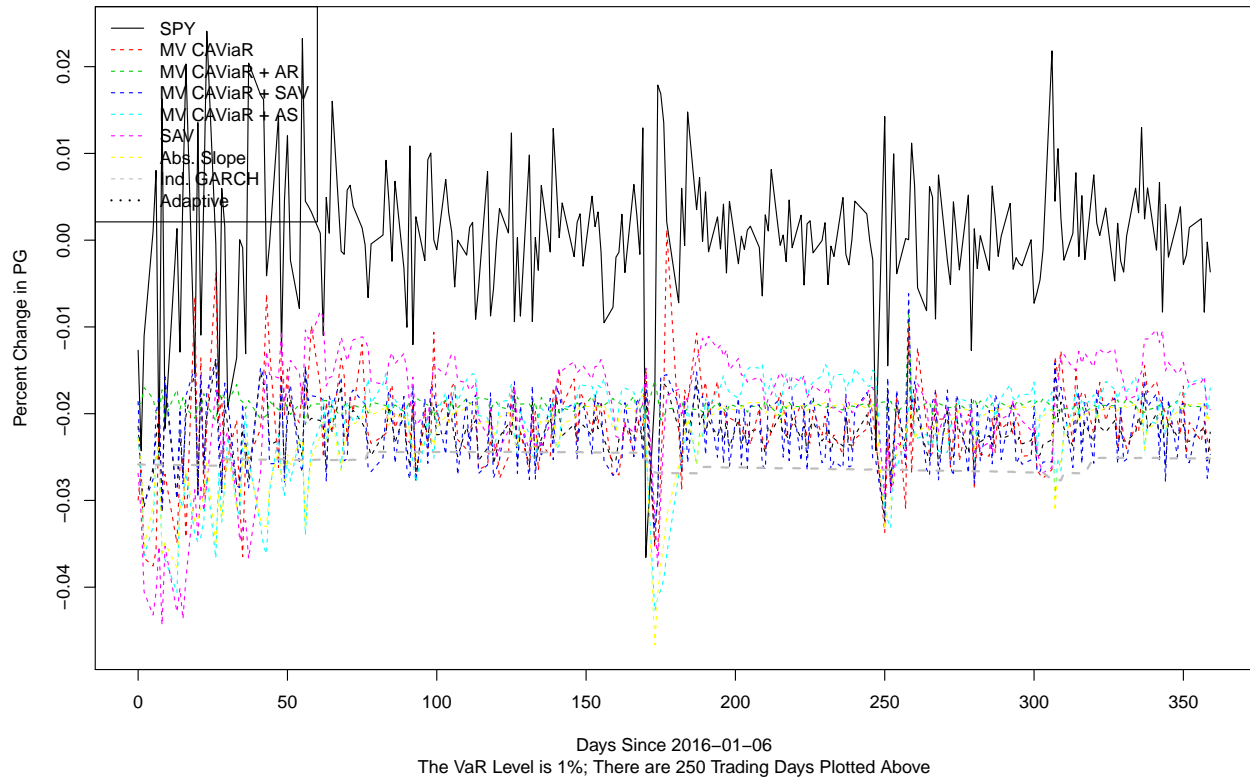


```
## $rect
## $rect$w
## [1] 74.79343
##
## $rect$h
## [1] 0.01676787
##
## $rect$left
## [1] -14.44
##
## $rect$top
## [1] 0.02634056
##
##
## $text
## $text$x
## [1] 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052 7.30052
##
## $text$y
## [1] 0.02466378 0.02298699 0.02131020 0.01963341 0.01795663 0.01627984
## [7] 0.01460305 0.01292627 0.01124948
```


2016 Ending

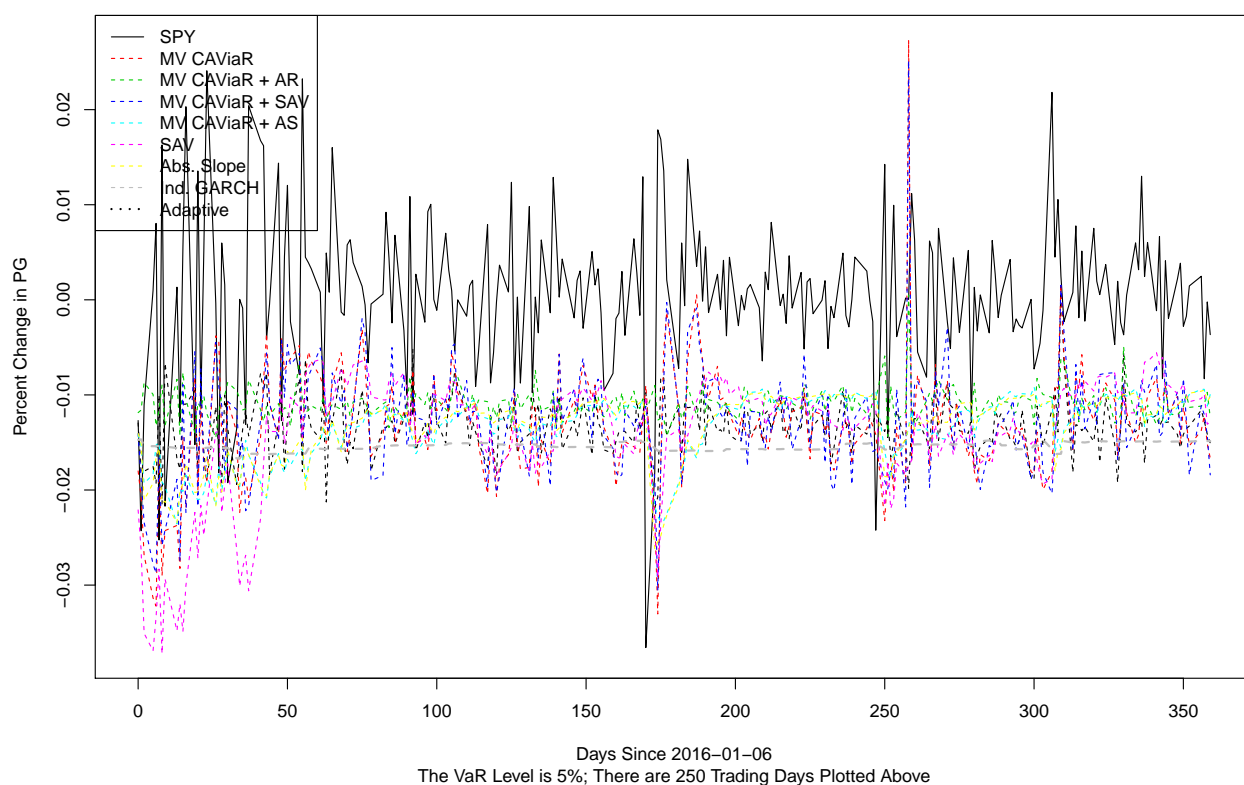
U.S. ETFs

Predicting SPY Returns from 2016-01-06 to 2016-12-30



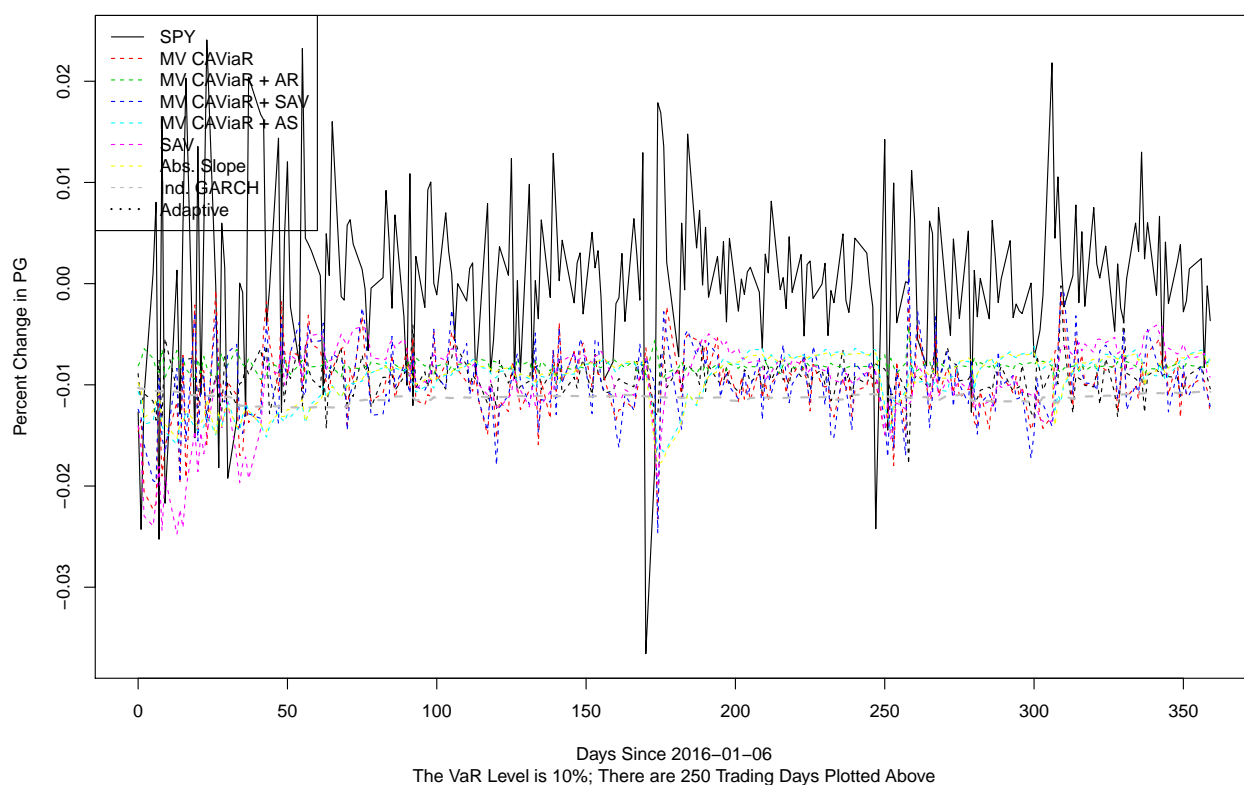
```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02480765
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.02691495
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.024434182 0.021953417 0.019472653 0.016991888 0.014511123 0.012030359
## [7] 0.009549594 0.007068830 0.004588065
```

Predicting SPY Returns from 2016-01-06 to 2016-12-30



```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02263288
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.02991372
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.027650429 0.025387141 0.023123853 0.020860565 0.018597277 0.016333989
## [7] 0.014070701 0.011807413 0.009544125
```

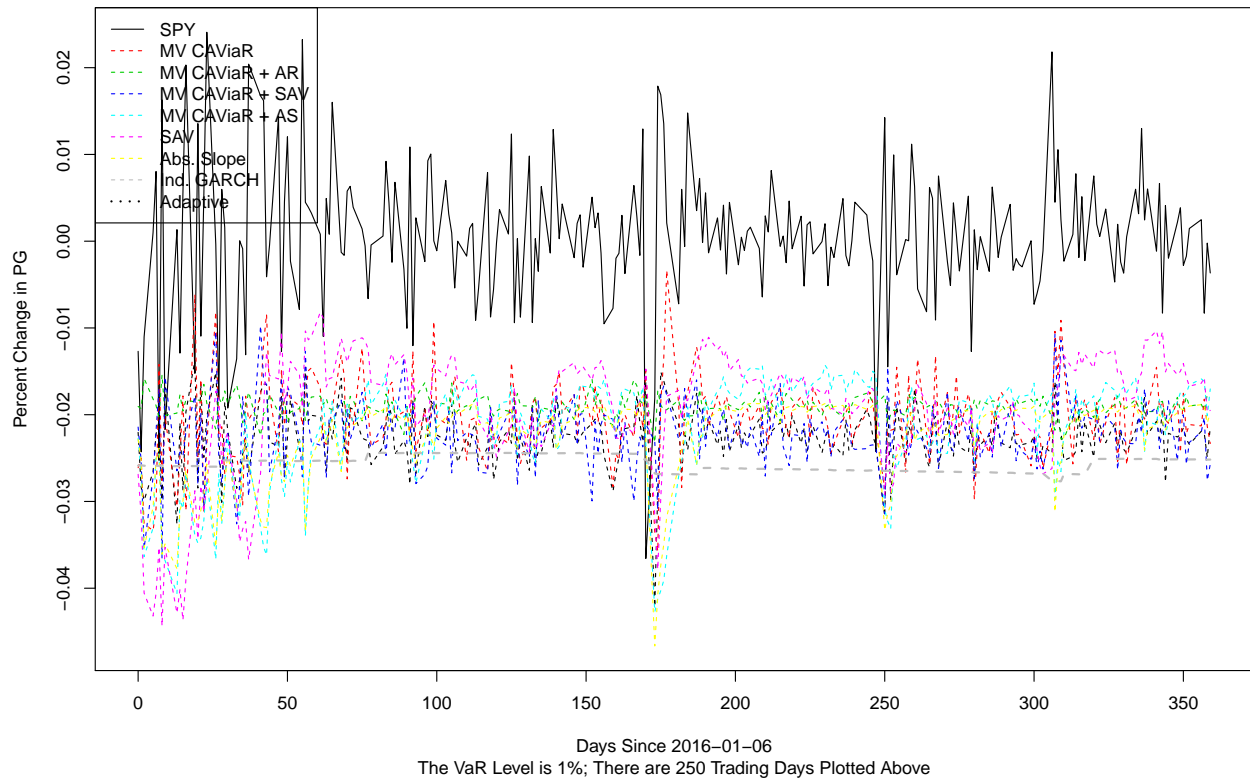
Predicting SPY Returns from 2016-01-06 to 2016-12-30



```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02126862
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.02651124
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.024384373 0.022257511 0.020130649 0.018003787 0.015876925 0.013750063
## [7] 0.011623201 0.009496339 0.007369477
```

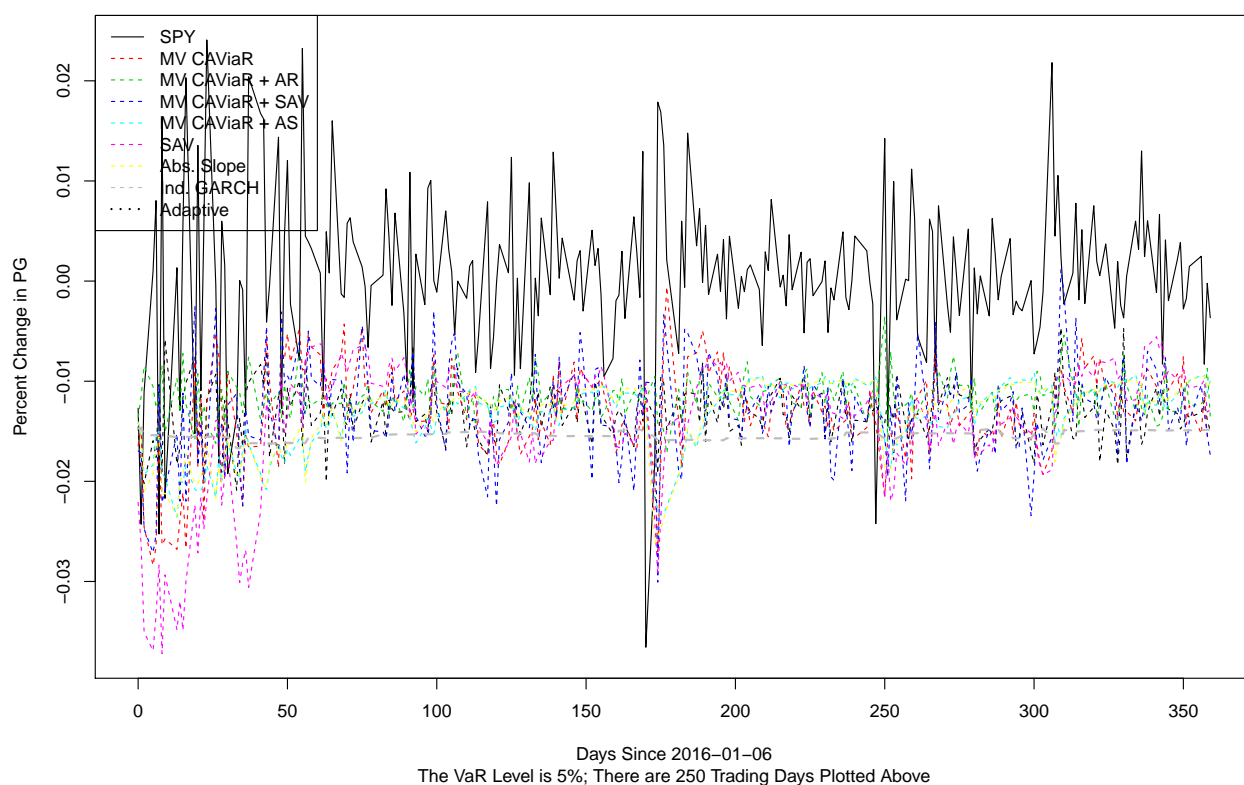
Global ETFs

Predicting SPY Returns from 2016-01-06 to 2016-12-30



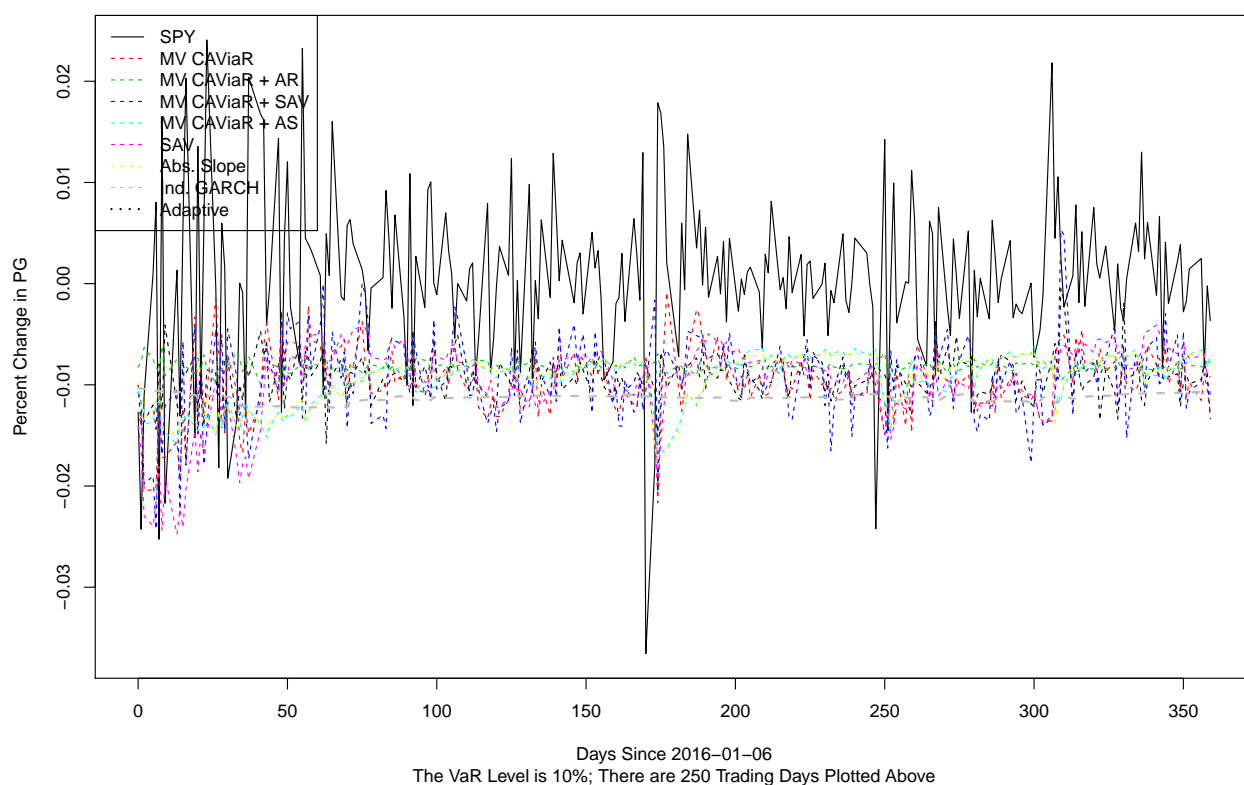
```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02480765
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.02691495
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.024434182 0.021953417 0.019472653 0.016991888 0.014511123 0.012030359
## [7] 0.009549594 0.007068830 0.004588065
```

Predicting SPY Returns from 2016-01-06 to 2016-12-30



```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02149437
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.02653699
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.024387551 0.022238113 0.020088676 0.017939239 0.015789802 0.013640364
## [7] 0.011490927 0.009341490 0.007192053
```

Predicting SPY Returns from 2016-01-06 to 2016-12-30

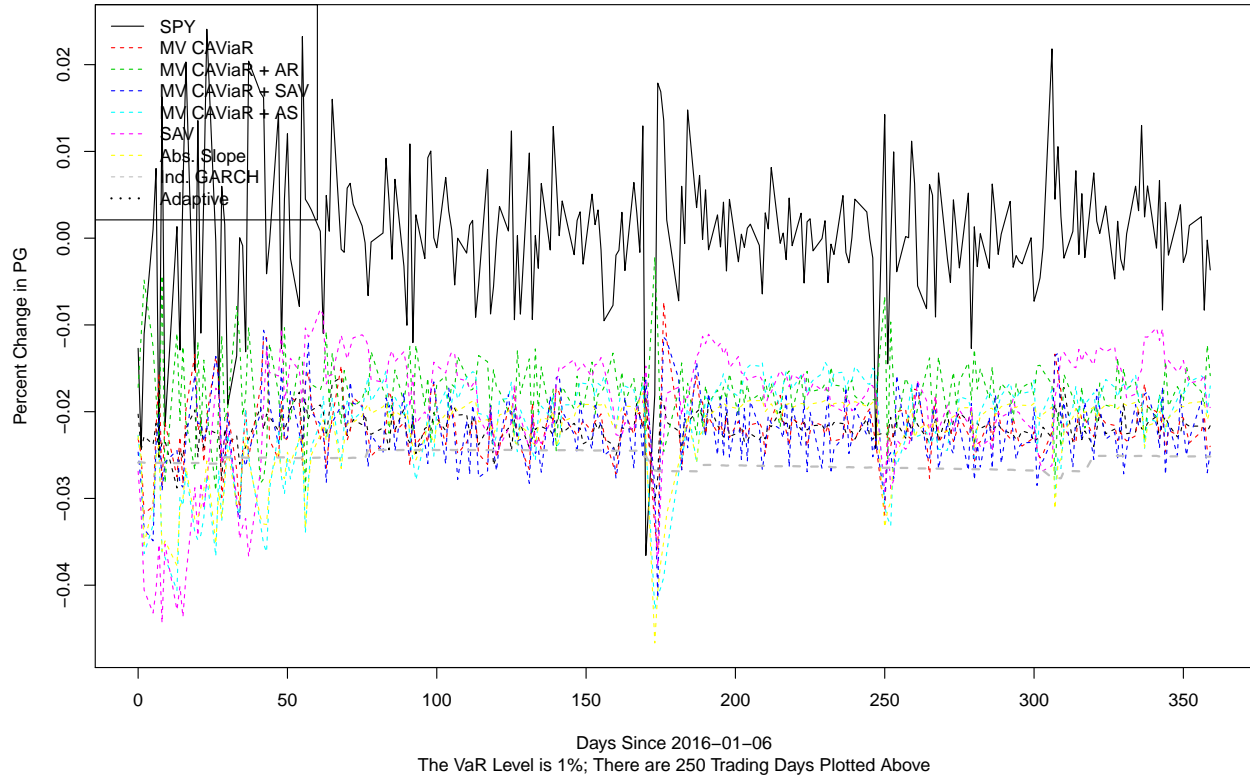


```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02126862
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.02651124
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.024384373 0.022257511 0.020130649 0.018003787 0.015876925 0.013750063
## [7] 0.011623201 0.009496339 0.007369477
```

Commodity ETFs

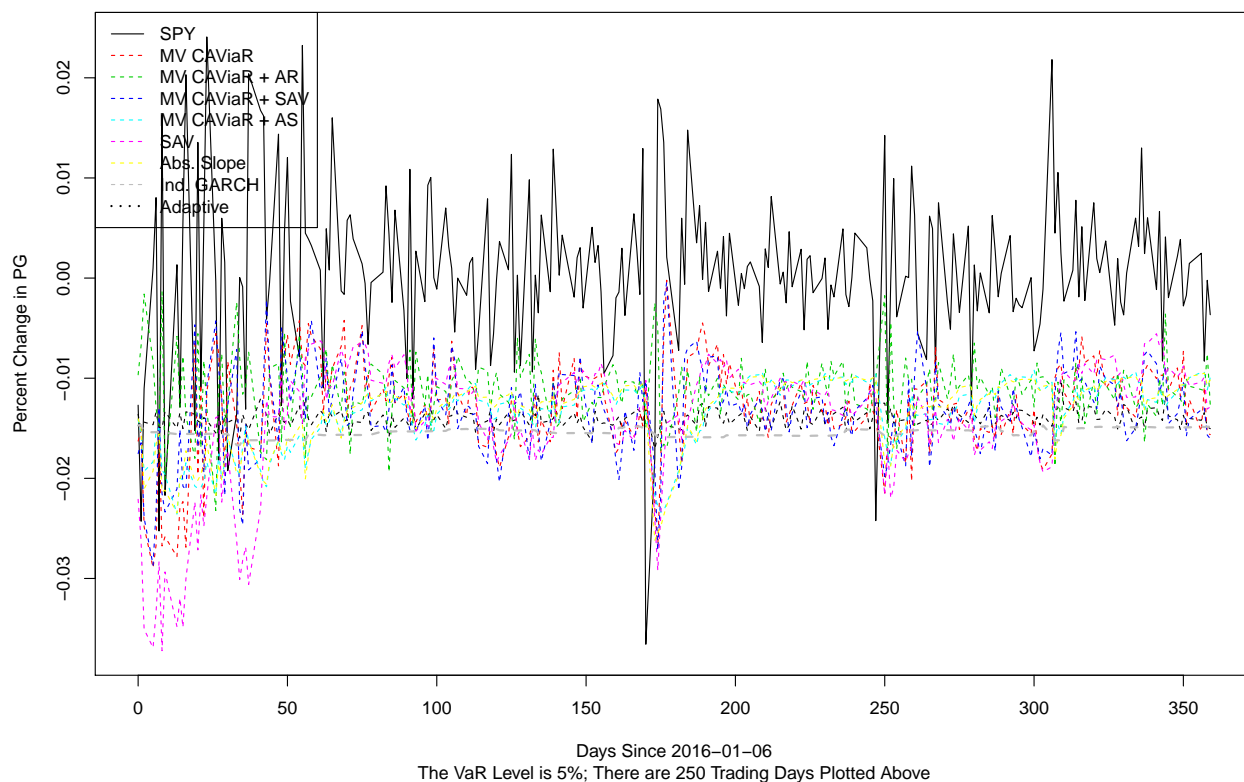
Bond ETFs

Predicting SPY Returns from 2016-01-06 to 2016-12-30



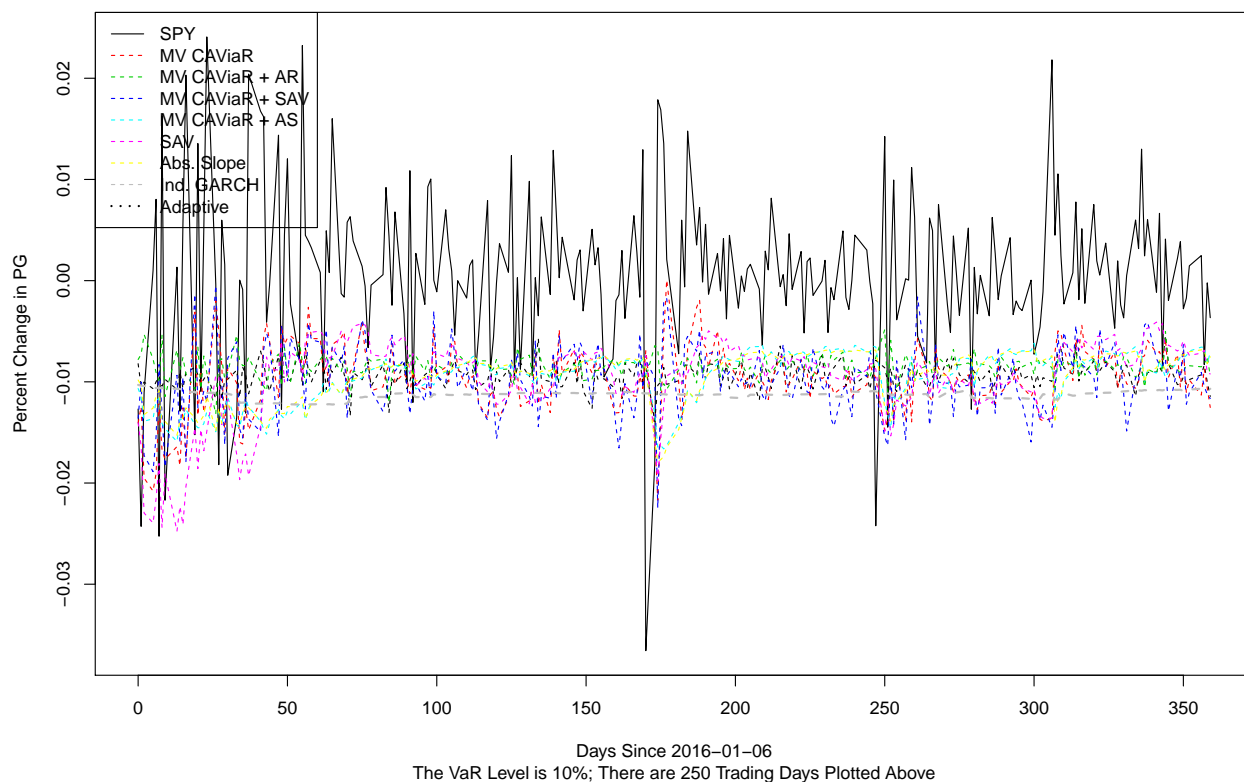
```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02480765
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.02691495
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.024434182 0.021953417 0.019472653 0.016991888 0.014511123 0.012030359
## [7] 0.009549594 0.007068830 0.004588065
```

Predicting SPY Returns from 2016-01-06 to 2016-12-30



```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02149437
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.02653699
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.024387551 0.022238113 0.020088676 0.017939239 0.015789802 0.013640364
## [7] 0.011490927 0.009341490 0.007192053
```

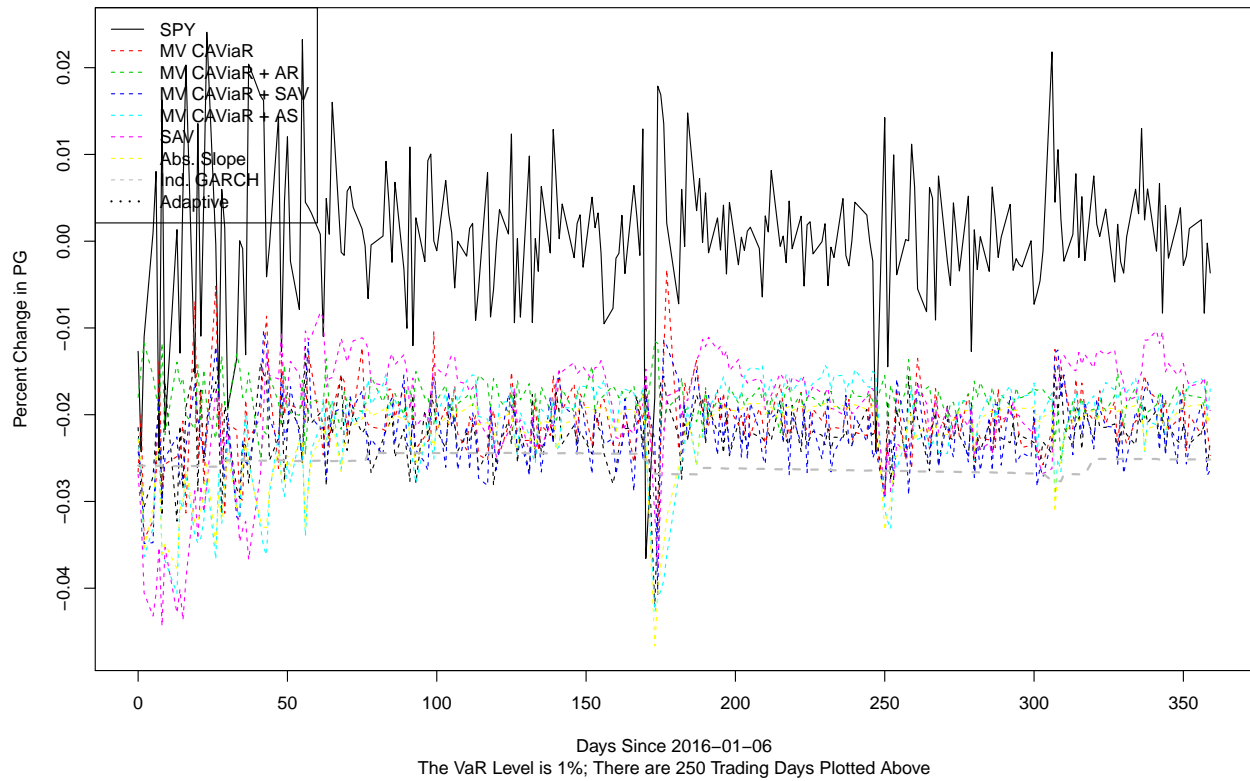

Predicting SPY Returns from 2016-01-06 to 2016-12-30



```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02126862
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.02651124
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.024384373 0.022257511 0.020130649 0.018003787 0.015876925 0.013750063
## [7] 0.011623201 0.009496339 0.007369477
```

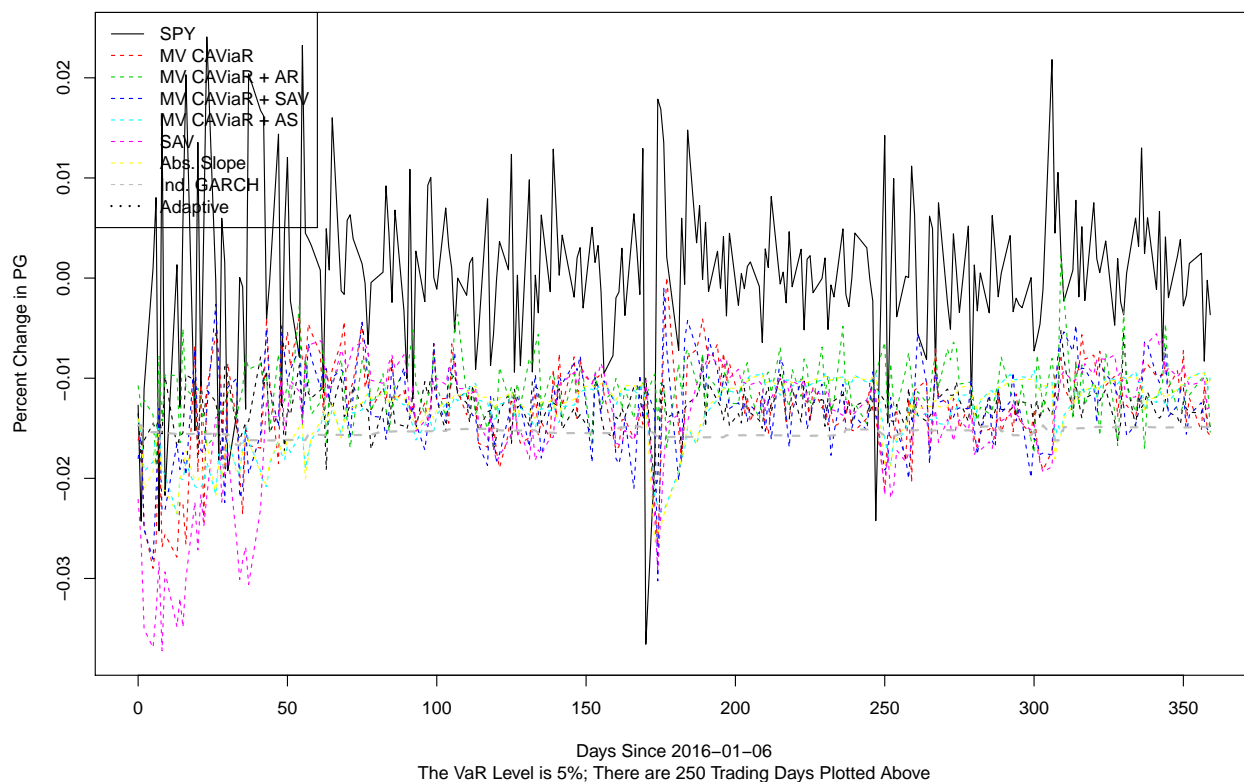
All ETFs

Predicting SPY Returns from 2016-01-06 to 2016-12-30



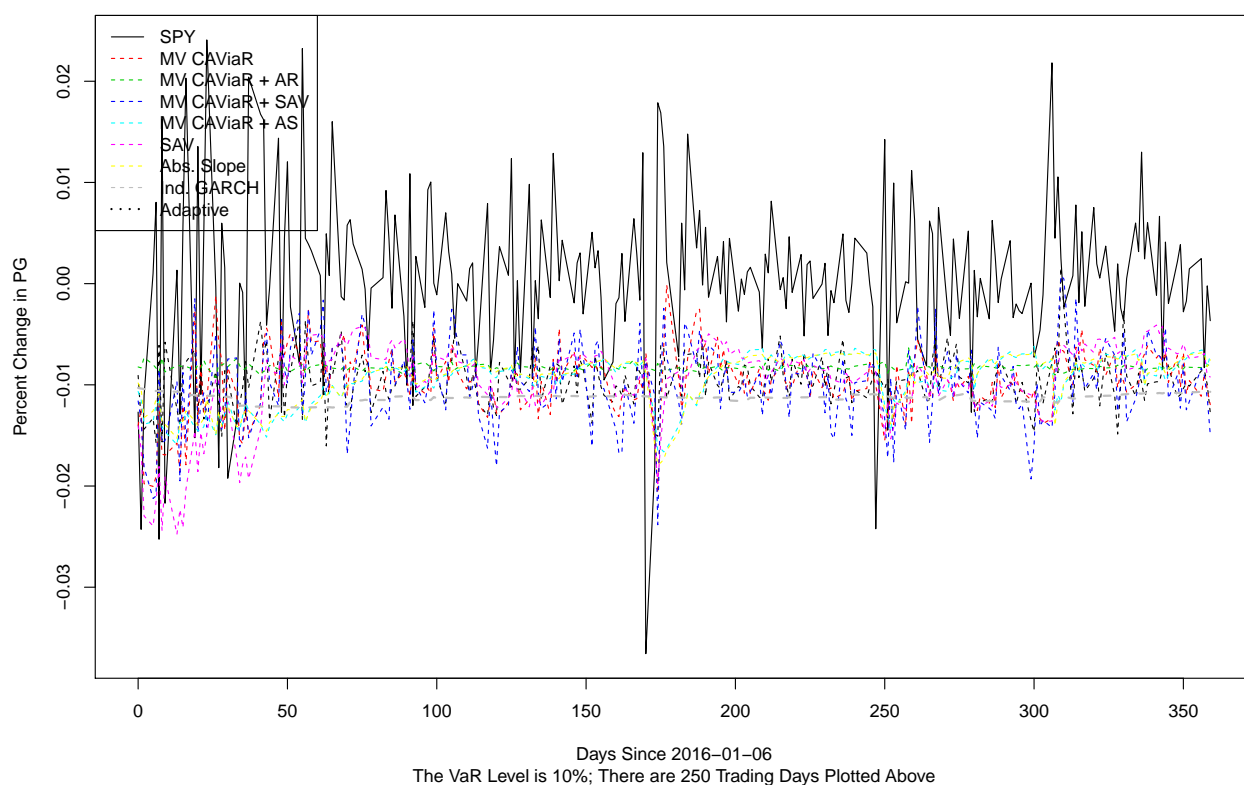
```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02480765
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.02691495
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.024434182 0.021953417 0.019472653 0.016991888 0.014511123 0.012030359
## [7] 0.009549594 0.007068830 0.004588065
```

Predicting SPY Returns from 2016-01-06 to 2016-12-30



```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02149437
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.02653699
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.024387551 0.022238113 0.020088676 0.017939239 0.015789802 0.013640364
## [7] 0.011490927 0.009341490 0.007192053
```

Predicting SPY Returns from 2016-01-06 to 2016-12-30



```
## $rect
## $rect$w
## [1] 74.37906
##
## $rect$h
## [1] 0.02126862
##
## $rect$left
## [1] -14.36
##
## $rect$top
## [1] 0.02651124
##
##
## $text
## $text$x
## [1] 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074 7.260074
## [9] 7.260074
##
## $text$y
## [1] 0.024384373 0.022257511 0.020130649 0.018003787 0.015876925 0.013750063
## [7] 0.011623201 0.009496339 0.007369477
```

JUNK CODE

Problem solving on 4.25.2020 to see why commodities ETFs code had a problem.