# Information Demand Effects on the Sign of the Change in Asset Index Returns at Daily Frequencies:

## Supplementary Material

EC981-7-FY-CO

Financial Econometrics Masters Dissertation

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Table 1: SVI Descriptive Statistics

| Variable | Statistic | | | | | |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Median | Skewness | Kurtosis | $1^{st}$ Lag Autocorrelation |
| $SVI^{FTSE}$ | 2.764727 | 2.916147 | 2 | 8.9068 | 236.1216 | 0.575 |
| $SVI^{SPX_1}$ | 11.8463 | 7.164055 | 10 | 3.135406 | 18.8146 | 0.869 |
| $SVI^{SPX_2}$ | 9.723473 | 6.673175 | 8 | 3.064971 | 19.41453 | 0.669 |
| $SVI^{SPX_{CPV}*}$ | 9.24238 | 4.948923 | 8 | 2.994608 | 31.55793 | 0.523 |
| $SVI^{SPX_{CPV-US}*}$ | 10.22849 | 5.953334 | 9 | 3.050486 | 25.5173 | 0.583 |

Tabulated statistics were computed from all full-sample trading days except the ones with asterisks (*) which were computed from full-CPV-sample trading days. Significant figures differ as per their origin in the R code.

Table 2: Descriptive Statistics

| Variable | | Statistic | | | | | |
|---|---|---|---|---|---|---|---|
| | | Mean | Standard Deviation | Median | Skewness | Kurtosis | $1^{st}$ Lag Autocorrelation |
| $R^{Index}$ | $R^{FTSE}$ | 0.000131821 | 0.01169291 | 0.000534463 | -0.01498459 | 8.390776 | -0.029 |
| | $R^{SPX}$ | 0.000311301 | 0.01142788 | 0.000660012 | -0.1953126 | 11.30544 | -0.109 |
| $\Delta SVI^{Index}$ | $\Delta SVI^{FTSE}$ | 0.5477989 | 2.347539 | 0 | 14.91342 | 495.2456 | 0.043 |
| | $\Delta SVI^{SPX_1}$ | 0.00342827 | 3.660369 | 0 | 0.6474908 | 64.14817 | -0.328 |
| | $\Delta SVI^{SPX_2}$ | 1.288502 | 4.958929 | 1 | 1.75178 | 28.29457 | -0.172 |
| | $\Delta SVI^{SPX_{CPV}}$ * | 1.026404 | 4.643211 | 1 | 0.8574528 | 46.73912 | -0.224 |
| | $\Delta SVI^{SPX_{CPV-US}}$ * | 1.177238 | 5.090036 | 1 | 2.279915 | 39.23575 | -0.186 |
| $RV^{Index}$ | $RV^{FTSE}$ | 0.009091193 | 0.005814697 | 0.0075211 | 3.733061 | 29.93447 | 0.725 |
| | $RV^{SPX}$ | 0.007907957 | 0.00610196 | 0.006119621 | 3.653883 | 22.38065 | 0.823 |
| $r_f^{Index}$ | $r_f^{FTSE}$ | $5.510478\text{x}10^{-05}$ | 0.002283866 | $3.954246\text{x}10^{-05}$ | 0.05807592 | 2.712622 | 0.003 |
| | $r_f^{SPX}$ | $-3.335806\text{x}10^{-07}$ | $5.495562\text{x}10^{-05}$ | 0 | 0.8408268 | 60.85758 | 0.171 |

All statistics were computed from all full-sample trading days except the ones with asterisks (*) which were computed from full-CPV-sample trading days. Results were shown in a manner akin to CPV to aid readers wishing to compare results. Significant figures differ as per their origin in the R code.

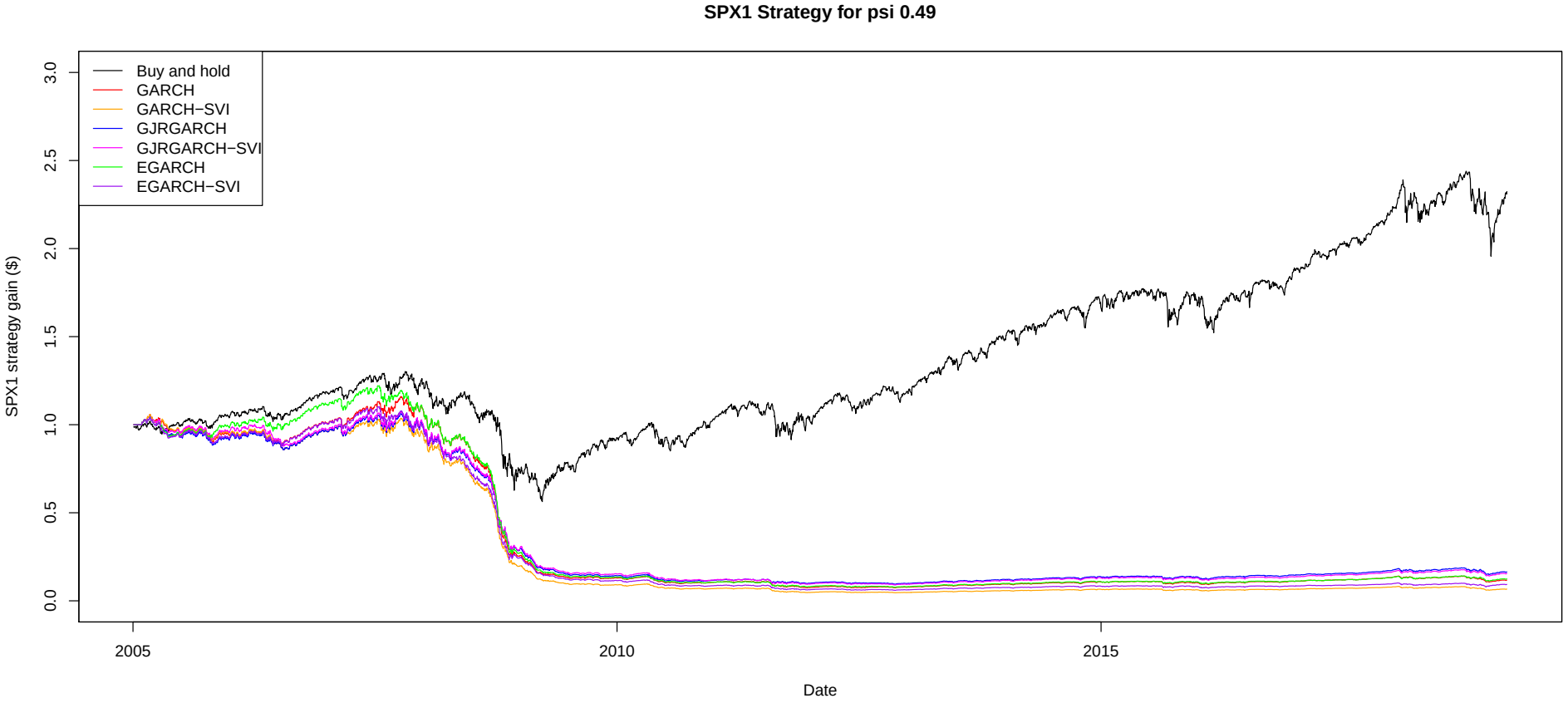


Figure 1: Cumulative Returns of an Agent Investing as per Strategies with the SPX for $\psi = 0.49$

This graph shows $\mathcal{R}_{j,t}^{SPX_1}$ for the out-of-sample period - *i.e.*: for $t$ in between 01/01/2005 and 13/03/2019. It clearly suggests that a cumulative Buy-and-Hold strategy is most beneficial.

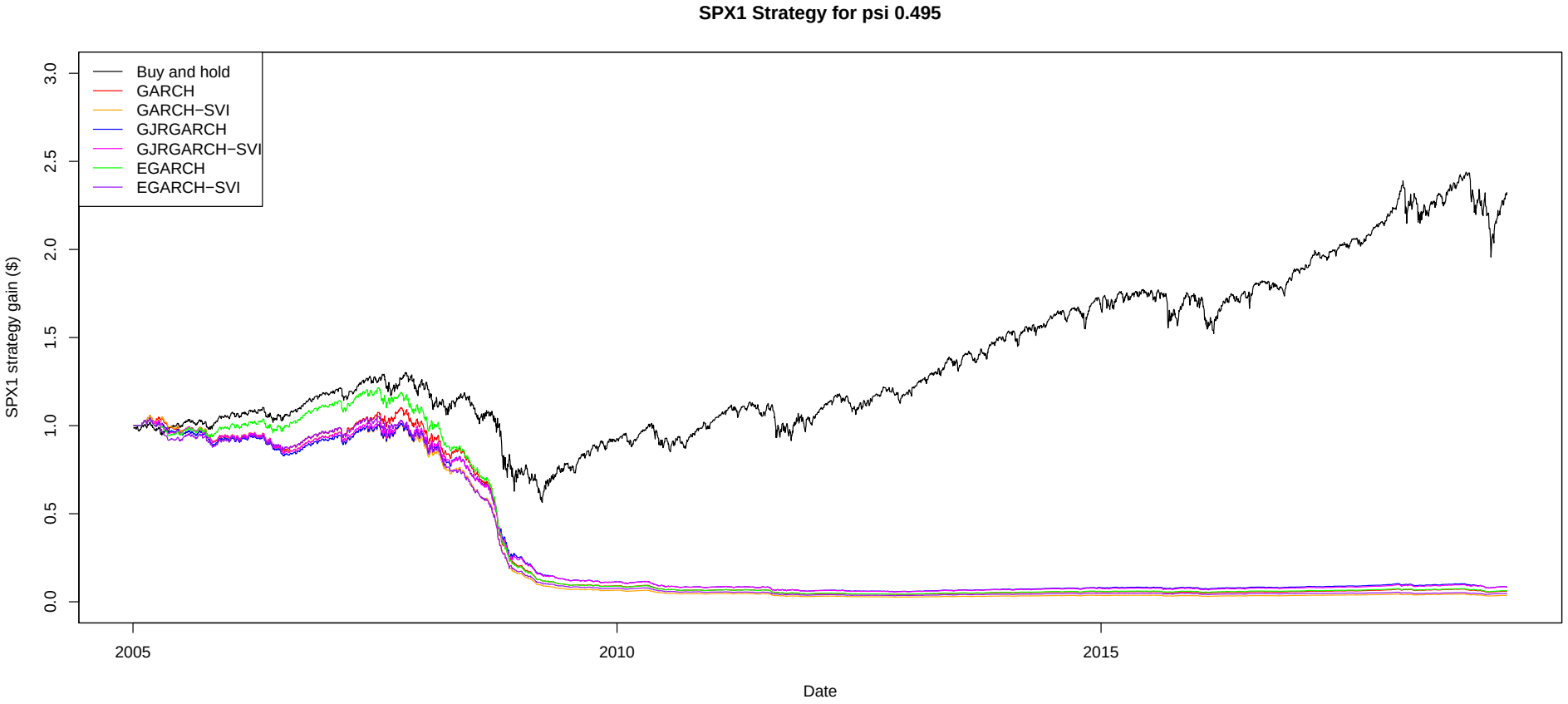


Figure 2: Cumulative Returns of an Agent Investing as per Strategies with the SPX for $\psi = 0.495$

This graph shows $\mathcal{R}_{j,t}^{SPX_1}$ for the out-of-sample period - *i.e.*: for $t$ in between 01/01/2005 and 13/03/2019. It clearly suggests that a cumulative Buy-and-Hold strategy is most beneficial.

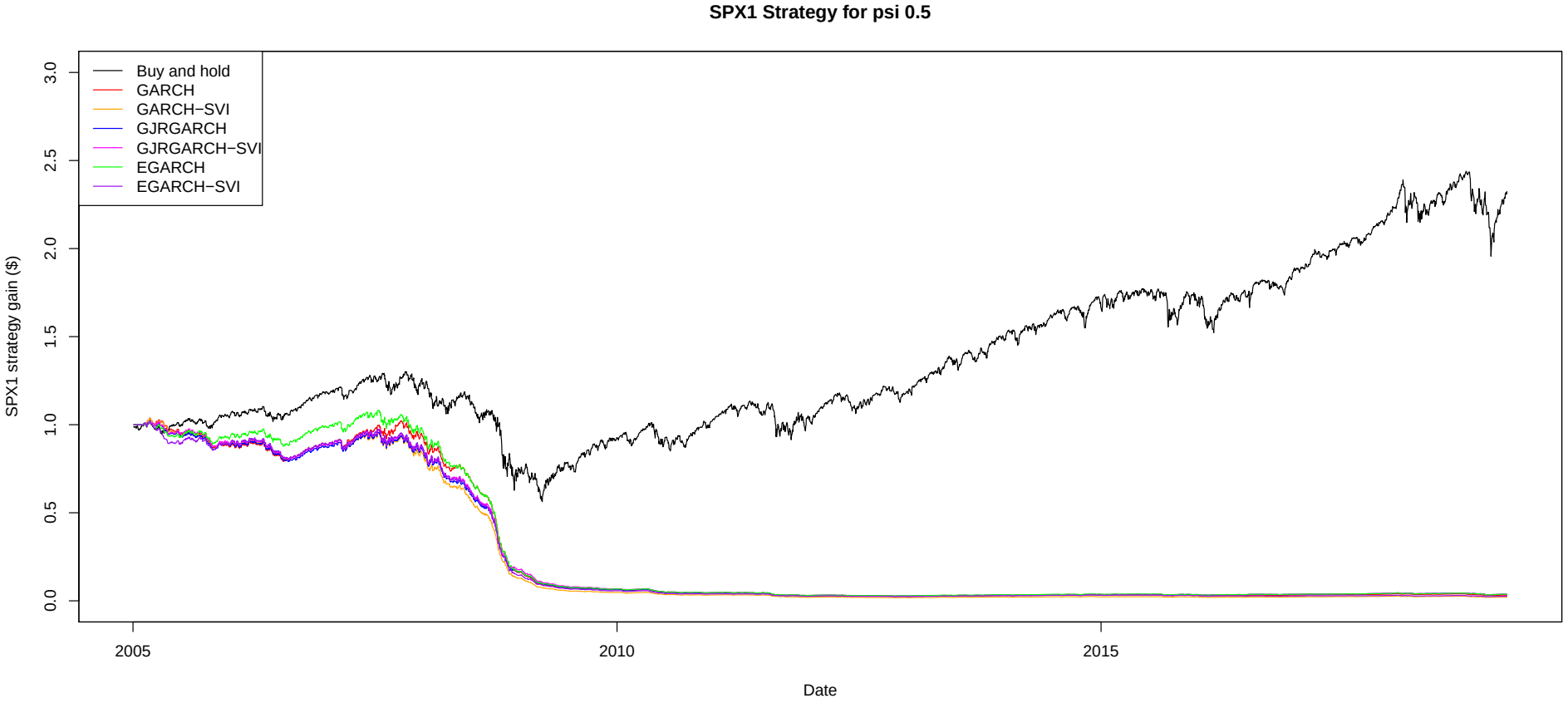


Figure 3: Cumulative Returns of an Agent Investing as per Strategies with the SPX for $\psi = 0.5$

This graph shows $\mathcal{R}_{j,t}^{SPX_1}$ for the out-of-sample period - *i.e.*: for $t$ in between 01/01/2005 and 13/03/2019. It clearly suggests that a cumulative Buy-and-Hold strategy is most beneficial.

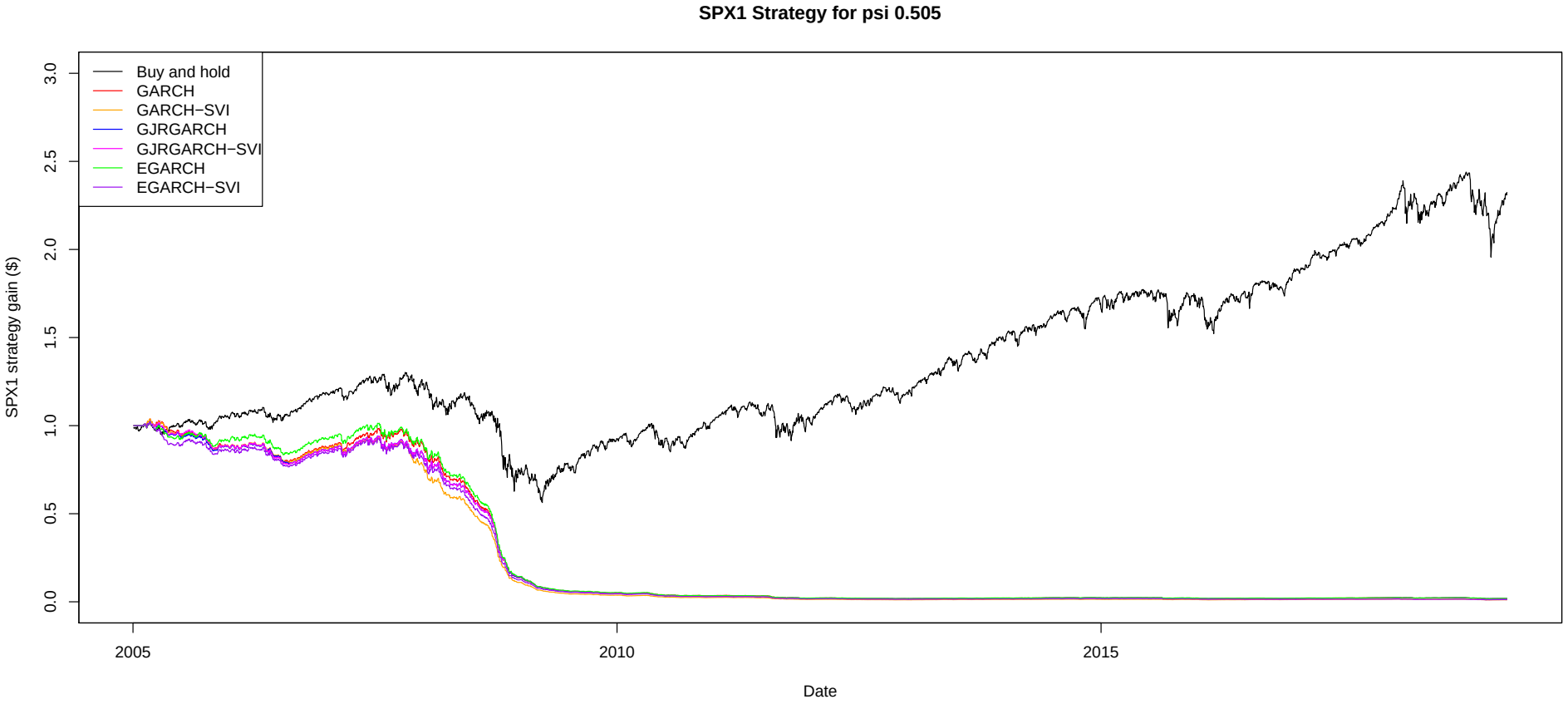


Figure 4: Cumulative Returns of an Agent Investing as per Strategies with the SPX for $\psi = 0.505$

This graph shows $\mathcal{R}_{j,t}^{SPX_1}$ for the out-of-sample period - *i.e.*: for $t$ in between 01/01/2005 and 13/03/2019. It clearly suggests that a cumulative Buy-and-Hold strategy is most beneficial.

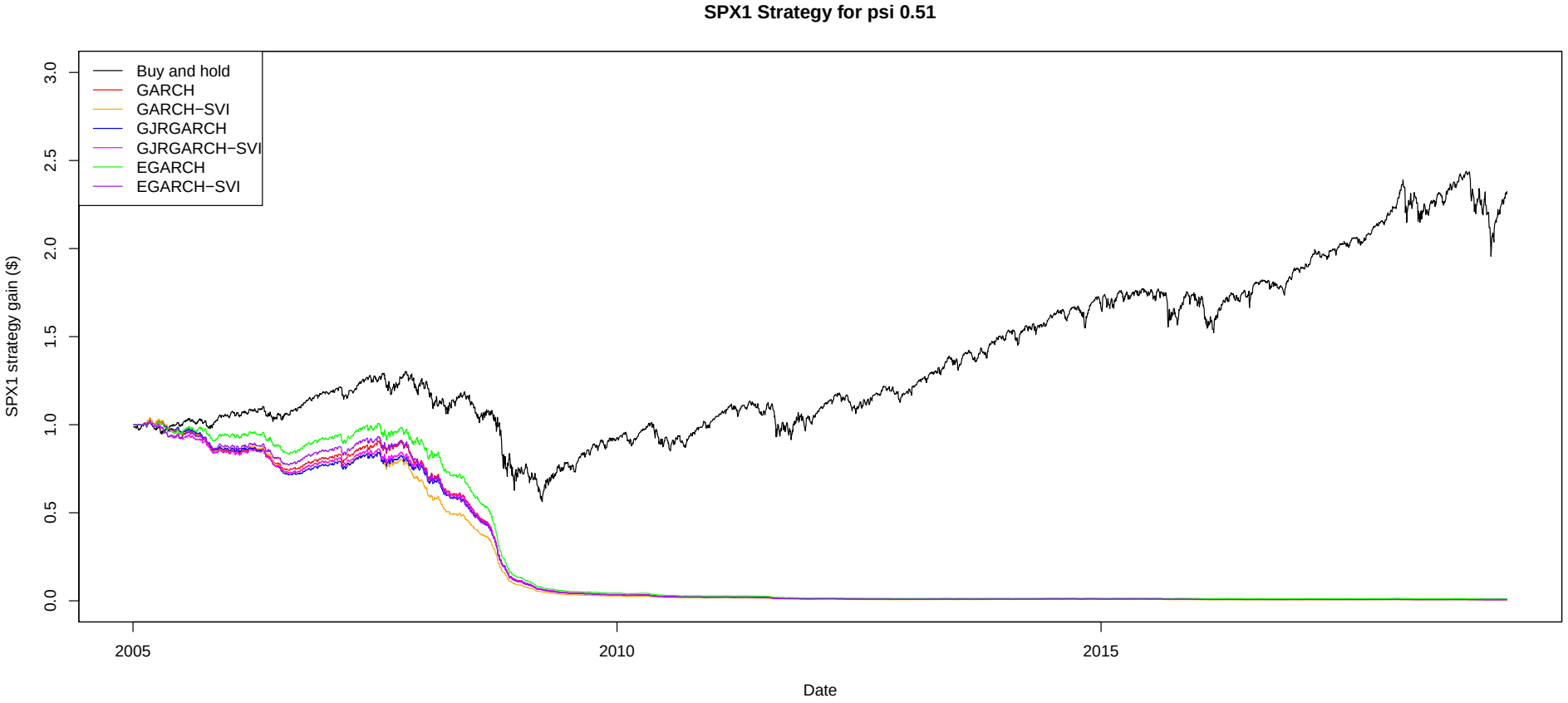


Figure 5: Cumulative Returns of an Agent Investing as per Strategies with the SPX for $\psi = 0.51$

This graph shows $\mathcal{R}_{j,t}^{SPX_1}$ for the out-of-sample period - *i.e.*: for $t$ in between 01/01/2005 and 13/03/2019. It clearly suggests that a cumulative Buy-and-Hold strategy is most beneficial.

Table 3: $\text{SPX}_{\text{CPV}}$ In-Sample Regression Coefficients

| Model | AR Model Coefficients | | | Variance Model Coefficients | | | | |
|---|---|---|---|---|---|---|---|---|
| | $C$ | $\phi_1$ | $\phi_2$ | $c$ | $\alpha$ | $\beta$ | $\gamma$ | $\delta$ |
| GARCH | 0.000407 | 0.007451 | | $2.672989\text{x}10^{-08}$ | 0.000044 | 0.998944 | | |
| | (0.000445) | (0.063518) | | (0.000001) | (0.000819) | (0.000870) | | |
| | [0.36105] | [0.90662] | | [0.96595] | [0.95730] | [0.00000] | | |
| GARCH-SVI$^{\text{SPX}_{\text{CPV}}}$ | 0.000384 | 0.00999 | 0.00004 | 0.00000 | 0.000103 | 0.999683 | | 0.00000 |
| | (0.000451) | (0.06431) | (0.000054) | (0.000001) | (0.000025) | (0.000029) | | (0.000001) |
| | [0.39539] | [0.87655] | [0.46534] | [1.00000] | [0.00004] | [0.00000] | | [0.9813] |
| GJRGARCH | 0.000317 | -0.007488 | | 0.000004 | $6.371049\text{x}10^{-10}$ | 0.885774 | 0.066545 | |
| | (0.000442) | (0.064021) | | (0.000000) | (0.013990) | (0.017150) | (0.046984) | |
| | [0.47272] | [0.90690] | | [0.00000] | [1.00000] | [0.00000] | [0.15667] | |
| GJRGARCH-SVI$^{\text{SPX}_{\text{CPV}}}$ | 0.000277 | -0.005637 | 0.000032 | 0.000002 | 0.000042 | 0.931814 | 0.058354 | 0.00000 |
| | (0.00044) | (0.063602) | (0.000054) | (0.000002) | (0.009747) | (0.004924) | (0.032944) | (0.00000) |
| | [0.528576] | [0.929376] | [0.5512] | [0.287679] | [0.996566] | [0.00000] | [0.076509] | [0.00000] |
| EGARCH | 0.000267 | -0.000534 | | -4.436117 | -0.305879 | 0.555263 | -0.276841 | |
| | (0.000443) | (0.051882) | | (0.140141) | (0.046682) | (0.014156) | (0.090104) | |
| | [0.546929] | [0.991785] | | [0.000000] | [0.000000] | [0.000000] | [0.002123] | |
| EGARCH-SVI$^{\text{SPX}_{\text{CPV}}}$ | 0.000262 | 0.008484 | 0.00003 | -4.388953 | -0.308007 | 0.560063 | -0.277695 | -0.000068 |
| | (0.000451) | (0.029618) | (0.000056) | (0.039679) | (0.0624) | (0.003765) | (0.103796) | (0.010271) |
| | [0.561093] | [0.774527] | [0.596947] | [0.00000] | [0.000001] | [0.00000] | [0.007464] | [0.994692] |

This tables shows coefficients estimated from models outlined in the dissertation under which are displayed their standard errors and p-values in brackets and square brackets respectively. Statistical-significance of the non-bracketed values (*i.e.* the coefficients) are to the CL of the difference between their attached square-bracketed values and one.Significant figures differ as per their origin in the R code.

Table 4: $\text{SPX}_{\text{CPV}}$ Out-of-CPV-Sample Regression Coefficients

| Model | AR Model Coefficients | | | Variance Model Coefficients | | | | |
|---|---|---|---|---|---|---|---|---|
| | $C$ | $\phi_1$ | $\phi_2$ | $c$ | $\alpha$ | $\beta$ | $\gamma$ | $\delta$ |
| GARCH | 0.000576 | -0.058178 | | 0.000002 | 0.107079 | 0.86976 | | |
| | (0.000127) | (0.018835) | | (0.000001) | (0.010964) | (0.012269) | | |
| | [0.000005] | [0.00201] | | [0.01025] | [0.000000] | [0.000000] | | |
| GARCH-SVI$^{\text{SPX}_{\text{CPV}}}$ | 0.000578 | -0.057564 | -0.000015 | 0.000002 | 0.107065 | 0.869897 | | 0.000000 |
| | (0.000087) | (0.01754) | (0.000029) | (0.000001) | (0.011281) | (0.012114) | | (0.000000) |
| | [0.000000] | [0.001031] | [0.617863] | [0.033188] | [0.000000] | [0.000000] | | [0.000000] |
| GJRGARCH | 0.000251 | -0.056098 | | 0.000002 | 0.000000 | 0.885186 | 0.178236 | |
| | (0.000114) | (0.018418) | | (0.000000) | (0.003675) | (0.007808) | (0.013578) | |
| | [0.027615] | [0.00232] | | [0.000000] | [0.999971] | [0.000000] | [0.000000] | |
| GJRGARCH-SVI$^{\text{SPX}_{\text{CPV}}}$ | 0.000279 | -0.054135 | -0.000042 | 0.000002 | 0 (0.011415) | 0.884319 | 0.18127 | 0.000000 |
| | (0.000038) | (0.018431) | (0.000027) | (0.000001) | [0.999997] | (0.012745) | (0.025751) | (0.000000) |
| | [0.000000] | [0.003313] | [0.120634] | [0.06902] | | [0.000000] | [0.000000] | [0.000000] |
| EGARCH | 0.000249 | -0.058445 | | -0.216729 | -0.146819 | 0.976623 | 0.125034 | |
| | (0.0001) | (0.018324) | | (0.002598) | (0.008819) | (0.000037) | (0.005885) | |
| | [0.012897] | [0.001425] | | [0.000000] | [0.000000] | [0.000000] | [0.000000] | |
| EGARCH-SVI$^{\text{SPX}_{\text{CPV}}}$ | 0.000268 | -0.058522 | -0.000042 | -0.236693 | -0.148078 | 0.97508 | 0.133889 | 0.005867 |
| | (0.000092) | (0.011508) | (0.000008) | (0.003009) | (0.007142) | (0.000123) | (0.009203) | (0.002042) |
| | [0.003655] | [0.000000] | [0.000000] | [0.000000] | [0.000000] | [0.000000] | [0.000000] | [0.004059] |

This tables shows coefficients estimated from models outlined in the dissertation under which are displayed their standard errors and p-values in brackets and square brackets respectively. Statistical-significance of the non-bracketed values (*i.e.* the coefficients) are to the CL of the difference between their attached square-bracketed values and one.Significant figures differ as per their origin in the R code.

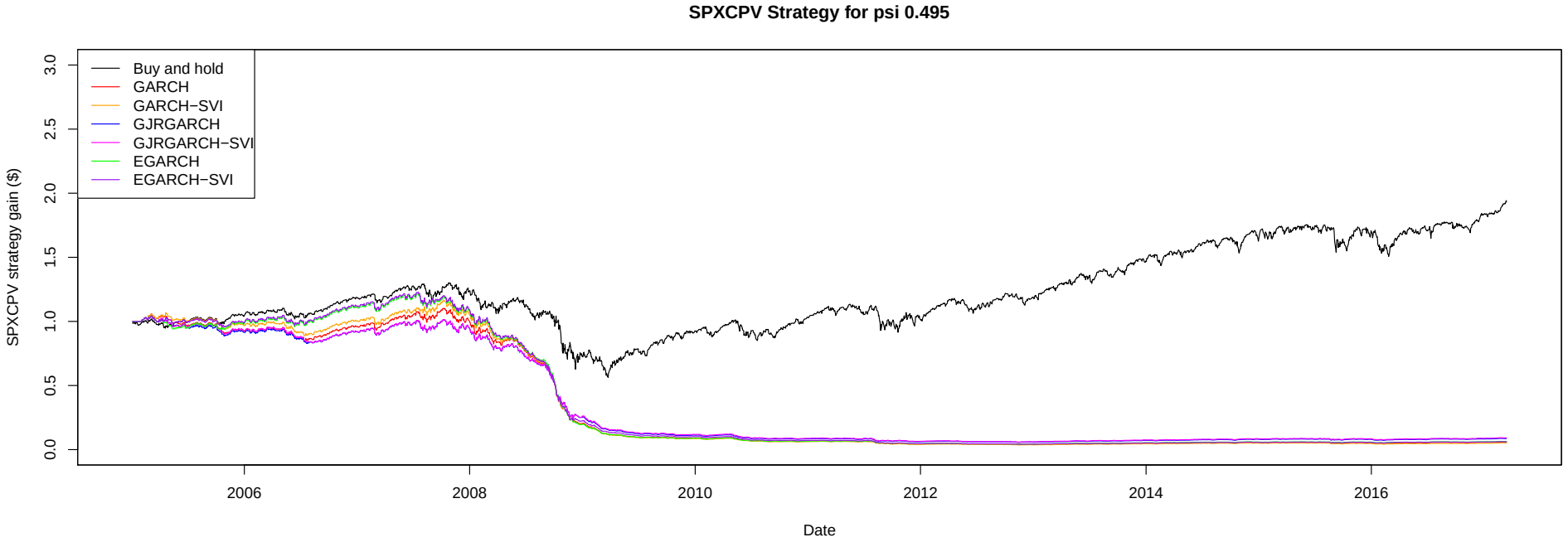


Figure 6: Cumulative Returns of an Agent Investing as per Strategies with the SPX as per the $\Delta SVI_{CPV}$ data over the out-of-CPV-sample for $\psi = 0.49$

This graph shows $\mathcal{R}_{j,t}^{SPX_{CPV}}$ for the out-of-CPV-sample period.

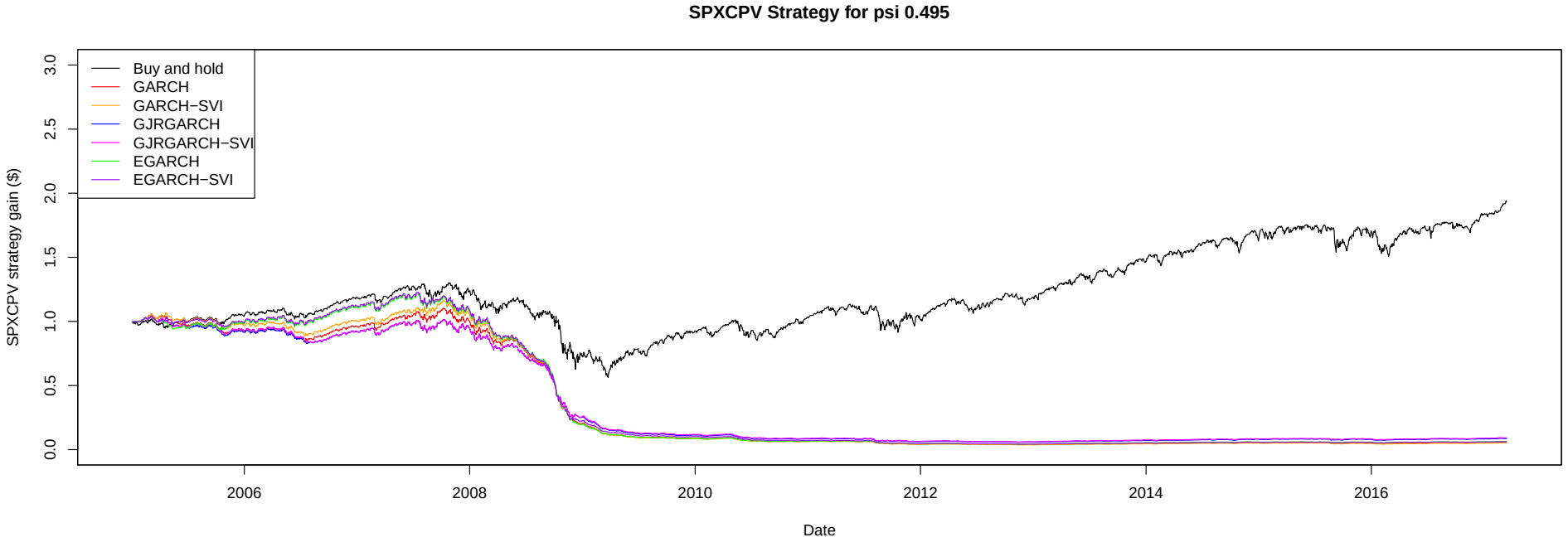


Figure 7: Cumulative Returns of an Agent Investing as per Strategies with the SPX SPX as per the $\Delta SVI_{CPV}$ data over the out-of-CPV-sample for $\psi = 0.495$

This graph shows $\mathcal{R}_{j,t}^{SPX_{CPV}}$ for the out-of-CPV-sample period.

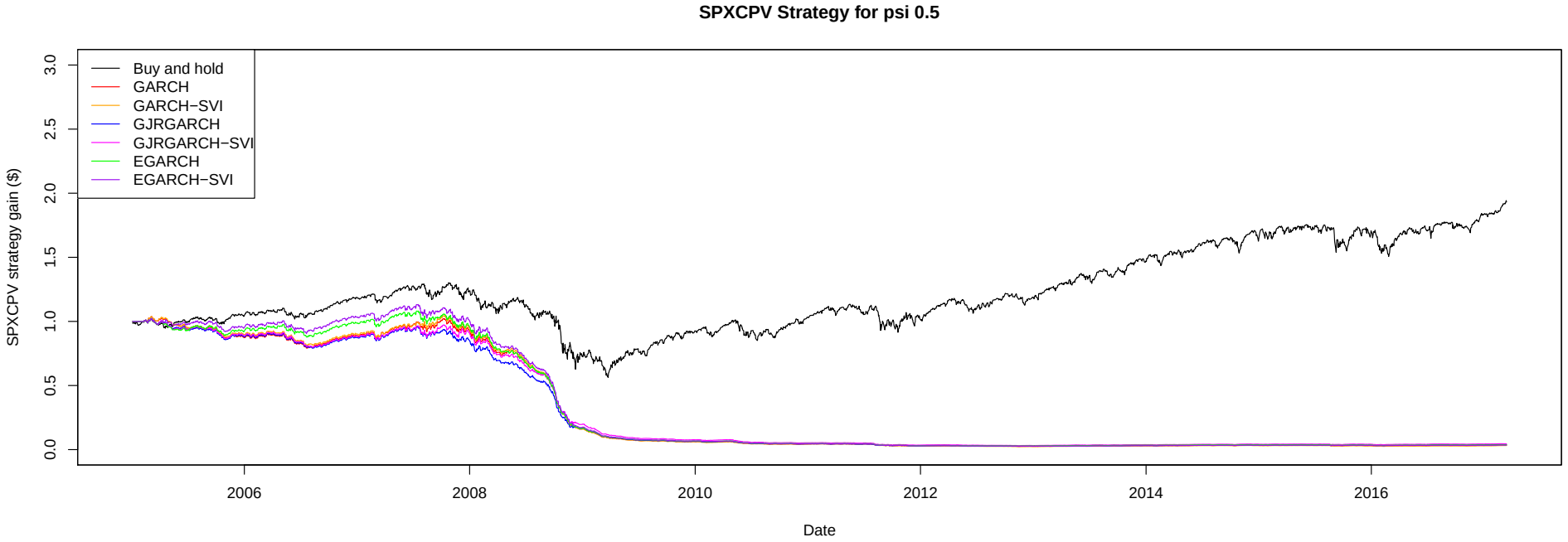


Figure 8: Cumulative Returns of an Agent Investing as per Strategies with the SPX as per the $\Delta SVI_{CPV}$ data over the out-of-CPV-sample for $\psi = 0.5$

This graph shows $\mathcal{R}_{j,t}^{SPX_{CPV}}$ for the out-of-CPV-sample period.

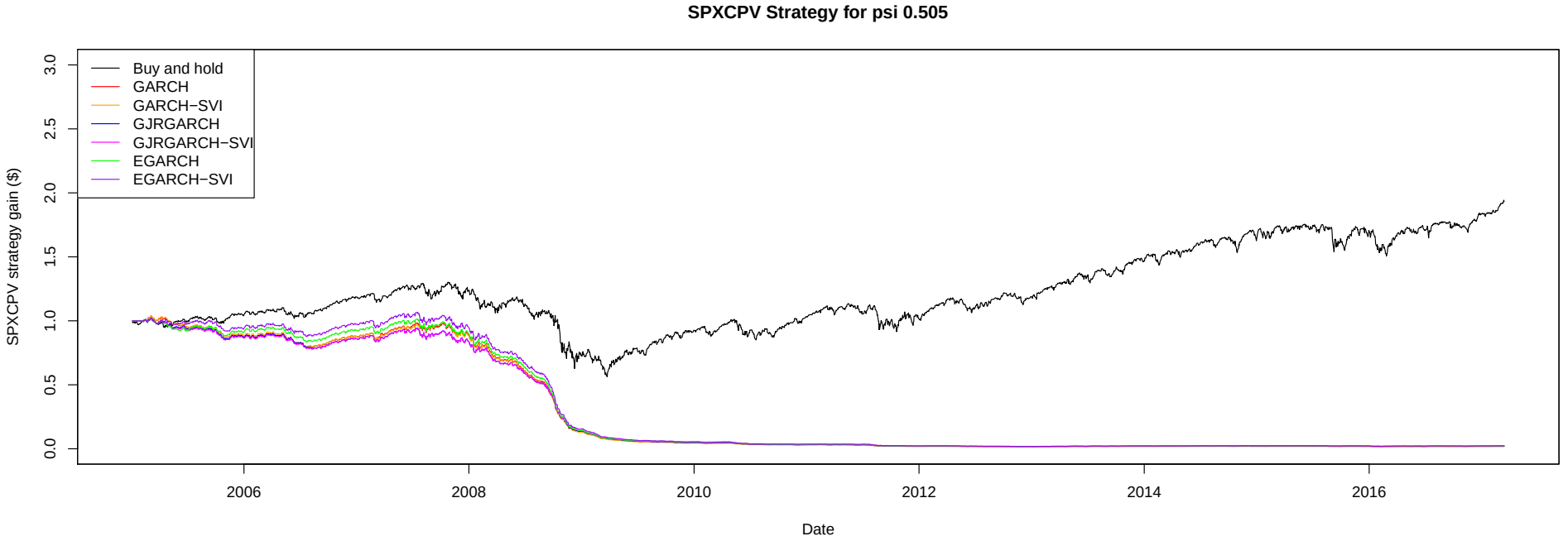


Figure 9: Cumulative Returns of an Agent Investing as per Strategies with the SPX as per the $\Delta SVI_{CPV}$ data over the out-of-CPV-sample for $\psi = 0.505$

This graph shows $\mathcal{R}_{j,t}^{SPX_{CPV}}$ for the out-of-sample period.

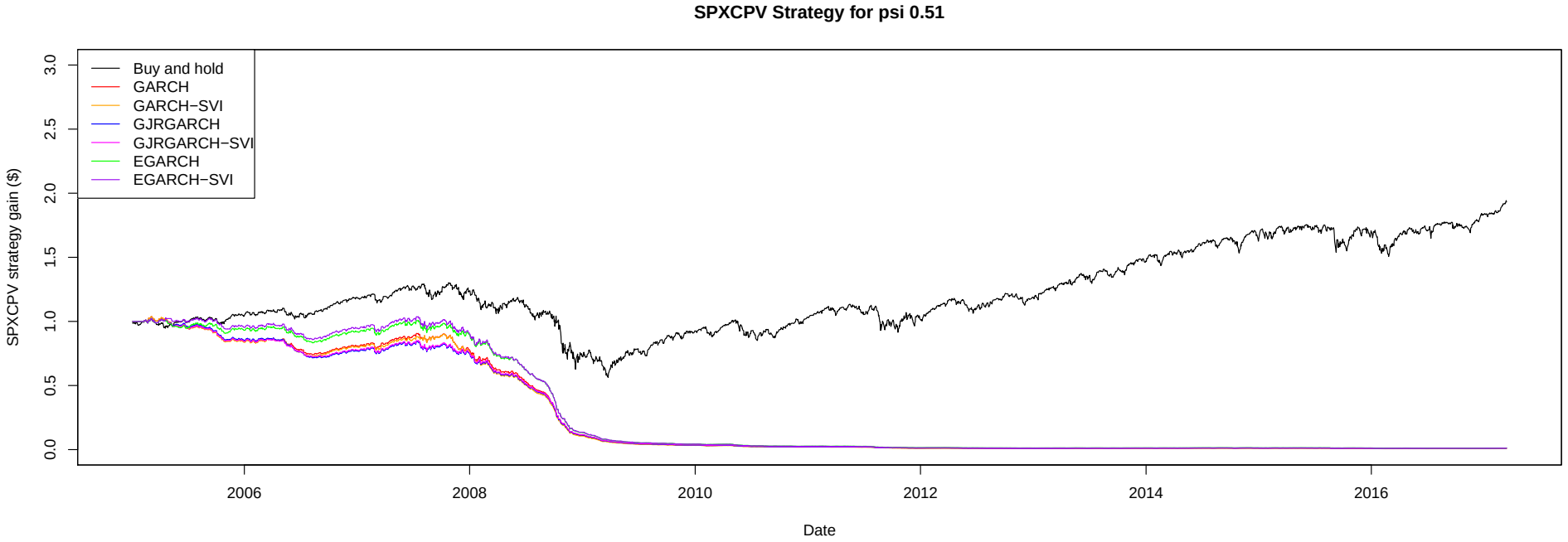


Figure 10: Cumulative Returns of an Agent Investing as per Strategies with the SPX as per the $\Delta SVI_{CPV}$ data over the out-of-CPV-sample for $\psi = 0.51$

This graph shows $\mathcal{R}_{j,t}^{SPX_{CPV}}$ for the out-of-CPV-sample period.

Table 5: SPX Out-of-Sample Recursive Variance Forecast (using $\Delta SVI^{SPX_{CPV}}$) Error Statistics

| $\hat{\sigma}_{t\|t-1}$ Model | Mean | Standard Deviation | RMSE | DM |
|---|---|---|---|---|
| GARCH | 0.001602547 | 0.004116072 | 0.004416406 | -13.51 |
| GARCH-SVI$^{\text{SPX}_{\text{CPV}}}$ | 0.0016737 | 0.004129915 | 0.004455542 | [2.2x10$^{-16}$] |
| GJRGARCH | 0.001437398 | 0.003692315 | 0.00396167 | -11.929 |
| GJRGARCH-SVI$^{\text{SPX}_{\text{CPV}}}$ | 0.001515589 | 0.003714896 | 0.0040116 | [2.2x10$^{-16}$] |
| EGARCH | 0.001164601 | 0.003584217 | 0.003768115 | -2.2602 |
| EGARCH-SVI$^{\text{SPX}_{\text{CPV}}}$ | 0.001465401 | 0.004769846 | 0.004989125 | [0.01194] |

Under DM test statistics are located their p-values in squared brackets; their alternative hypothesis is that the SVI-implementing model is less accurate than the SVI-free one. Significant figures differ as per their origin in the R code.

Table 6: SPX Out-of-Sample Positive Excess Return Probability Forecast (using $\Delta SVI_{CPV}$) Error Statistics

| $\hat{\sigma}_{t\|t-1}$ and $\hat{\mu}_{t\|t-1}$ Model | Mean | Standard Deviation | Brier Score | DM |
|---|---|---|---|---|
| GARCH | 0.008349835 | 0.4990836 | 0.2490721 | -0.86718 |
| GARCH-SVI$^{\text{SPX}_{\text{CPV}}}$ | 0.006548647 | 0.4991179 | 0.2490792 | [0.807] |
| GJRGARCH | 0.001995008 | 0.4988365 | 0.2487602 | -2.1296 |
| GJRGARCH-SVI$^{\text{SPX}_{\text{CPV}}}$ | 0.003271621 | 0.4989303 | 0.2488605 | [0.9834] |
| EGARCH | 0.002367203 | 0.4988579 | 0.2487831 | -1.3117 |
| EGARCH-SVI$^{\text{SPX}_{\text{CPV}}}$ | 0.001883716 | 0.4990035 | 0.2489263 | [0.9051] |

Under the DM test statistics are located their p-values in squared brackets; their alternative hypothesis is that the SVI-implementing model is more accurate than the SVI-free one. Significant figures differ as per their origin in the R code.

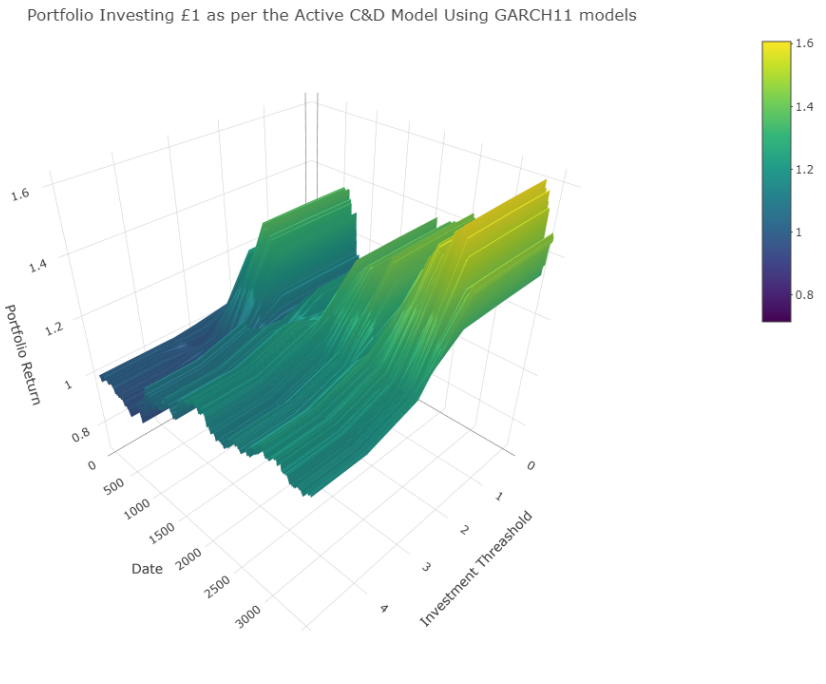


Figure 11: Cumulative Returns of Active Investment Strategy Following the C&D$_{\text{GARCH}}$ strategy for $0 \leq \psi \geq 1$

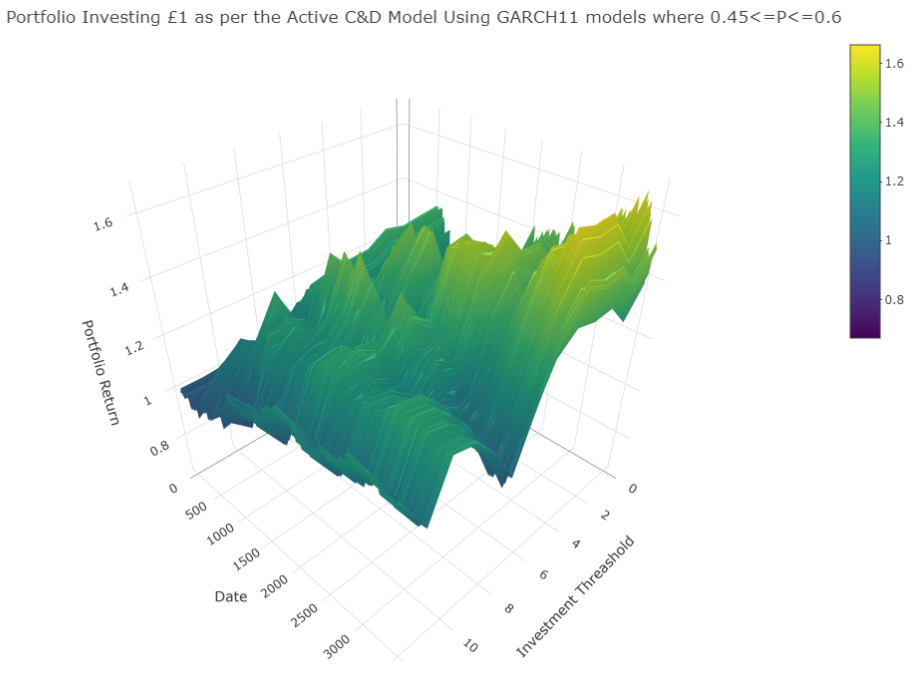


Figure 12: Cumulative Returns of Active Investment Strategy Following the C&D$_{\text{GARCH}}$ strategy for $0.45 \leq \psi \geq 0.6$

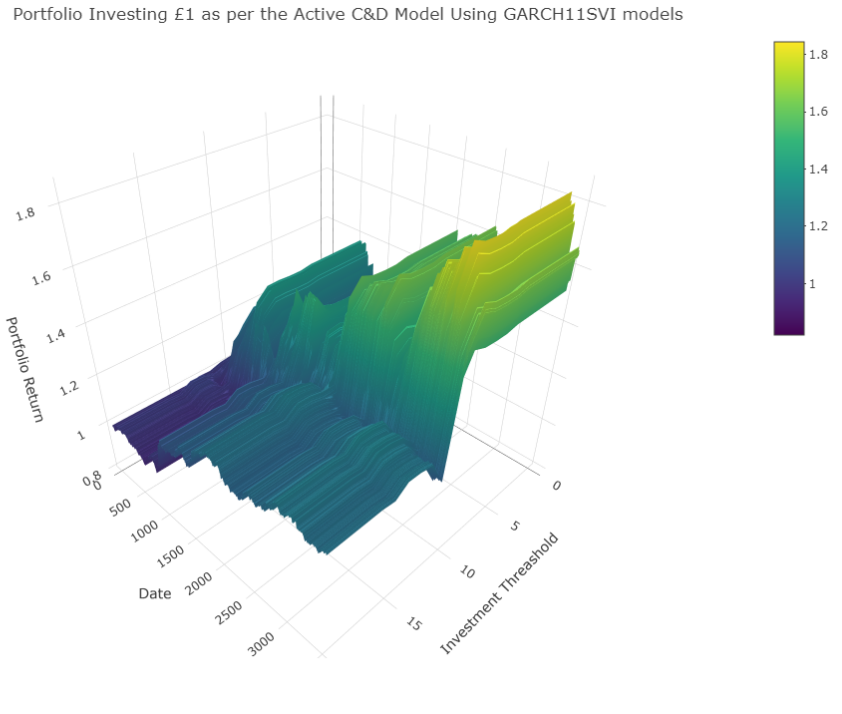


Figure 13: Cumulative Returns of Active Investment Strategy Following the C&D$_{\text{GARCHSVI}}$ strategy for $0 \leq \psi \geq 1$

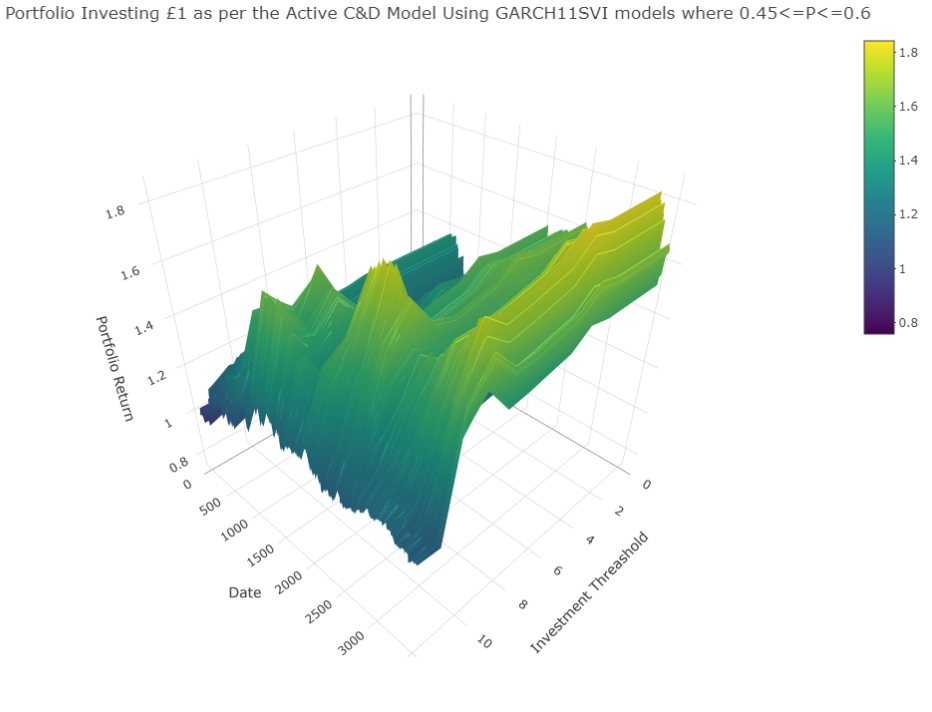


Figure 14: Cumulative Returns of Active Investment Strategy Following the C&D$_{\text{GARCHSVI}}$ strategy for $0.45 \leq \psi \geq 0.6$

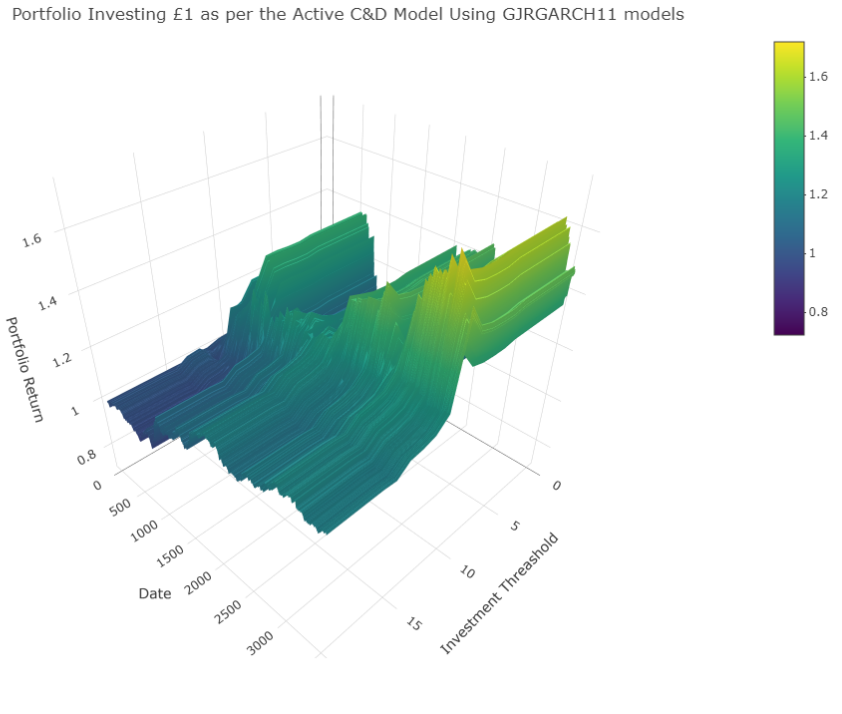


Figure 15: Cumulative Returns of Active Investment Strategy Following the C&D$_{\text{GJRGARCH}}$ strategy for $0 \leq \psi \geq 1$

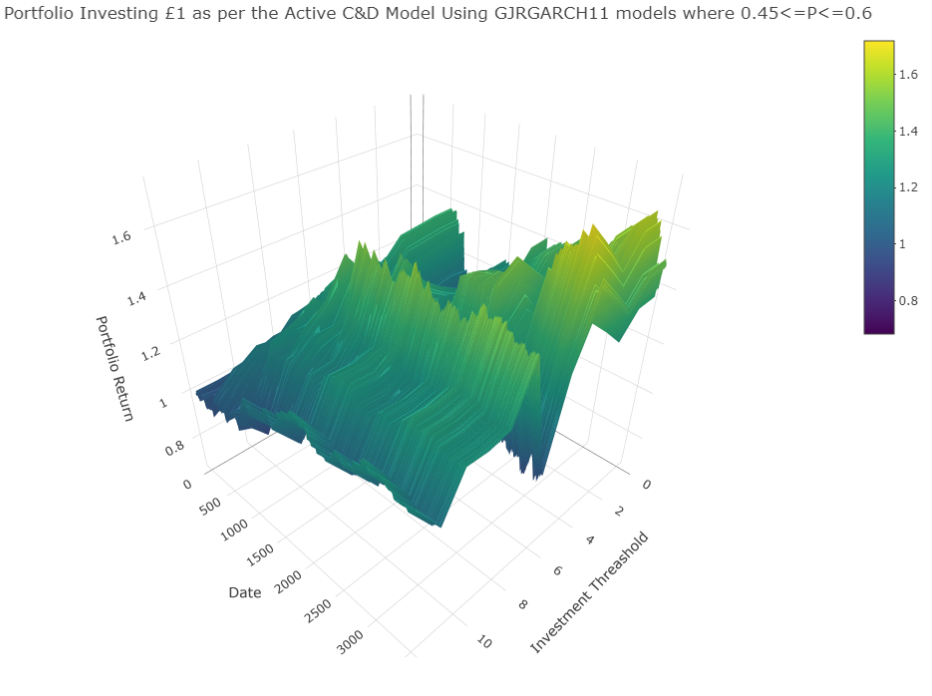


Figure 16: Cumulative Returns of Active Investment Strategy Following the C&D$_{\text{GJRGARCH}}$ strategy for $0.45 \leq \psi \geq 0.6$

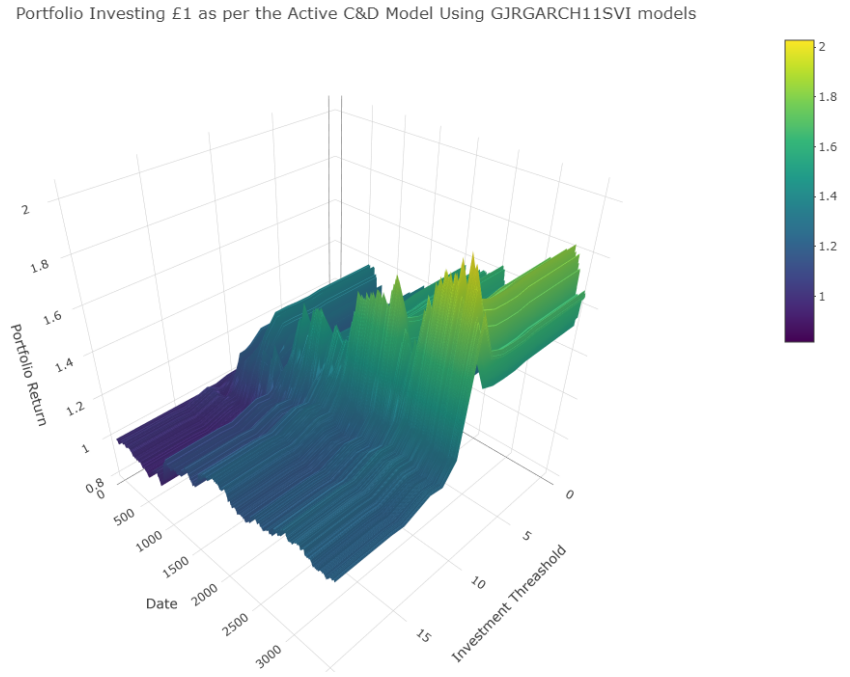


Figure 17: Cumulative Returns of Active Investment Strategy Following the C&D$_{\text{GJRGARCHSVI}}$ strategy for $0 \leq \psi \geq 1$

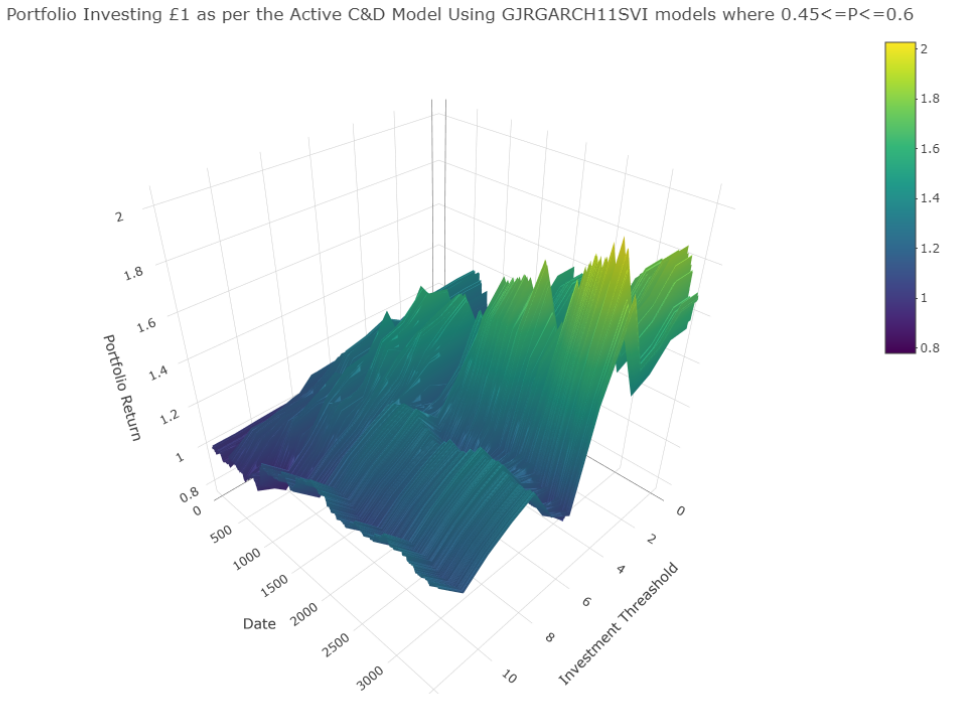


Figure 18: Cumulative Returns of Active Investment Strategy Following the C&D$_{\text{GJRGARCHSVI}}$ strategy for $0.45 \leq \psi \geq 0.6$

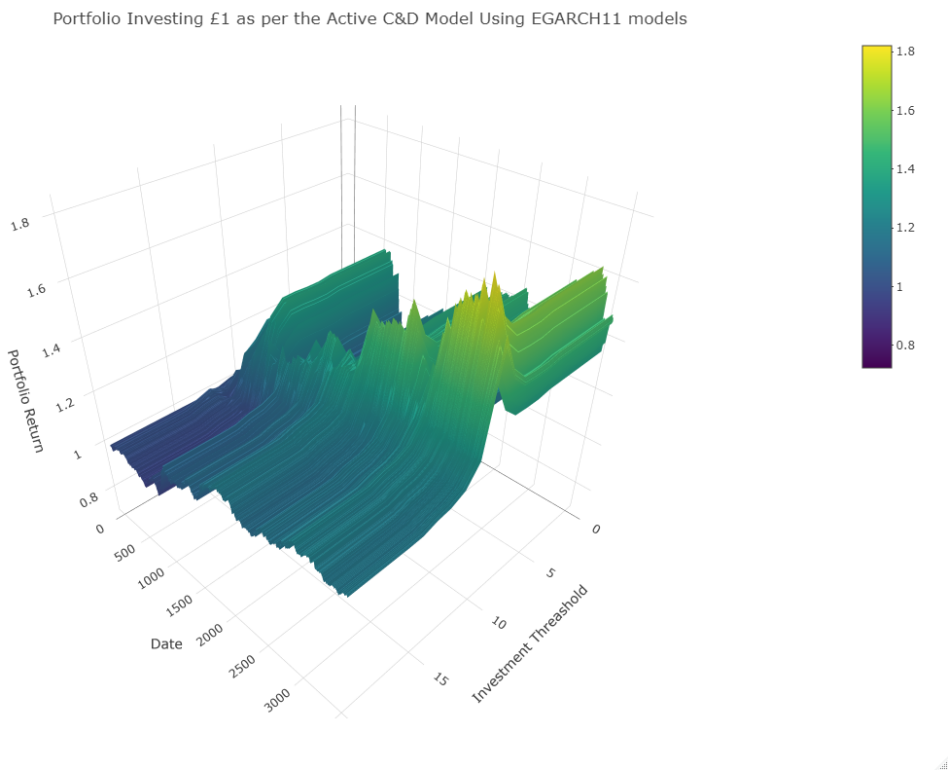


Figure 19: Cumulative Returns of Active Investment Strategy Following the C&D$_{\text{EGARCH}}$ strategy for $0 \leq \psi \geq 1$

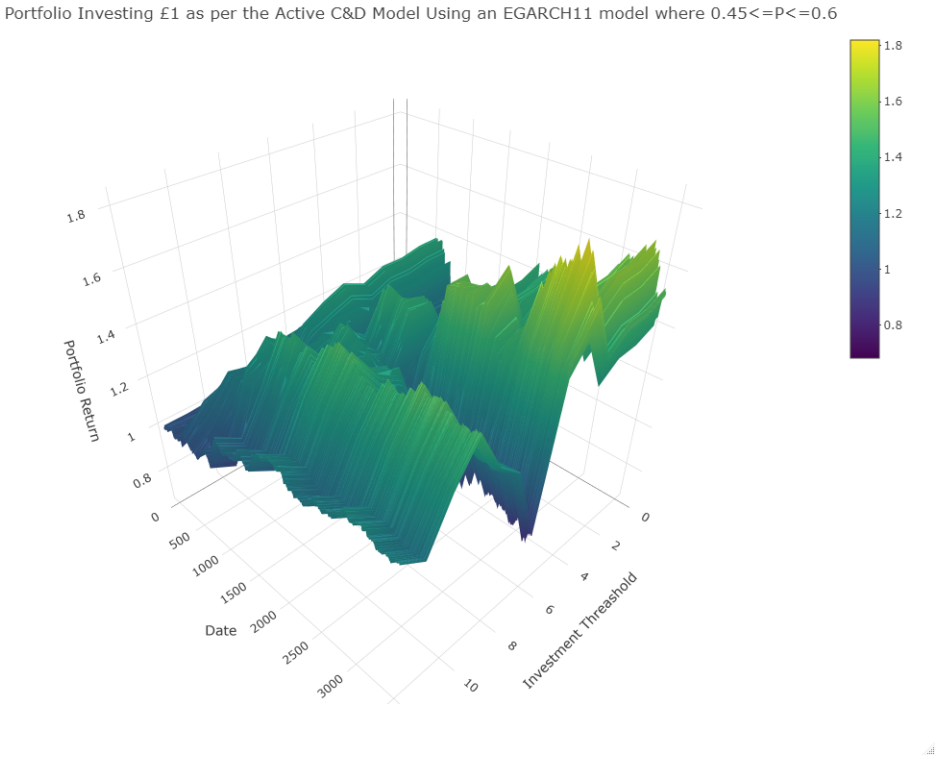


Figure 20: Cumulative Returns of Active Investment Strategy Following the C&D$_{\text{EGARCH}}$ strategy for $0.45 \leq \psi \geq 0.6$

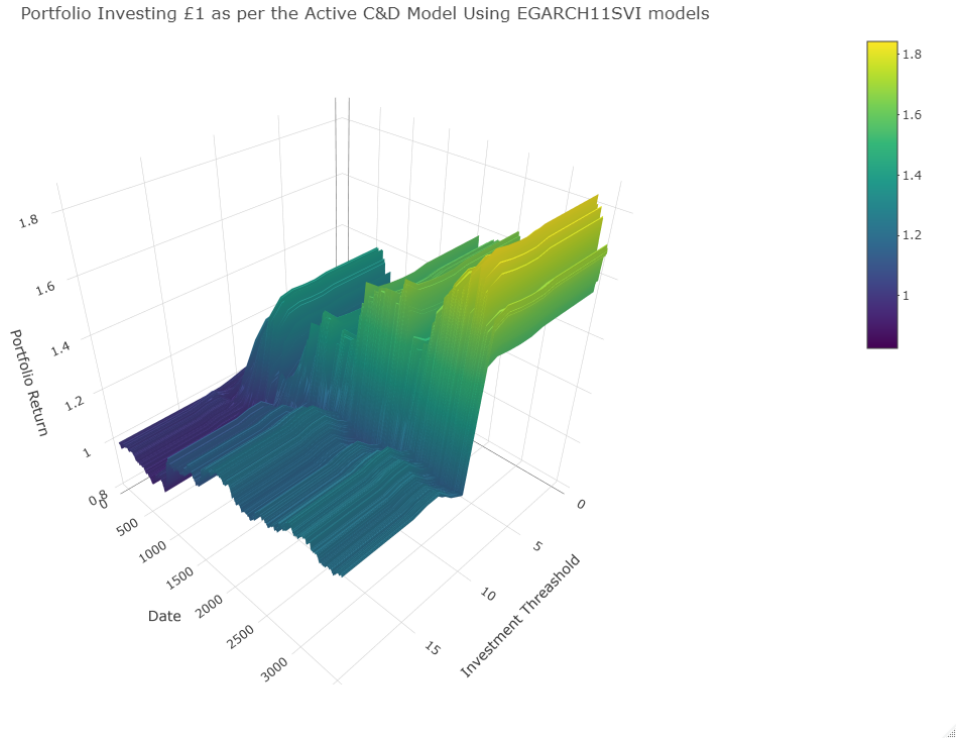


Figure 21: Cumulative Returns of Active Investment Strategy Following the C&D$_{\text{EGARCHSVI}}$ strategy for $0 \leq \psi \geq 1$

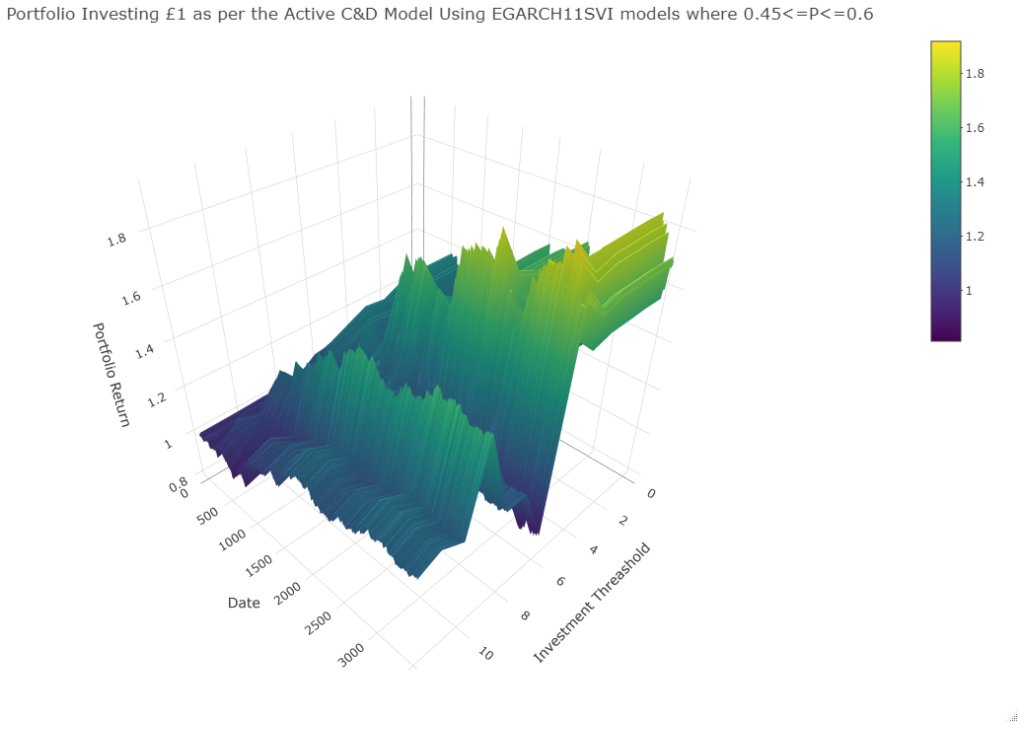


Figure 22: Cumulative Returns of Active Investment Strategy Following the C&D$_{\text{EGARCHSVI}}$ strategy for $0.45 \leq \psi \geq 0.6$